

# CLIMATE RISKS IN FOOD FOR PEACE GEOGRAPHIES

## ETHIOPIA

### DOCUMENT OVERVIEW

Food security is essential for advancing sustainable development, strengthening resilience, improving nutrition, and reducing the need for humanitarian assistance in Ethiopia. This Climate Risk Profile assists the United States Agency for International Development (USAID)/Ethiopia Mission and Food for Peace (FFP) program to:

1. Better understand how climate change-related stressors threaten Ethiopia's food security, and
2. Identify potential measures that the USAID/Ethiopia Mission, FFP, implementing partners, and development assistance might undertake to prevent climate risks from exacerbating food insecurity in Ethiopia.

This document consists of four main sections:

- **Country Overview**, which provides context on food insecurity in Ethiopia, and the major climate-related stressors that have historically threatened and are projected to continue to threaten food security.
- **Climate Summary**, which describes recent trends and projected changes in climate by mid-century.
- **Livelihoods and Climate in Food for Peace Program Areas**, which describes FFP programming in Ethiopia, as well as Ethiopia's livelihoods within FFP target geographies.
- **Sector Impacts and Vulnerabilities**, which describes the major climate-related risks facing key sectors that impact food security and potential adaptation response to address these risks:
  - Agriculture
    - Crop Production
    - Livestock and Pastoralism
    - Invasive Species
    - Pesticide Use and Storage
    - Food Processing and Storage
  - Human Health: Nutrition, Water Supply, Sanitation, and Hygiene (WASH), and Health Services
  - Sensitive Ecosystems and Ecosystem Services

### February 2020

This document was prepared under Environmental Compliance Support (ECOS) Task Order No. DCHA-007 and is meant to provide a brief overview of climate risk issues. The key resources at the end of the document provide more in-depth country and sectoral analysis. The contents of this report do not necessarily reflect the views of USAID.

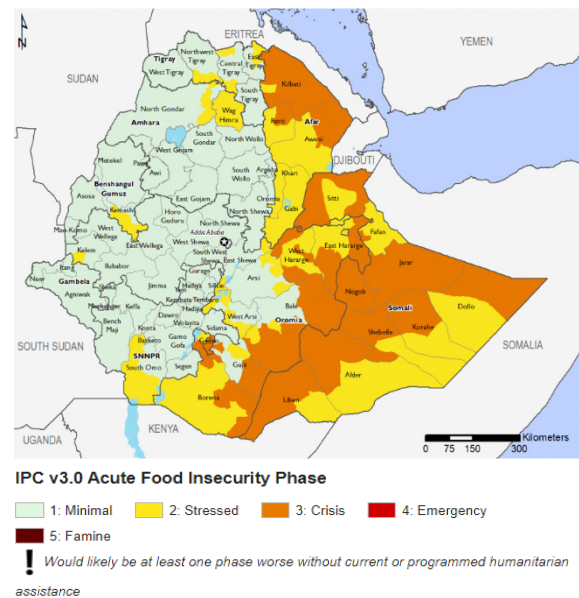
## COUNTRY OVERVIEW

Chronic food insecurity affects 10 percent of Ethiopia's population, and rates typically rise higher during drought years. (1) Children are especially affected; in 2019, 37 percent of children under age 5 were stunted and 12 percent were severely stunted. (2, 3)

Ethiopia faces multiple challenges that exacerbate food insecurity, such as conflicts over natural resources, poverty, high food prices, lack of access to basic services and sanitation, rapid population growth that has created a youth bulge, and a lack of employment opportunities. (1, 2, 4) In particular, in 2018, conflict resulted in extensive displacement, which has disrupted livelihoods and created food security challenges. (5, 6)

Even when conflict does not disrupt livelihoods, crop production—99 percent of which is rainfed—and pastoralism are hindered by desertification and drought. (1) Currently, Ethiopia is experiencing its second severe drought in less than two years; poor 2019 spring rains affected long-cycle crops, while the 2015–2017 drought created catastrophic livestock losses and crop failures throughout the country (Figure 1). (4, 5, 6, 7, 8)

Projected changes in climate have the potential to further aggravate food insecurity. Through mid-century, droughts are projected to become more frequent and more intense, stressing crop production and livestock rearing. (1) Warmer temperatures and more frequent and intense floods and rain-driven landslides may also harm crops, livestock, and post-harvest processes. (1) Climate change may decrease national gross domestic product by 8–10 percent by 2050; however, adaptation action for agriculture could cut losses related to climate shock in half. (9) The combination of more frequent and intense drought and warmer temperatures may also accelerate desertification, limiting the availability of arable land and pasture, and driving conflict. In addition, more frequent and intense extreme rains may damage and disrupt health services and water supply, sanitation, and hygiene (WASH) infrastructure and services, exacerbating malnutrition and poor health.



FEWS NET classification is IPC-compatible. IPC-compatible analysis follows key IPC protocols but does not necessarily reflect the consensus of national food security partners.

**Figure 1. IPC Acute Food Insecurity Phase for Ethiopia, October 2019 – January 2020. Source: FEWS NET 2019**

## CLIMATE STRESSORS AND PROJECTIONS



Hotter and longer heatwaves; 1°C–2°C increase in average annual temperatures by 2050



Projected increase in extreme rain and flood frequency and intensity



Projected increase in frequency and intensity of drought, and accelerated desertification

## KEY CLIMATE IMPACTS

### Agriculture



Extreme rains damaging crops, livestock, and infrastructure  
Drought harming crops and livestock  
Desertification limiting the availability of agricultural land

### Human Health: Nutrition, WASH, and Health Services



Reduced nutrition  
Reduced availability of clean drinking water  
Increased risk of vector- and waterborne diseases  
Reduced ease of accessing health services

## CLIMATE SUMMARY

Ethiopia's topography creates large regional differences in climate. In general, the lower lying areas are hotter and drier, while the higher elevations are cooler and wetter. (10) The arid lowlands in the southeast and northeast have average annual temperatures of 25°C–30°C and are exposed to high temperatures and prolonged droughts. The central and northern highlands—which encompass the FFP target geographies—have average annual temperatures of 15°C–20°C and are more prone to intense precipitation with high seasonal variability. (1)

Ethiopia is considered an arid country and experiences high interannual variability in its precipitation. (1) The country also experiences high spatial variability in precipitation, with western parts of the country generally experiencing more precipitation than the eastern parts, as shown in Figure 3. (10) The FFP target geographies largely fall in the middle of the country's extremes, receiving 400–1,300 millimeters per year, on average (Figure 3). Seasonal precipitation patterns vary across the country. These patterns are made up of several types of rains, some of which occur only in certain parts of the country (see Figure 3) (1, 10):

- *Kremt* or *Kiremt* (June–October), which occurs throughout the country except in the southeast. The season is longest in the southwest and shortest in the northeast, and accounts for 50–80 percent of annual precipitation totals.

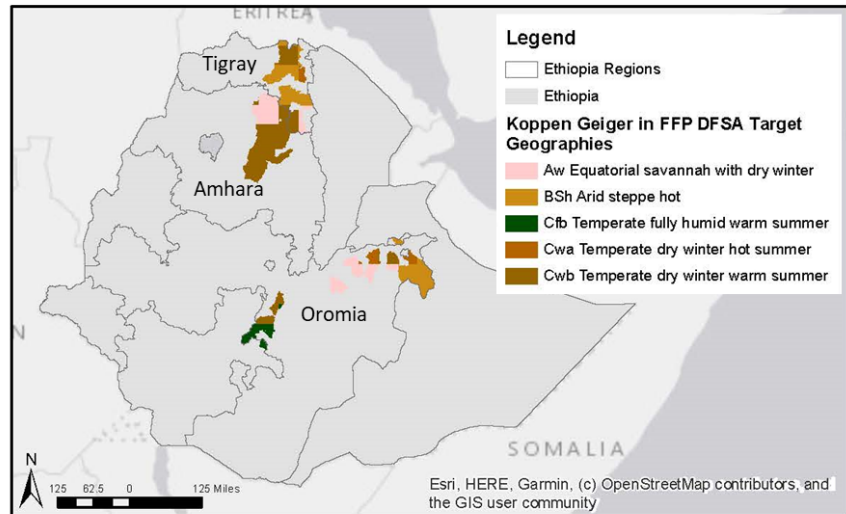


Figure 2. Köppen-Geiger climate classifications in FFP target geographies. Source: USAID and Rubel et al. 2017

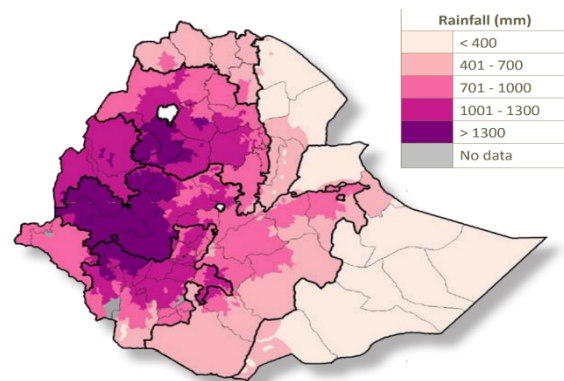


Figure 3. Average annual precipitation and administrative boundaries. Source: USAID and Government of Ethiopia Disaster Risk Management and Food Security Sector, MOARD 2016

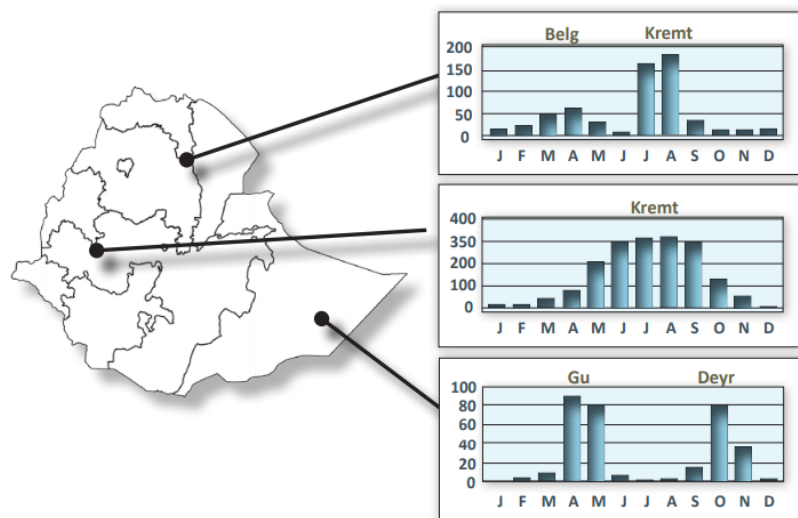


Figure 4. Ethiopia's three main precipitation patterns. Source: USAID and Government of Ethiopia Disaster Risk Management and Food Security Sector, MOARD 2016

- *Belg* (March–May), which typically occurs in the north and central portions of the country, as well as in the south. Together with *Kremt* rains, *Belg* rains create a bimodal precipitation pattern.
- *Gu* (April–May) and *Deyr* (October–November), which are the main rains for the pastoral south and southeast, and which create a bimodal precipitation pattern. They can be thought of as early and late *Kremt* rains.

The eastern parts of Ethiopia experience the most severe droughts, and experience seasonal-scale water shortages when *Kremt* arrives late. (1, 10, 11)

Since 1960, the average annual temperature in Ethiopia has increased by 1°C, with higher temperature increases from July through September. (1) Between 1960 and 2003, the average number of hot nights per year (the hottest 10 percent annually) increased by 38 percent, while the average number of hot days per year increased by 20 percent. (1) Regarding precipitation, for much of the country, it is difficult to determine long-term trends due to strong interannual and interdecadal variability in precipitation data. (12) However, since 1960, the south-central region of the country has experienced a 20 percent decrease in precipitation. (12) Since the 1960s, Ethiopia has also experienced more intense precipitation during storms, more frequent and intense droughts, and *Belg* season rains that are more unpredictable in timing. (1)

In Ethiopia, the average annual temperature is projected to increase by 1.4°C–1.8°C by mid-century.<sup>1</sup> The number of hot days (maximum temperature over 25°C) is projected to increase by 25–32 days, while the number of hot nights (maximum temperature over 20°C) is projected to increase by 37–55 days. Temperature increases in the FFP target geographies are projected to be similar to the countrywide values, although increases are expected to be slightly higher in the northern target geographies in Tigray and Amhara relative to those in Oromia.

The country is projected to continue to experience a high degree of interannual variability in precipitation. In addition, high degrees of uncertainty remain around projected changes in average annual precipitation. (13) Climate model ensemble averages indicate that mean annual precipitation is projected to rise by 2–5 percent by 2050 at the country level; projected changes are similar for the FFP target geographies.

In addition, both wet and dry extremes are projected to intensify. The amount of precipitation that falls during very wet days (heaviest 5 percent of precipitation events) is projected to increase by 15–27 percent by 2050, while the likelihood of a severe drought occurring is projected to increase by 8–9 percent by 2050. (13) In the northern FFP target geographies, average monthly precipitation is projected to increase most in July through October during the *Kremt* wet season, and precipitation during very wet days<sup>2</sup> is projected to increase the most during the height of the *Kremt* season in July and August. (13) In the southern FFP target geographies, average monthly precipitation and precipitation during very wet days are projected to increase most in October during the *Deyr* rainy season. (13) The likelihood of severe drought is projected to increase slightly more in the northern FFP target geographies relative to the southern FFP target geographies.

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<sup>1</sup> For all projections, the range reflects the projections for Representative Concentration Pathway (RCP) 4.5 and RCP 8.5 for the average of 32 Coupled Model Intercomparison Project Phase 5 (CMIP5) climate models. Projected change reflects the difference between the historical baseline (1986–2005) and mid-century (2040–2059). This scenario was used for all climate variables. Source: World Bank Climate Change Knowledge Portal

<sup>2</sup> The amount of precipitation received when the daily precipitation rate exceeds the local 95<sup>th</sup> percentile of daily precipitation.

Rising sea surface temperatures in the Indian Ocean influence the migration of the Intertropical Convergence Zone, which may further increase the variability in timing and duration of precipitation seasons and increase the frequency of drought. (12)

Table 1 summarizes the country-level current climate conditions and recent trends, as well as projected changes for mid-century.

*Table 1. Climate conditions and projections*

| Climate Parameter                                                                                                               | Current Conditions and Recent Trends (since the 1960s)                                                                                                                                                                                                                                                                                    | Projected Changes by 2050 <sup>3</sup>                                                                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Temperature</b><br>                         | <ul style="list-style-type: none"> <li>• Average annual temperature has increased by 1°C since 1960, with higher temperature increases from July through September</li> <li>• From 1960 to 2003, average number of hot nights per year increased by 38 percent and average number of hot days per year increased by 20 percent</li> </ul> | <ul style="list-style-type: none"> <li>• Increase in average annual temperature of 1.4°C–1.8°C</li> <li>• Increase in number of hot days by 25–32 days</li> <li>• Increase in number of hot nights by 37–55 days</li> </ul> |
| <b>Average Precipitation &amp; Drought</b><br> | <ul style="list-style-type: none"> <li>• 20 percent decrease in average annual precipitation in south-central region since the 1960s</li> <li>• More frequent and intense drought since the 1960s</li> </ul>                                                                                                                              | <ul style="list-style-type: none"> <li>• Increase in mean annual precipitation by 2–5 percent</li> <li>• Likelihood of severe drought projected to increase by 8–9 percent</li> </ul>                                       |
| <b>Extreme Events</b><br>                     | <ul style="list-style-type: none"> <li>• More intense precipitation during storms since the 1960s</li> <li>• <i>Belg</i> season rains have become more unpredictable since the 1960s</li> </ul>                                                                                                                                           | <ul style="list-style-type: none"> <li>• Very wet days (heaviest 5 percent of precipitation events) projected to become 15–27 percent wetter</li> </ul>                                                                     |

Sources: 1, 12, 13

<sup>3</sup> Ranges reflect projections for RCP 4.5 and RCP 8.5 for the average of all 32 CMIP5 climate models. Projected change reflects the difference between the historical baseline (1986–2005) and mid-century (2040–2059). Source: World Bank Climate Change Knowledge Portal

## LIVELIHOODS AND CLIMATE IN FOOD FOR PEACE PROGRAM AREAS

### FFP PROGRAMMING

USAID/FFP Ethiopia Development Food Security Activity (DFSA) aims to enable communities to strengthen local systems to manage shocks and improve food security and resilience, promote alternative livelihoods that may be less exposed to climate shocks than rainfed agriculture, and support and strengthen national safety net and humanitarian response systems that help mitigate and manage shocks.

The FFP DFSA focuses on highland geographies within Tigray, Amhara, and Oromia (Figure 5). These efforts are aimed at ameliorating food insecurity in vulnerable Productive Safety Net Program households in selected *woredas* (districts) in these regions. They include:

- Conditioned transfers,
- Public works activities,
- Livelihood activities and support, and
- Contingency support for food insecure households suffering from acute shocks.

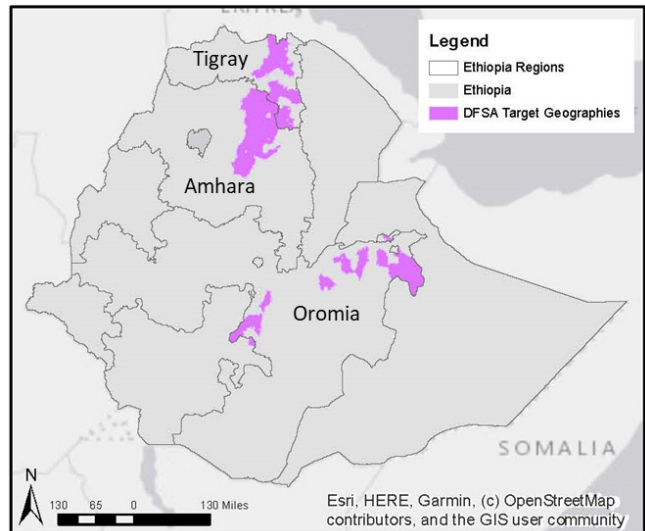


Figure 5. USAID/FFP Ethiopia DFSA target geographies.

## LIVELIHOOD ZONES IN FFP PROGRAM AREAS

Livelihoods are primarily agricultural, with smallholder farming accounting for 85 percent of employment and highland smallholder farmers managing more than 90 percent of agricultural land. (2, 14) Livelihoods are largely tied to topography and precipitation (shown in Figure 6 and Figure 7). In the highlands—where most Ethiopians reside and where the FFP target geographies are located—crop production is the main livelihood, although better-off households keep livestock as well. In areas that are slightly drier and slightly lower in elevation, and in areas with rivers and seasonal watercourses that allow for “flood-retreat” cultivation, households often rely on agropastoralism, meaning that they depend on a mix of crop production and herding. Lower lying areas generally do not receive enough precipitation to support crops, and households are therefore reliant on pastoralism (Figure 7). (10) Figure provides a more detailed map of each of the livelihood zones within the DFSA target geographies.

Wealthier households typically own land, oxen, and/or other productive assets, and use these to generate food and cash used to purchase food. (10) While poorer households typically generate cash and purchase food by collecting and selling natural resources, such as firewood, and working for local wealthier households or working on cash crop plantations, in some cases, they travel to areas with cash crops in order to generate income. (10)

Of the FFP target geographies, poorer regions include the eastern parts of Tigray and Amhara. (10) Poor and very poor households typically are unable to achieve food self-sufficiency in their own crop production, forcing many of these households to earn cash through labor or assistance so they can augment their food source with market purchases. Income sources among poor households vary regionally—poor households in Tigray earn more income through labor, while the average poor household in Oromia generates more income from livestock and crop sales. (10)

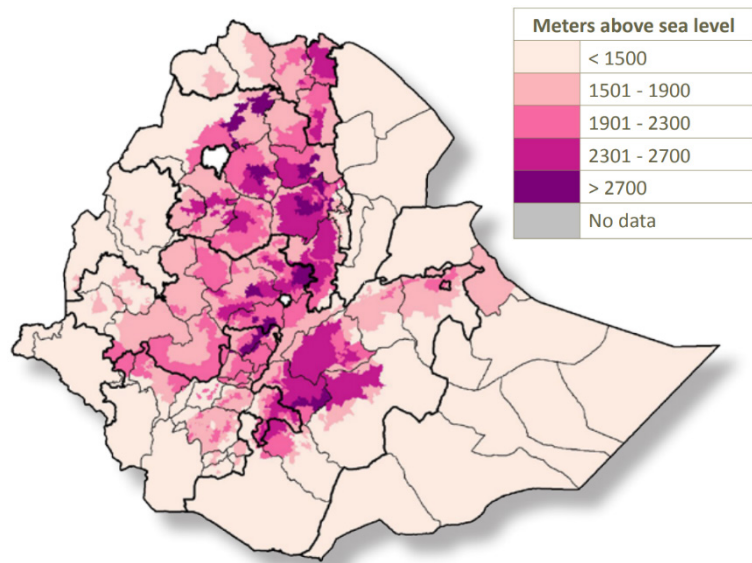


Figure 6. Topography in Ethiopia. Source: [USAID and Government of Ethiopia Disaster Risk Management and Food Security Sector, MOARD 2016](#)

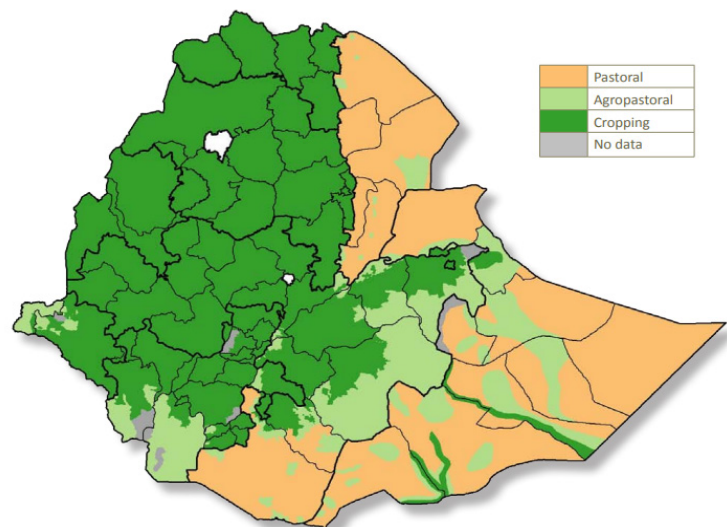


Figure 7. Livelihood zone types in Ethiopia. Source: [USAID and Government of Ethiopia Disaster Risk Management and Food Security Sector, MOARD 2016](#)

In Ethiopia, a lack of precipitation and erratic seasonal precipitation are the most widespread hazards to livelihoods in the eastern parts of the FFP geography regions. In the western parts of FFP geography regions, livestock, crop pests and disease, and livestock feed shortages tend to have the greatest impact on livelihoods. (10)

Table 2 below offers a brief summary of the main livelihood zone types, crops produced, and livestock raised in the DFSA target geographies within Amhara, Oromia, and Tigray. Cropping tends to dominate livelihoods in Amhara and Tigray, while agropastoral activities, as well as cropping, play a significant role in Oromia. Each region grows its own distinct crops, although staple cereals such as barley, wheat, sorghum, maize, and teff are also widely produced across all three regions. (15) Cattle and shoats are the main livestock raised in the DFSA target geographies. (15) As mentioned above, Figure provides a map of each of the livelihood zones within the DFSA target geographies.

*Table 2. Livelihood zone characteristics within DFSA target geographies*

| Region        | Main LHZ Types         | Main Crops                                                                                                             | Main Livestock |
|---------------|------------------------|------------------------------------------------------------------------------------------------------------------------|----------------|
| <b>Amhara</b> | Cropping               | Barley, wheat, teff, sorghum, pulses, maize, millet, Irish potatoes, flax, fruits/vegetables, sesame                   | Cattle, shoats |
| <b>Oromia</b> | Cropping, agropastoral | Maize, sorghum, pulses, barley, wheat, chat, Irish potatoes, groundnuts, teff, millet, coffee, oilseeds, enset, sesame | Cattle, shoats |
| <b>Tigray</b> | Cropping               | Sorghum, wheat, barley, maize, pulses, teff, millet, cactus fruit, gesho, groundnuts                                   | Cattle, shoats |

Sources: 15

Notably, livelihoods have been disrupted as conflict in 2018 led to major displacement, including in the FFP target geographies of Amhara and Oromia. In 2019, around 2.9 million new people in Ethiopia became internally displaced, the highest of any country that year. (16) Many of these internal displacements have been driven by ethnic-based violence and breakdowns in social cohesion, including in areas that already face climatic shocks. Since May 2019, the government has helped 2.1 million internally displaced people return to their place of origin. (16)

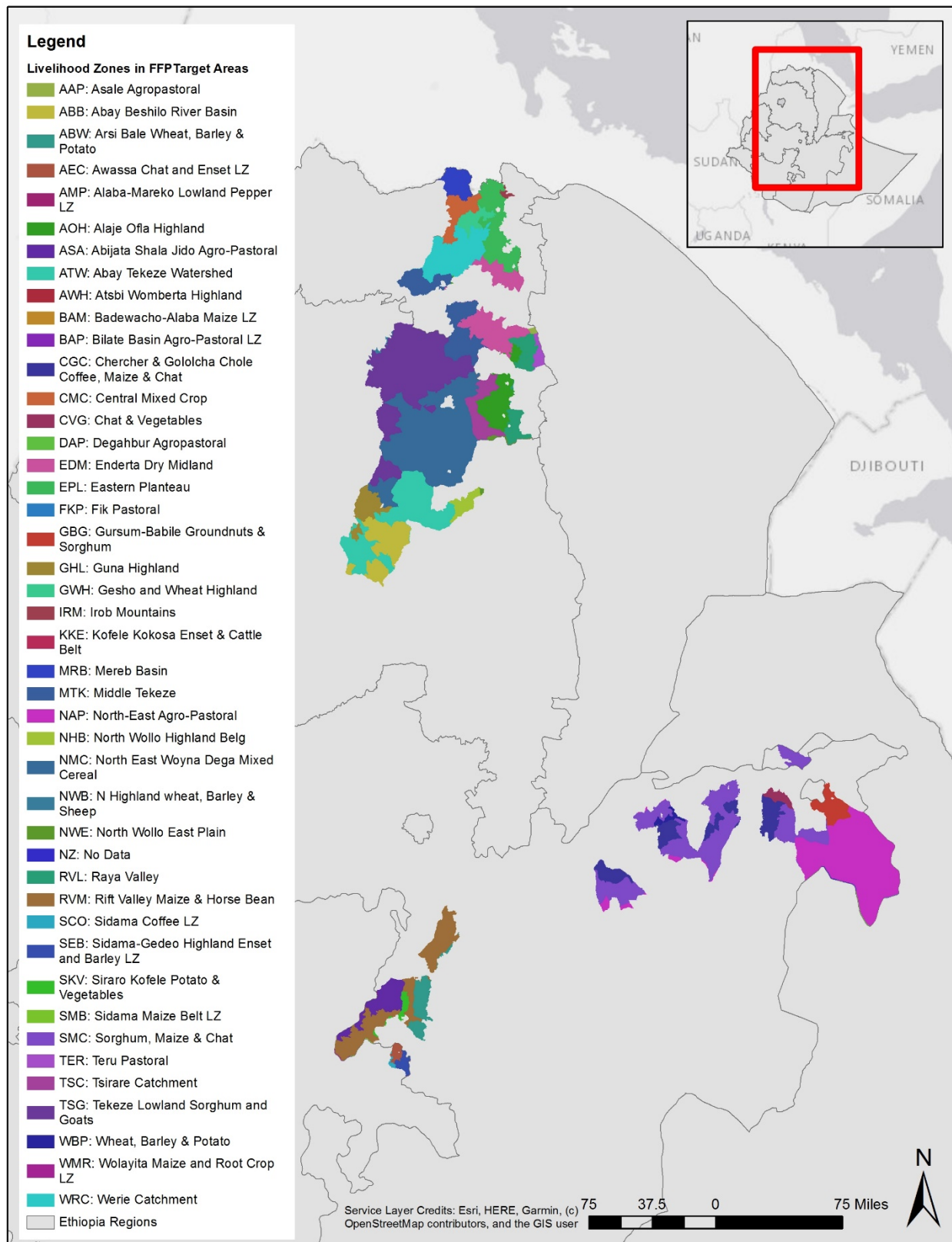


Figure 8. Livelihood zones in DFSA target areas. Source: USAID and FEWS NET 2009

## SECTOR IMPACTS AND VULNERABILITIES

### AGRICULTURE

The following sections describe food insecurity drivers, including climate-related drivers, in various agriculture components, including crop production, livestock and pastoralism, invasive species, pesticide use and storage, and food processing and storage.

Notably, the impacts on the food production value chain described in these sections can affect food availability in markets, compromising the food security of poorer households who depend heavily on market purchases. (17, 18) Furthermore, climate hazards limit households' physical access to markets, as few roads are all-weather roads, and poorer, more rural households tend to be farther from market towns. (17) In addition, climate impacts can compromise income from agricultural and non-agricultural livelihoods, eroding household purchasing power. (17, 18)

#### Crop Production

Most crops are produced by small-scale subsistence farmers with rainfed plots; more than 90 percent of gross agricultural outputs come from farms that are smaller than 2 hectares. (1, 11) These operations are typically limited by a range of stressors, including the following:

- **Drought, delayed precipitation, and insufficient rains are the main drivers of crop failure.** (1, 11) Only 1 percent of cultivated land is irrigated, therefore crop production—and food security—is heavily linked to the quality and timing of the rainy seasons. (1) The droughts of 1984, 2003, and 2015–2017 affected the livelihoods and food security of more than 30 million people combined. (11) Furthermore, many farmers grow slow-maturing, high-yield crops that require two rainy seasons to reach harvest, making these farmers even more sensitive to seasonal precipitation changes. (1) These two rainy seasons include the short *Belg* rains, which are important for short-cycle crops and livestock pasture regeneration, and the longer *Kiremt* rains, which feed longer cycle crops; failure of just one of these rainy seasons can result in crop and livestock damage. (19)
- **Extreme events such as floods, landslides, frost, hail, and heavy rain can damage crops and further degrade land through erosion.** (1, 11) A 2015–2016 survey of farmers in Ethiopia found that some crop damage was caused by extreme events, such as frost or floods (9 percent), hail (7 percent), and heavy rain (5 percent). (11) These extreme events can also threaten human lives and cause damage to infrastructure, both of which support the agricultural sector. In 2006, heavy flooding resulted in 800 casualties and 20,000 damaged or destroyed homes. (11)
- **Pests and diseases have killed or damaged crops.** (11) Ethiopia's most damaging crop pests and diseases include maize lethal necrosis disease, wheat rust, faba bean leaf and stem gall, and weeds. (1) In more recent years, Ethiopia has also become infested by the fall armyworm, which thrives in warm and humid conditions and has infested 642,000 hectares of maize since its introduction to the country in 2017. (20) The current locust outbreak in Ethiopia and other parts of East Africa is the worst in 25 years and is a serious threat to food security in the region. (21) Heavy precipitation and high temperatures, as well as lack of control over hopper bands, have contributed to the severe outbreak; as of January 2020, the situation in Ethiopia is still serious, with an overall crop loss of 4 percent. (22, 23)
- **Desertification, land degradation, and fragmentation limit crop production potential and are driven by poor agricultural practices, pressure on natural resources, and**

**population growth.** Reductions in soil fertility and increases in soil erosion have reduced the availability of arable land. (1, 11) In the highlands where most Ethiopians live, 40 percent of the land area is undergoing some form of soil erosion, causing topsoil losses of 1.5 billion tons per year, and affecting regional and national crop production. (11) Population growth has also led to land fragmentation and land tenure insecurity; as a result, highland farmers are left with increasingly small land holdings and are often unwilling to invest in improved management practices. (2, 11) Household plot sizes in the highlands are typically too small to produce enough food for the average five-person family, let alone enough for commercial sales. (2) The small plot sizes are also less suitable for practices such as agroforestry, fertilizer, using improved seeds, and using technology that improves productivity. (11) Restrictive land tenure laws prevent land rental and other plot consolidation practices that would enable farmers to achieve economies of scale. (2)

- **Lack of access to services, financial resources, and improved practices.** Farmers often lack access to extension services and lack the financial resources and credit to invest in improved inputs, such as capital to invest in agricultural machinery or access to online platforms and resources, thus limiting crop productivity. (1, 11, 24)

Climate change is expected to intensify these stressors, further threatening crop production. Increased frequency and severity of drought may drive more crop failure, while heavier precipitation during rain events may cause more floods and landslides, exacerbating land degradation. (1) At the seasonal scale, rains are also likely to become more unpredictable, which can create challenges for crop production. (11) Warmer temperatures and more frequent and intense drought may further accelerate desertification, reducing the availability of arable land. (25) Increasing temperatures can expand the range of crop pests and diseases. (1) Furthermore, more extended exposure to high temperatures (i.e., from longer heatwaves) can increase heat stress on crops, increase evapotranspiration, and reduce soil moisture content, leading to crop failure. (1)

Table 3 summarizes the climate sensitivities and adaptive characteristics of Ethiopia's staple crops, while Table 4 summarizes the major climate-related risks facing the agricultural sector and potential adaptation responses to address these risks. The adaptation measures are intended to both improve crop production to prevent food security emergencies and bolster long-term agricultural development and resilience to climate risk.

In addition to adaptation measures related to climate-smart agriculture, the Government of Ethiopia is undertaking systemic efforts to address food insecurity, including developing a national safety net and alternative livelihoods for smallholder farmers. For example, the Productive Safety Net Programme (PSNP) provided food and cash transfers to food-insecure households after the 2002/2003 drought and has supported investments in socioeconomic infrastructure. (26) PSNP aims to implement a system that provides social protection and disaster risk management, continued food and cash transfers, access to social services, and support for livelihood opportunities (including off-farm income and employment).

*Table 3. Climate sensitivities and adaptive characteristics of staple crops and crops with the greatest gross production value in FFP program areas*

| Crop                              | Climate Sensitivities                                                                                                                                                                                                                                                                                               | Adaptive Characteristics                                                                                                                                                                                             |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Barley</b><br>(Amhara, Oromia) | <ul style="list-style-type: none"> <li>• Sensitive to rain shortages (11)</li> <li>• Yields are sensitive to the timing of <i>Belg</i> rains, which may become more unpredictable in the future (27)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul> | <ul style="list-style-type: none"> <li>• Potential to use improved seeds that are heat- and drought-tolerant (11)</li> <li>• Can be farmed several times a year; not constrained to a certain season (27)</li> </ul> |

| Crop                                                         | Climate Sensitivities                                                                                                                                                                                                                                                                                                                                                                                                                              | Adaptive Characteristics                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Maize</b><br>(Amhara, Oromia)                             | <ul style="list-style-type: none"> <li>• Sensitive to rain shortages (11)</li> <li>• Yields are sensitive to the timing of <i>Belg</i> rains, which may become more unpredictable in the future (27)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul>                                                                                                                                | <ul style="list-style-type: none"> <li>• High potential to use improved seeds that are heat- and drought-tolerant (11)</li> <li>• Use green maize (maize nearing maturity that is harvested before it has thoroughly dried) to break hunger season (February–May and July)</li> </ul> |
| <b>Sorghum</b><br>(Amhara, Oromia)                           | <ul style="list-style-type: none"> <li>• Sensitive to rain shortages (11)</li> <li>• Sensitive to low temperatures (e.g., those in high-altitude areas) and high temperatures (e.g., due to increases in temperature) (11, 28)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> <li>• Decreases in precipitation more likely to affect yield than increases in temperature (28)</li> </ul> | <ul style="list-style-type: none"> <li>• Potential to use improved seeds that are heat- and drought-tolerant (11)</li> <li>• High tolerance to drought and high temperatures (11)</li> </ul>                                                                                          |
| <b>Wheat</b><br>(Amhara, Oromia)                             | <ul style="list-style-type: none"> <li>• Sensitive to rain shortages (11)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul>                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• Potential to use improved seeds that are heat- and drought-tolerant (11)</li> </ul>                                                                                                                                                          |
| <b>Teff</b><br>(Tigray, Amhara, Oromia)                      | <ul style="list-style-type: none"> <li>• Sensitive to rain shortages (11)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul>                                                                                                                                                                                                                                                           | <ul style="list-style-type: none"> <li>• Potential to use improved seeds that are heat- and drought-tolerant (11)</li> <li>• Adaptable to lower elevations and a variety of moisture, temperature, and soil conditions (11)</li> </ul>                                                |
| <b>Pulses</b><br>(faba beans, chickpeas)<br>(Amhara, Oromia) | <ul style="list-style-type: none"> <li>• Sensitive to increased heat (11)</li> <li>• Sensitive to drought (11)</li> <li>• Very sensitive to hailstorms and frost in November (27)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul>                                                                                                                                                   | <ul style="list-style-type: none"> <li>• Potential to use improved varieties (11)</li> <li>• Using cropping calendars informed by meteorological data can determine better planting times (11)</li> </ul>                                                                             |
| <b>Potatoes</b>                                              | <ul style="list-style-type: none"> <li>• Yields are sensitive to the timing of <i>Belg</i> rains, which may become more unpredictable in the future (27)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul>                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• Potential to use improved varieties (11)</li> <li>• Integrated disease management</li> </ul>                                                                                                                                                 |
| <b>Coffee</b>                                                | <ul style="list-style-type: none"> <li>• Sensitive to heat (11)</li> <li>• Sensitive to pests (11)</li> <li>• Flowers can be sensitive to late <i>Belg</i> rains, affecting next season's harvest (27)</li> <li>• Sensitive to damage from flooding during the main harvest period (October–November) (27)</li> </ul>                                                                                                                              | <ul style="list-style-type: none"> <li>• Potential to use improved varieties (11)</li> <li>• Mulching and agroforestry can improve coffee production (11)</li> </ul>                                                                                                                  |

Table 4. Crop production climate risks and responses

| Climate Risks                                                                                    | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| More frequent and intense drought, more frequent delayed and erratic precipitation harming crops | <ul style="list-style-type: none"> <li>• Improve water availability <ul style="list-style-type: none"> <li>◦ Increase rainwater harvesting (28, 29, 30)</li> <li>◦ Sustainably expand irrigation (11)</li> <li>◦ Implement measures to conserve water and soil (e.g., soil/stone bunds, terracing, infiltration ditches, tie-ridges) (11)</li> <li>◦ Implement agroforestry practices that can help retain water (29, 31) <ul style="list-style-type: none"> <li>▪ Rotational woodlot allows for better water infiltration (30)</li> <li>▪ Improved fallows increase water infiltration and soil water holding capacity, mitigate dry spells and drought, and reduce weeds that compete with crops for water (30)</li> <li>▪ Domestication of indigenous trees provides high-value products if crops fail (30)</li> </ul> </li> </ul> </li> <li>• Improve and modify inputs <ul style="list-style-type: none"> <li>◦ Increase use of improved seeds; currently, improved seed area only accounts for 10.7 percent of total cereal-growing area (11)</li> <li>◦ Use organic fertilizers and biofertilizers (11)</li> </ul> </li> </ul> |

| Climate Risks                                                                                                                                  | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                | <ul style="list-style-type: none"> <li>○ Change and/or diversify crops or crop varieties (e.g., shift toward using more drought-tolerant varieties) (29, 31)</li> <li>○ Turn to green maize or sweet potatoes to break the hunger season (10)</li> <li>● Apply conservation agriculture practices to improve resilience to dry spells (29) <ul style="list-style-type: none"> <li>○ Reduce tillage (29)</li> <li>○ Use crop residue for mulching (29)</li> <li>○ Rotate crops and intercrop with cereals and legumes (29)</li> </ul> </li> <li>● Improve water use efficiency (29)</li> <li>● Shift planting and harvesting dates based on seasonal shifts in precipitation patterns (30)</li> <li>● Develop early warning systems for drought events (19)</li> <li>● Offer weather index insurance for farmers to provide financial protection if a climate event destroys crops (32, 29)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                        |
| More frequent and intense <b>extreme precipitation and associated floods</b> and rain-driven landslides <b>damaging crops and eroding soil</b> | <ul style="list-style-type: none"> <li>● Implement measures that conserve soil and retain soil moisture (e.g., soil/stone bunds, terracing, infiltration ditches, tie-ridges) (11)</li> <li>● Implement agroforestry to prevent soil erosion (31) <ul style="list-style-type: none"> <li>○ Boundary planting provides erosion control (30)</li> <li>○ Rotational woodlots provide erosion control (30)</li> </ul> </li> <li>● Develop early warning systems for flooding events (19)</li> <li>● Offer weather index insurance for farmers to provide financial protection if a climate event destroys crops (32)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Rising temperatures leading to <b>heat stress, evapotranspiration, and reduced soil moisture content harming crops</b>                         | <ul style="list-style-type: none"> <li>● Improve and modify inputs <ul style="list-style-type: none"> <li>○ Increase use of improved seeds; currently, improved seed area only accounts for 10.7 percent of total cereal-growing area (11)</li> <li>○ Use organic fertilizers and biofertilizers (11)</li> <li>○ Change crops or crop varieties (31)</li> </ul> </li> <li>● Agroforestry to provide shade from trees for crops (31) <ul style="list-style-type: none"> <li>○ Plant trees to offer a microclimate for reducing heat stress (30)</li> <li>○ Use boundary planting to provide microclimate control (30)</li> <li>○ Domesticate indigenous trees to provide high-value products if crops fail (30)</li> </ul> </li> <li>● Apply conservation agriculture practices to improve resilience to hot spells (29) <ul style="list-style-type: none"> <li>○ Reduce tillage (29)</li> <li>○ Apply crop residue as mulch to reduce soil temperatures; this can also improve the effectiveness of fallows (29, 30)</li> <li>○ Rotate crops and intercrop with cereals and legumes (29)</li> </ul> </li> <li>● Shift planting and harvesting dates based on seasonal shifts in precipitation patterns (30)</li> <li>● Undertake measures to improve water availability as described in row above</li> </ul> |
| Higher temperatures and more frequent and intense drought <b>accelerating desertification</b> , resulting in the loss of arable land           | <ul style="list-style-type: none"> <li>● Use crop rotation and intercropping to reduce the intensity of land use (11)</li> <li>● Use agroforestry to grow crops within forests or with trees (31)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Cross-cutting risks reducing agricultural productivity and affecting agriculture-based livelihoods</b>                                      | <ul style="list-style-type: none"> <li>● Improve the business enabling environment (33)</li> <li>● Increase alternative livelihood pathways, such as employment and entrepreneurship, particularly for youth and women (33)</li> <li>● Expand access to markets with increased urban opportunities (33)</li> <li>● Strengthen the systems needed to avert, mitigate, and recover from shocks and stresses by promoting local ownership and capacity building of local systems and stakeholders (33)</li> <li>● Provide food and cash transfers to help people during droughts and hunger seasons, as well as to prepare for and mitigate shocks (33)</li> <li>● Support the commercialization of agriculture to increase income for smallholder farmers (33)</li> <li>● Provide loans to farmers and businesses to increase financial access to invest in their enterprises (33)</li> <li>● Improve land governance, land administration, and strengthen land tenure rights to promote economic growth, increase agricultural productivity, and reduce conflict and resource degradation (34)</li> <li>● Incubate and strengthen sustainable agribusiness (34)</li> </ul>                                                                                                                                    |

| Climate Risks | Potential Adaptation Responses                                                                                                                                                                                                                                                        |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               | <ul style="list-style-type: none"> <li>Capacity building of agricultural institutions for project implementation and impact maximization (11)</li> <li>Diversify livelihoods through supporting commercialization of crops such as chickpeas, lentils, and faba beans (11)</li> </ul> |

## Livestock and Pastoralism

Ethiopia has the largest livestock sector in Africa, with 88 percent of rural households holding livestock and 10 million to 15 million pastoralists using rangelands in more than 60 percent of the country. (1, 11) As shown in Figure , while the FFP geography regions are mostly crop-based, the eastern parts of Oromia are agropastoral. (10)

Livestock provides a variety of resources and services, such as draught power, meat, milk, eggs, and leather products. (11) Livestock offers a safety net because households can sell the animals when crop production fails. (10, 31) Livestock can provide more than 75 percent of annual cash income in eastern Oromia. (10, 31)

Livestock and therefore pastoralist livelihoods face threats from existing land use tensions and climate stressors. Tensions exist between rangers due to conflicts over land and water, and unsustainable open grazing practices have led to pasture degradation. (1, 11) Herders also often lack access to basic inputs such as feed, fodder, reproductive aids, and vaccines. (6)

Decreasing livestock productivity may force shifts to agropastoralist livelihoods or crop cultivation. (11)

The livestock sector is dependent upon precipitation since livestock primarily depends on natural pastures or crop residues for nourishment. (1, 11) Past droughts have degraded land, and the combination of water shortages plus higher temperatures magnify existing conflicts over resources such as pasture and water. (1) As such, livestock health is tied to annual precipitation conditions. (35)

Climate change is likely to exacerbate existing hazards, further threatening the livestock sector. Higher temperatures and more frequent and intense heatwaves may harm livestock health and productivity, and increase livestock mortality, particularly for chickens, which tolerate only narrow ranges of temperature for reproduction and growth. (1, 31) Increased frequency and severity of droughts and rain shortages may reduce the food available for livestock, further reducing productivity and increasing susceptibility to disease. (1) The effects of insufficient rains will likely be greatest in low-latitude arid and semi-arid parts of Ethiopia, including the FFP target geography of Oromia. (10) Accelerated desertification may also limit available pasture and aggravate conflict among farmers. Rising temperatures and shifts in precipitation patterns may also increase the

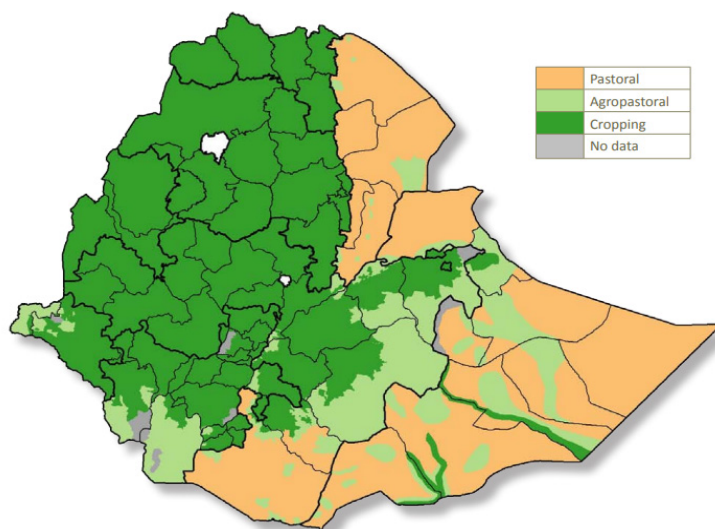


*Figure 9. Areas where pastoral and agropastoral livelihoods dominate. Source: USAID and Government of Ethiopia Disaster Risk Management and Food Security Sector, MOARD 2016*

incidence of livestock diseases. (31) In 2015 and 2017, droughts dried up pastures and water sources, killing millions of livestock and affecting the livelihoods of the herders who depended on them for income. (36, 37) Herders who face a sudden loss of livestock usually must rely on humanitarian aid for food and income. (10)

Table 5 summarizes the climate risks to livestock and potential adaptation responses to address these risks. The adaptation measures are intended to help farmers adapt their livestock production to climate stressors while minimizing the harmful effects that livestock farming can have on the environment.

*Table 5. Livestock climate risks and responses*

| Climate Risks                                                                                                                | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Cross-cutting</b>                                                                                                         | <ul style="list-style-type: none"> <li>• Offer support tools and regulations, such as livestock insurance, and early warnings for events (42)</li> <li>• Diversify of livestock types (38)</li> <li>• Switch to other livelihoods to adapt to sudden death of livestock due to climate events (10) <ul style="list-style-type: none"> <li>◦ Local labor and labor migration (10)</li> <li>◦ Firewood sales (10)</li> <li>◦ Rent out land to better-off households (10)</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| More frequent and intense drought and accelerated desertification<br><b>reducing water, fodder, and pasture availability</b> | <ul style="list-style-type: none"> <li>• Water availability <ul style="list-style-type: none"> <li>◦ Develop other water resources, such as irrigation or groundwater (42)</li> <li>◦ Begin using watering troughs (38, 43)</li> <li>◦ Adopt improved breeds (hybrids or crossbreeds) that can better withstand water stress (11)</li> <li>◦ Diversify livestock types (38)</li> </ul> </li> <li>• Fodder and pasture availability <ul style="list-style-type: none"> <li>◦ Conserve and keep emergency fodder (11, 42)</li> <li>◦ Use supplemental feeding (39)</li> <li>◦ Integrate livestock with agroforestry and crop production to diversify livelihood and leverage the byproducts of agroforestry and crop production than can be used as animal feed (40)</li> <li>◦ Improve feeding practices (e.g., modify diet composition, change feeding time/frequency, incorporate agroforestry species in diet) (38)</li> <li>◦ Improve rangeland management, such as through controlled grazing, planting of fodder trees, and area closures, which can improve soils and natural vegetation, regulate floods, improve soil fertility, and provide alternate income by allowing space for other activities (11)</li> <li>◦ Shift locations of livestock production to reduce soil erosion and improve moisture and nutrient retention (42)</li> <li>◦ Adopt nomadic lifestyles to search out pastures for livestock (31)</li> </ul> </li> </ul> |
| Increased temperatures causing <b>heat stress, reducing milk production, and reducing reproduction</b>                       | <ul style="list-style-type: none"> <li>• Provide shade for livestock (43)</li> <li>• Increase livestock resilience by improving feeding practices (e.g., modify diet composition, change feeding time/frequency, incorporate agroforestry species in diet) (38)</li> <li>• Adopt improved breeds (hybrids or crossbreeds) that can better withstand heat stress (11)</li> <li>• Develop international gene banks for livestock (42)</li> <li>• Improve animal veterinary services and training of community animal health workers (paravets) (11)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Rising temperatures driving increased spread of <b>livestock disease</b>                                                     | <ul style="list-style-type: none"> <li>• Adopt improved breeds (hybrids or crossbreeds) that are less susceptible to disease (11)</li> <li>• Begin holding more resilient animal types, such as goats (11)</li> <li>• Improve animal veterinary services and training of community animal health workers (paravets) (11)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Invasive Species

Invasive species in eastern Africa can reduce biodiversity and affect rural livelihoods that depend on natural resources, such as by reducing rangeland capacity. (41) The most problematic invasive

species displace native plants, are toxic to livestock and people, result in pasture loss, disrupt water and nutrients in soils, and compete with or smother crops. (41)

Climate change has facilitated plant invasions in Ethiopia, both by expanding the range of invasive species and by allowing them to thrive in these new areas. (41, 42) Trees and shrubs that have adapted to low precipitation have moved into new habitats opened from land degradation, overgrazing, and deforestation. (41) Other plants that were intentionally introduced were able to spread much more rapidly in these increasingly semi-arid areas. (41)

Increased frequency and severity of drought may result in more arid conditions, further allowing other invasive species, such as the Agavaceae, to thrive. (41) As ranges for invasive species expand, crops may face competition for resources. Native species that serve ecosystem functions which mitigate climate impacts may also be replaced by invasive species. (42)

Table 6 summarizes notable climate-related invasive species risks facing Ethiopia's agricultural sector and potential adaptation responses for addressing these risks. The adaptation measures are intended to help eradicate or control the population growth of the invasive species while protecting agricultural crops.

*Table 6. Spread of invasive species climate risks and responses*

| Climate Risks                                                                                                   | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warming temperatures and more frequent and intense drought <b>expanding the range of invasive species</b>       | <ul style="list-style-type: none"> <li>• Improve governance surrounding the control of invasive species (41) <ul style="list-style-type: none"> <li>◦ Implement appropriate policies</li> <li>◦ Increase the capacity to identify and manage invasive plants</li> <li>◦ Increase awareness among officials and stakeholders of the impact of invasive plants</li> <li>◦ Increase the resources available to tackle issues</li> <li>◦ Discourage ascribing useful properties to invasive species, which promotes their cultivation</li> </ul> </li> <li>• Use biological control, such as bud-galling or seed-feeding insects (41)</li> <li>• Use invasive species for purposes such as fuel, charcoal production, livestock feed, and construction (42)</li> </ul> |
| Rising temperatures and more frequent and intense drought drying vegetation and <b>increasing wildfire risk</b> | <ul style="list-style-type: none"> <li>• Use invasive species for purposes such as fuel, charcoal production, livestock feed, and construction (42)</li> <li>• Employ a controlled burn after water drainage (42)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

## Pesticide Use and Storage

Through a 2016 survey, farmers reported that diseases and pests were responsible for 18 percent of crop damage. (11) From 1997 to 2014, pesticide use in Ethiopia increased from 0.2 to 0.6 kilograms per hectare, along with general increases in pesticide imports and production. (43) While pesticides help eradicate pests that are harmful to agriculture, they can threaten human health. In 2017, almost one-third of the 150 registered pesticides were categorized as a “danger,” which meant that they would be toxic or fatal if inhaled by humans. (43) Many pesticides have also been found to contain carcinogens, reproductive toxins, and mutagens. (43)

Climate change has already begun to impact pest infestations. In Ethiopia, higher winter temperatures have reduced the mortality of aphids, allowing earlier and more widespread dispersion. (30) Changing precipitation patterns in sub-Saharan Africa have also changed locust migration patterns, bringing this pest to other parts of Africa, including Ethiopia. (30) Due to heavier rains and higher temperatures, Ethiopia is currently facing its worst desert locust outbreak in 25 years. (21)

Projected increases in temperature and changes in precipitation patterns in Ethiopia may further the spread of crop pests and diseases, such as maize lethal necrosis disease, wheat rust, faba bean leaf and stem gall, and weeds. (11, 31) Climate change may also make pesticide use more hazardous by increasing the intensity of rain events, which can increase runoff with pesticide residue, damaging ecosystems and creating human health hazards. (1)

Table 7 summarizes the primary pests that impact Ethiopia's major crops, and potential non-pesticide adaptation responses to address these risks. Table 8 summarizes the major climate risks with the potential to exacerbate the prevalence of pests, limit pesticide effectiveness, and increase environmental contamination from the use of pesticides, and adaptation measures intended to address these.

*Table 7. Major crop pests and potential non-pesticide response to address these risks*

| Crop       | Major Pests                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------------------|
| Maize      | <ul style="list-style-type: none"> <li>• Maize stack borer</li> <li>• Maize lethal necrosis disease</li> <li>• Armyworm</li> </ul> |
| Wheat      | <ul style="list-style-type: none"> <li>• Wheat rust</li> <li>• Armyworm</li> </ul>                                                 |
| Faba beans | <ul style="list-style-type: none"> <li>• Faba bean leaf and stem gall</li> </ul>                                                   |
| Multiple   | <ul style="list-style-type: none"> <li>• Stem gall, caused by insects</li> <li>• Aphids</li> <li>• Desert locusts</li> </ul>       |

*Table 8. This table includes (1) climate risks that may (a) increase the prevalence of pests, (b) reduce the effectiveness of pesticides, or (c) increase human or environmental health risk from pesticides; and (2) adaptation responses to address these risks*

| Climate Risks                                                                                       | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rising temperatures <b>expanding the range of crop pests</b> , resulting in increased pesticide use | <ul style="list-style-type: none"> <li>• Implement policies that promote the use of integrated pest management, such as biological pest controls (43)</li> <li>• Use botanical controls or plant extracts that are toxic to certain pests (20)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| More intense precipitation events <b>increasing runoff with pesticide residue</b>                   | <ul style="list-style-type: none"> <li>• Implement policies that promote the use of integrated pest management, such as biological pest controls (43)</li> <li>• Use meteorological forecasts to avoid applying pesticides before extreme events</li> <li>• Avoid pesticide use near areas of biological importance (44)</li> <li>• Create safe areas for washing and disposing of pesticides to protect waterways (44)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Rising temperatures <b>reducing the effectiveness/shelf life of pesticides</b>                      | <ul style="list-style-type: none"> <li>• Store pesticides in shaded shelters and sealed containers</li> <li>• Increase the use of pesticides that can withstand high temperatures</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Cross-cutting</b>                                                                                | <ul style="list-style-type: none"> <li>• Adopt use of pest-resistant crop varieties (29)</li> <li>• Employ tighter restrictions on which pesticides can be used and registered (43)</li> <li>• Disseminate training on proper pesticide use (43)</li> <li>• Increase the surveillance, monitoring, and early warning systems in place of pesticide use (43)</li> <li>• Use pesticides indicated as being less harmful, such as those in USAID PERSUAP (Pesticide Evaluation Report and Safer Use Action Plan) (44)</li> <li>• Provide proper equipment/clothing to avoid injuries and health issues associated with pesticide use (44)</li> <li>• Use pesticide sprays or granules instead of dusts (44)</li> <li>• Avoid pesticide use in areas where and during times when pollinators are active (44)</li> <li>• Monitor pests and pesticide effects (44)</li> </ul> |

## Food Processing and Storage

Inadequate storage facilities contribute to food insecurity in Ethiopia; studies have found that post-harvest losses reach 40 percent. (11) Yield losses tend to be highest for maize. (45) In order to reduce post-harvest losses, the Government of Ethiopia is investing in roads to connect rural farms to transport and manufacturing corridors, storage facilities, households, and businesses. (11)

Climate-related extreme events that coincide with harvesting already result in devastating losses to post-harvest crops. For example, floods have damaged transportation infrastructure, preventing food from reaching its destination in time and increasing the likelihood of spoilage. (45) More frequent and intense precipitation and the resulting floods in the future may further exacerbate flood-related food losses. In addition, rising temperatures may result in faster food spoilage, especially given that cold storage in Ethiopia is very limited, particularly among smallholder farmers. (45, 46)

Table 9 summarizes climate risks to post-harvesting processes and potential adaptation responses to address these risks.

*Table 9. Post-harvest climate risks and responses*

| Post-Harvest Component        | Climate Risks                                                                                                                                                                                                                                                                                                                                                                                                                                      | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Storage                       | <ul style="list-style-type: none"><li>• Higher temperatures increasing the rate of bacteria growth and food spoilage</li><li>• More frequent and intense precipitation and flooding damaging storage facilities or processing plants</li><li>• More frequent and intense drought causing scarcity of water for food processing</li><li>• More frequent and intense extreme precipitation events polluting the water used to process food</li></ul> | <ul style="list-style-type: none"><li>• Deliver behavior change communication messages focused on proper food storage (48)<ul style="list-style-type: none"><li>◦ Focus on resources for women, who play an important role in food processing and storage (48)</li></ul></li><li>• Increase the use of alternative fuels for generating electricity to power cold storage facilities (38)</li><li>• Use recycled wastewater or dry processing/packaging methods for food processing (38)</li><li>• Increase the reliance on rapid processing of food to extend shelf life (38)</li></ul> |
| Transportation & Distribution | <ul style="list-style-type: none"><li>• More frequent and intense extreme events destroying crops post-harvest and inhibiting food transportation</li></ul>                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>• Build effective linkages (e.g., roads and railway) between producers and local processing companies for more efficient transport and distribution (48)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                 |

## HUMAN HEALTH: NUTRITION, WASH, AND HEALTH SERVICES

### Nutrition

Malnutrition is a persistent problem in Ethiopia, particularly for women and children; malnutrition contributes to more than half of infant and child deaths in Ethiopia. (4) In 2016, undernutrition among women was 22 percent; in 2019, among children under age 5, 37 percent were stunted, 7 percent were wasted, and 21 percent were underweight. (2, 3)

Food insecurity and low-quality diets are the main drivers of malnutrition in Ethiopia. However, other factors such as poor feeding practices, poor hygiene and sanitation, high incidence of infectious diseases, and limited access to nutrition services also contribute. (2, 4)

Climate impacts on agricultural production, as described previously in this document, may further harm human health and nutrition, particularly among the poorest households. Climate impacts on WASH, vector-borne diseases, and health services also have the potential to adversely affect human health.

## **Water Supply, Sanitation, and Hygiene (WASH)**

Roughly one-third of Ethiopians have access to safe potable drinking water, and only 7 percent use an improved toilet facility, while 27 percent have no facilities at all. (2) Rates of access to improved WASH services and facilities are particularly low among rural populations. (47) As a result, diarrheal diseases make up more than 75 percent of outpatient cases and are the third leading cause of death for children under age 5. (48, 49) Ethiopia also experienced an outbreak of acute watery diarrhea from 2006–2011, resulting in illnesses and deaths throughout the country. (49)

Climate hazards such as drought can reduce the availability of safe drinking water, compounding the problems that already exist due to lack of access to safe water. During the 2015–2017 El Niño drought, 5.8 million Ethiopians were left without access to WASH services. (1) Past floods have also caused drinking water to become contaminated, furthering the spread of waterborne illnesses through drinking water. (47)

In the future, drought is projected to become more frequent and more intense, further threatening supplies of safe drinking water. (1) Increased precipitation intensity and flooding during storm events could spread waterborne diseases such as diarrhea, cholera, and dysentery. (1) Extreme events, such as increased frequency and intensity of heavy rains, may also damage WASH infrastructure in the future, further creating threats to sanitation and hygiene. (1)

## **Vector-borne diseases**

Malaria poses a threat to human health, particularly for children. About 70 percent of Ethiopians live in malaria-endemic areas, and outbreaks that occur every 5–8 years make up 20 percent of deaths for children under age 5. (1)

Certain climate hazards have already affected susceptibility to disease. Children born during drought in Ethiopia are 36 percent more likely to be malnourished and contract diseases such as malaria. (1) In the future, more frequent and intense drought has the potential to increase the prevalence of malnourishment and diseases such as malaria. Warming temperatures may also increase the range of malaria vectors, leading malaria to extend to Ethiopia's highlands. (1) This may be devastating for populations that have not had to deal with the disease before and may not have the proper health services to manage the disease.

## **Health Services**

Health services in Ethiopia tend to be limited, particularly in rural areas and for women and girls. Most health development and healthcare in Ethiopia occur at the community level. (48) However, this capacity has been increasing, with a fourfold increase in hospitals and health centers between 2004 and 2009, and a fivefold increase in health posts during the same period. (48) Ethiopia has also deployed more trained health workers and supervisors, although mostly in urban areas. (48)

Historically, climate hazards have had a limited impact on health services. However, more frequent and intense floods may threaten health center infrastructure and access. Furthermore, climate impacts that aggravate food insecurity and conflict may further disrupt and limit access to health services. (1)

Table 10 summarizes climate risks to human health—including nutrition, WASH, and health services—and potential adaptation responses to address these risks.

Table 10. Human Health: Nutrition, WASH, and health services climate risks and responses

| Climate Risks                                                                              | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Warmer temperatures driving the spread of malaria                                          | <ul style="list-style-type: none"> <li>• Increase malaria control, case management, and epidemic surveillance and responses (48)</li> <li>• Make anti-malaria drugs more available at community-level health posts (48)</li> <li>• Increase access to community health centers (48)</li> <li>• Expand health facilities (48)</li> <li>• Upgrade health centers to primary hospitals (48)</li> <li>• Improve the quality of laboratory systems (48)</li> <li>• Alert people regarding the importance of using bed nets and recognizing malaria symptoms (48)</li> <li>• Consider climate projections for temperature, precipitation, and humidity in assessing how malaria seasons may change, and incorporate this information into malaria early-warning systems (50, 51) <ul style="list-style-type: none"> <li>◦ For example, Malaria Early Warning System (MEWS) (19)</li> </ul> </li> <li>• Develop malaria risk maps based on climate projection data to help malaria control and health services plan activities (52)</li> </ul> |
| More frequent and intense precipitation and flooding events spreading waterborne diseases  | <ul style="list-style-type: none"> <li>• Increase education on effective hygiene and sanitation practices (48)</li> <li>• Make antibiotics more available at community-level health posts (48)</li> <li>• Increase access to community health centers (48)</li> <li>• Increase hygiene and sanitation services and practices in rural areas (47)</li> <li>• Replace old and rusty water reservoirs (47)</li> <li>• Cover manholes with metal sheets (47)</li> <li>• Replace old and damaged galvanized pipes with high-density polyethylene plastic (47)</li> <li>• Construct roads to water supply sources (47)</li> <li>• Develop risk maps for waterborne diseases based on climate projection data for temperature, precipitation, flooding, and drought (53)</li> </ul>                                                                                                                                                                                                                                                            |
| Multiple climate hazards decreasing agricultural productivity and driving malnutrition     | <ul style="list-style-type: none"> <li>• Offer training to health and agriculture workers on food security and nutrition to ensure a comprehensive response to malnutrition (48)</li> <li>• Provide nutrient-rich food seeds to vulnerable households to combat malnutrition (54)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| More frequent and intense drought reducing the quantity and quality of drinking water      | <ul style="list-style-type: none"> <li>• Increase rural self-supply of water by shifting to local procurement of handpumps (47)</li> <li>• Research and develop technology options to improve the design of rope pumps, 50-millimeter small-bore handpumps, and sludge well drilling (47)</li> <li>• Train local artisans and users in the installation and use of appropriate technology to obtain water (47)</li> <li>• Introduce remote-sensing technologies to improve hydrogeological knowledge of groundwater aquifers (47)</li> <li>• Build water-retaining structures such as diversion ditches and retaining walls (47)</li> <li>• Construct roads to water supply sources (47)</li> </ul>                                                                                                                                                                                                                                                                                                                                     |
| More frequent and intense flooding resulting in the loss of human lives and infrastructure | <ul style="list-style-type: none"> <li>• Build water-retaining structures such as diversion ditches and retaining walls (47)</li> <li>• Plant indigenous vegetation around water sources to avoid heavy flooding and improve water recharge (47)</li> <li>• Cover manholes with metal sheets (47)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## SENSITIVE ECOSYSTEMS AND ECOSYSTEM SERVICES

Ethiopia has a protected area system covering 14 percent of its landmass. (55) The country has 12 major river basins, about seven of which fall within the FFP target geography regions. (56, 57) The main watershed is in the country's highlands, providing an important ecosystem service for the more arid lowlands. (55) Both Ethiopia's highland plateau and arid Horn of Africa are biodiversity hotspots due to their high rate of endemism, and the country's wetlands are home to breeding sites for threatened bird species. (55, 56) Ethiopia also has several United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage sites, including one natural site, the

Simien National Park (located in Amhara, an FFP target geography), and eight cultural sites (five of which are in FFP target geographies, with one in Tigray, two in Amhara, and two in Oromia). (58)

The rich ecosystems in Ethiopia provide a multitude of services; for example, its montane forests regulate downstream water flows and mitigate against extreme climate hazards, such as flooding. (56) African ecosystems typically support livelihoods (e.g., by providing firewood, supporting ecotourism), and ecosystems with high biodiversity help regulate climate and diseases, support soil and nutrients, sequester carbon, and support recreation. (59) For example, the bovine tuberculosis infection rate has been associated with a loss of abundance of mammalian species. (59)

Many of the existing threats to Ethiopia's sensitive ecosystems—such as land degradation, conversion to agricultural production, overgrazing, and invasive species—may intensify due to projected changes in climate. (55) Increased drought frequency and severity may cause more drying of ecosystems—particularly wetlands—threatening the species that rely on these habitats. (1, 55) Warmer temperatures and more frequent and intense extreme events are also expected to alter ecosystems and the species that can thrive within them, drive a loss of biodiversity, and potentially expand the range of invasive species and the competition that they pose to native ones. (1, 55, 59) These impacts to ecosystems also have the potential to adversely affect ecosystem services, such as nutrient cycling, disease regulation, carbon sequestration, and provision of resources such as food, fuel, and water. (59)

Table 11 summarizes climate risks to sensitive ecosystems and ecosystem services, and potential adaptation responses to address these risks.

*Table 11. Sensitive ecosystems climate risks and ecosystem services and responses*

| Climate Risks                                                                                                      | Potential Adaptation Responses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Drought and insufficient rains <b>threatening wetland habitats</b>                                                 | <ul style="list-style-type: none"> <li>• Improve the capacity of water resource management agencies (56)</li> <li>• Support river basin monitoring networks (56)</li> <li>• Strengthen the capacity to monitor forest and biodiversity resources, evaluate status and threats, and formulate actions (56)</li> <li>• Develop and test new governance arrangements for forest resources (56)</li> <li>• Seedling propagation and planting for reforestation (60)</li> <li>• Implement anti-erosive barriers to protect riverbanks (60)</li> <li>• Habitat and watershed rehabilitation (60)</li> <li>• Identify and protect ecologically significant areas (e.g., spawning grounds, nursery grounds, areas of high diversity) (61)</li> <li>• Remove hard protection or other barriers to riverine flow (61)</li> <li>• Connect landscapes with corridors to enable migrations (61)</li> </ul> |
| Multiple climate hazards lowering agricultural productivity and <b>driving more conversion of land for farming</b> | <ul style="list-style-type: none"> <li>• Use of agroforestry to improve soil fertility (60)</li> <li>• Implement policies that provide incentives for environmental stewardship (62)</li> <li>• Invest in livestock productivity (62)</li> <li>• Improve access to non-farm markets to reduce pressure on land resources (62)</li> <li>• Improve government effectiveness and land tenure security (62)</li> <li>• Increase adoption of integrated soil fertility management (62)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                  |
| Changes in climate altering ecosystems and <b>threatening native and endemic species</b>                           | <ul style="list-style-type: none"> <li>• Implement conservation programs to protect ecosystems and native and endemic species</li> <li>• Establish protected areas to prevent human-caused damage to ecosystems that further threaten ecosystem health</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## KEY RESOURCES

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- <sup>1</sup> USAID. 2016. Climate Change Risk Profile: Ethiopia. [https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Factsheet%20-%20Ethiopia\\_use%20this.pdf](https://www.climatelinks.org/sites/default/files/asset/document/2016%20CRM%20Factsheet%20-%20Ethiopia_use%20this.pdf)
- <sup>2</sup> The U.S. Government's Global Hunger & Food Security Initiative. 2019. Feed the Future Global Food Security Strategy: Ethiopia Country Plan 2019–2023. <https://www.usaid.gov/sites/default/files/documents/1867/GFSS-Country-Plan-Ethiopia-FINAL-April-2019.pdf>
- <sup>3</sup> Ethiopian Public Health Institute. 2019. Mini Demographic and Health Survey 2019: Key Indicators. <https://dhsprogram.com/pubs/pdf/PR120/PR120.pdf>
- <sup>4</sup> USAID. 2019. Food Assistance Fact Sheet: Ethiopia. <https://reliefweb.int/report/ethiopia/ethiopia-food-assistance-fact-sheet-updated-august-21-2019>
- <sup>5</sup> USAID. 2019. USAID Disaster Assistance: Ethiopia. <https://www.usaid.gov/crisis/ethiopia>
- <sup>6</sup> USAID. 2019. Ethiopia – Complex Emergency, Fact Sheet #2, Fiscal Year (FY) 2019, August 21, 2019. [https://www.usaid.gov/sites/default/files/documents/1866/ethiopia\\_ce\\_fs02\\_08-21-2019.pdf](https://www.usaid.gov/sites/default/files/documents/1866/ethiopia_ce_fs02_08-21-2019.pdf)
- <sup>7</sup> FEWES NET. 2019. East Africa: Ethiopia. <http://fewes.net/east-africa/ethiopia>
- <sup>8</sup> USAID. 2018. Feeding Ethiopia. [https://www.usaid.gov/sites/default/files/documents/1860/Ethiopia-Fact\\_Sheet\\_Feeding-Ethiopia\\_Oct-2018.pdf](https://www.usaid.gov/sites/default/files/documents/1860/Ethiopia-Fact_Sheet_Feeding-Ethiopia_Oct-2018.pdf)
- <sup>9</sup> Feed the Future. 2018. Climate-Smart Agriculture in Ethiopia. <https://ccafs.cgiar.org/publications/climate-smart-agriculture-ethiopia#.XkrvwWhKiUk>
- <sup>10</sup> USAID and Government of Ethiopia Disaster Risk Management and Food Security Sector, MOARD. 2016. An Atlas of Ethiopian Livelihoods: The Livelihoods Integration Unit. [http://foodeconomy.com/wp-content/uploads/2016/02/Atlas-Final-Web-Version-6\\_14.pdf](http://foodeconomy.com/wp-content/uploads/2016/02/Atlas-Final-Web-Version-6_14.pdf)
- <sup>11</sup> CIAT; BFS/USAID. 2017. Climate-Smart Agriculture in Ethiopia: CSA Country Profiles for Africa Series. <https://cgspace.cgiar.org/handle/10568/92491>
- <sup>12</sup> World Bank. 2019. Climate Change Knowledge Portal: Ethiopia: Historical. <https://climateknowledgeportal.worldbank.org/country/ethiopia/climate-data-historical>
- <sup>13</sup> World Bank. 2019. Climate Change Knowledge Portal: Ethiopia: Projections. <https://climateknowledgeportal.worldbank.org/country/ethiopia/climate-data-projections>
- <sup>14</sup> Food and Agriculture Organization of the United Nations. 2019. FAO in Ethiopia. <http://www.fao.org/ethiopia/fao-in-ethiopia/ethiopia-at-a-glance/en/>
- <sup>15</sup> FEWES NET. 2009. Ethiopia Livelihood Zones: Livelihood Zone Map. <https://fewes.net/east-africa/ethiopia/livelihood-zone-map/november-2009>
- <sup>16</sup> United Nations. 2020. Global Humanitarian Overview. [https://www.unocha.org/sites/unocha/files/GHO-2020\\_v9.1.pdf](https://www.unocha.org/sites/unocha/files/GHO-2020_v9.1.pdf)
- <sup>17</sup> World Food Programme. 2019. Comprehensive Food Security and Vulnerability Analysis (CFSVA). <https://docs.wfp.org/api/documents/WFP-0000106754/download/>
- <sup>18</sup> FAO. 2008. Climate Change and Food Security: A Framework Document. <http://www.fao.org/3/k2595e/k2595e00.pdf>
- <sup>19</sup> IRI. 2007. Climate risk management in Africa: Learning from practice. [https://iri.columbia.edu/wp-content/uploads/2013/07/Climate-and-Society-No1\\_en.pdf](https://iri.columbia.edu/wp-content/uploads/2013/07/Climate-and-Society-No1_en.pdf)
- <sup>20</sup> Assefa, F., Ayalew, D., and Tejada Moral, M. 2019. Status and control measures of fall armyworm (*Spodoptera frugiperda*) infestations in maize fields in Ethiopia: A review. *Cogent Food & Agriculture* 5(1). <https://www.tandfonline.com/doi/full/10.1080/23311932.2019.1641902>
- <sup>21</sup> Intergovernmental Authority on Development (IGAD). 2019. IGAD Concludes the 4th National Consultation on the Red Sea and the Gulf of Aden. <https://www.igad.int/about-igad/61-statements?limit=5>
- <sup>22</sup> FAO. 2019. Desert Locust outbreak worsens in Ethiopia. <http://www.fao.org/emergencies/fao-in-action/stories/stories-detail/en/c/1247226/>

- 
- <sup>23</sup> USAID OFDA. 2020. Emergency Transboundary Outbreak Pests (ETOPs) Situation for December with a forecast through mid-February 2020.  
[https://www.usaid.gov/sites/default/files/documents/1866/etop\\_bulletin\\_12-2019.pdf](https://www.usaid.gov/sites/default/files/documents/1866/etop_bulletin_12-2019.pdf)
- <sup>24</sup> The West Wing Think Tank. 2019. The Future of Work for smallholder farmers in Ethiopia.  
<https://www.government.nl/binaries/government/documents/reports/2019/07/04/the-future-of-work-for-smallholder-farmers-in-ethiopia/The+Future+of+Work+for+smallholder+farmers+in+Ethiopia.pdf>
- <sup>25</sup> McSweeney, R. 2019. Explainer: 'Desertification' and the role of climate change. CarbonBrief.  
<https://www.carbonbrief.org/explainer-desertification-and-the-role-of-climate-change>
- <sup>26</sup> Ethiopia Ministry of Agriculture. 2014. Productive Safety Net Programme (PSNP) Phase IV: Programme Implementation Manual.  
[https://www.usaid.gov/sites/default/files/documents/1866/psnp\\_iv\\_programme\\_implementation\\_manual\\_14\\_dec\\_14.pdf](https://www.usaid.gov/sites/default/files/documents/1866/psnp_iv_programme_implementation_manual_14_dec_14.pdf)
- <sup>27</sup> FEWS NET. 2006. Southern Nation, Nationalities and People's Region, Ethiopia Livelihood Profiles.  
[https://fews.net/sites/default/files/documents/reports/et\\_baseline\\_rural\\_SNNPR\\_en.pdf](https://fews.net/sites/default/files/documents/reports/et_baseline_rural_SNNPR_en.pdf)
- <sup>28</sup> Eggen, M. 2019. Vulnerability of sorghum production to extreme, sub-seasonal weather under climate change. <https://iopscience.iop.org/article/10.1088/1748-9326/aafe19/pdf>
- <sup>29</sup> Kebede, B. T., Abdisa, T. O., & Berkessa, A. J. Review on The Expected Role of Climate Smart Agriculture on Food System in Ethiopia.  
<https://pdfs.semanticscholar.org/cb69/ca09fb413f92c2fd51a8e7dde0493daf7360.pdf>
- <sup>30</sup> Wubie, A. A. 2015. Review on the Impact of Climate Change on Crop Production in Ethiopia.  
<https://pdfs.semanticscholar.org/ecc2/76cfc5a33b69efff80ee6b08ccb166eb76d9.pdf>
- <sup>31</sup> Gezie, M. 2019. Farmer's response to climate change and variability in Ethiopia: A review.  
<https://www.tandfonline.com/doi/full/10.1080/23311932.2019.1613770>
- <sup>32</sup> IRI. 2009. Index insurance and climate risk: Prospects for development and disaster management.  
[https://www.preventionweb.net/files/10755\\_ClimateandSocietyIssueNumber21.pdf](https://www.preventionweb.net/files/10755_ClimateandSocietyIssueNumber21.pdf)
- <sup>33</sup> Feed the Future. 2019. Feed the Future Ethiopia Country Strategy at a Glance.  
[https://www.usaid.gov/sites/default/files/documents/1867/Feed\\_the\\_Future\\_Ethiopia\\_Country\\_Plan\\_At\\_A\\_Glance\\_FINAL\\_4-5-2019.pdf](https://www.usaid.gov/sites/default/files/documents/1867/Feed_the_Future_Ethiopia_Country_Plan_At_A_Glance_FINAL_4-5-2019.pdf)
- <sup>34</sup> USAID. 2020. Feed the Future Activities in Ethiopia. <https://www.usaid.gov/ethiopia/agriculture-and-food-security/feed-future/usaidthiopia-feed-future-activities>
- <sup>35</sup> Gebeyehu, A. 2014. Climate Change Adaptation to Enhance Livestock Production.  
[https://www.academia.edu/6488294/Climate\\_Change\\_Adaptation\\_to\\_Enhance\\_Livestock\\_Production](https://www.academia.edu/6488294/Climate_Change_Adaptation_to_Enhance_Livestock_Production)
- <sup>36</sup> Oxfam. 2016. With drought killing their livestock, many Ethiopians have no other source of food or income.  
<https://www.oxfamamerica.org/explore/stories/with-drought-killing-their-livestock-many-ethiopians-have-no-other-source-of-food-or-income/>
- <sup>37</sup> FAO. 2017. Drought-stricken herders in Ethiopia need urgent support.  
<http://www.fao.org/news/story/en/item/1028825/icode/>
- <sup>38</sup> Lamesegn, D. 2019. Review on effects of climate change on livestock production in Ethiopia.  
[https://www.researchgate.net/publication/331383659\\_Review\\_on\\_effects\\_of\\_climate\\_change\\_on\\_livestock\\_production\\_in\\_Ethiopia](https://www.researchgate.net/publication/331383659_Review_on_effects_of_climate_change_on_livestock_production_in_Ethiopia)
- <sup>39</sup> Ruo, G., Weldegebrial, B., Yohannes, G., and Yohannes, G. 2018. Climate change adaptation practices by ruminant livestock producer in Hintalo Wajerat District Tigray Regional State, Northern Ethiopia.  
<https://biomedres.us/pdfs/BJSTR.MS.ID.002166.pdf>
- <sup>40</sup> Rojas-Downing, M. M., Nejadhashemi, A. P., Harrigan, T., and Woznicki, S. A. 2017. Climate change and livestock: Impacts, adaptation, and mitigation.  
<https://www.sciencedirect.com/science/article/pii/S221209631730027X>
- <sup>41</sup> Witt, A., Beale, T., and van Wilgen, B. W. 2018. An assessment of the distribution and potential ecological impacts of invasive alien plant species in eastern Africa.  
<https://www.tandfonline.com/doi/full/10.1080/0035919X.2018.1529003>
- <sup>42</sup> Shiferaw, W., Demissew, S., and Bekele, T. 2018. Invasive alien plant species in Ethiopia: Ecological impacts on biodiversity, a review paper. <https://medcraveonline.com/IJMBOA/IJMBOA-03-00072.pdf>
- <sup>43</sup> Mulas, M., Negussie, E., Mibei, H., Onyango, D., Bateman, M., Wood, A., and Dougoud, J. 2018. Study on crop protection where the 'Green Innovation Centres for the Agriculture and Food Sector' (GIAE) initiative is

---

being implemented.

<https://www.cabi.org/Uploads/CABI/projects/GIZ/Giz%20Country%20Report%20Ethiopia%20Final.pdf>

<sup>44</sup> USAID. 2013. Farmer-to-Farmer Programmatic PERSUAP: Pesticide Evaluation Report and Safer Use Action Plan. [https://pdf.usaid.gov/pdf\\_docs/PA00K2BJ.pdf](https://pdf.usaid.gov/pdf_docs/PA00K2BJ.pdf)

<sup>45</sup> Vermeulen, S. J., Campbell, B. M., and Ingram, J. S. I. 2012. Climate Change and Food Systems. <https://sustainabledevelopment.un.org/content/documents/881annurev.pdf>

<sup>46</sup> FAO. 2016. Developing the cold chain in the agrifood sector in sub-Saharan Africa. <http://www.fao.org/3/a-i3950e.pdf>

<sup>47</sup> UNICEF. 2016. Evaluation of the UNICEF Ethiopia Water, Sanitation & Hygiene (WASH) Country Programme Document (CPD): 2012–2016.

<https://www.unicef.org/ethiopia/media/396/file/UNICEF%20Ethiopia%20WASH%20CPD.pdf>

<sup>48</sup> USAID. 2011. Country Development Cooperation Strategy: 2011–2019.

[https://www.usaid.gov/sites/default/files/documents/1860/CDCS\\_Ethiopia\\_December\\_2018r1\\_updated20192.pdf](https://www.usaid.gov/sites/default/files/documents/1860/CDCS_Ethiopia_December_2018r1_updated20192.pdf)

<sup>49</sup> WHO. 2016. Climate Change and Health – Ethiopia. <https://www.who.int/globalchange/resources/wash-toolkit/climate-change-and-health-lessons-learned-documentation.pdf?ua=1>

<sup>50</sup> Reid, C. 2013. Utilizing NASA EOS to Improve Early Warning and Mitigation of Malaria in Ethiopia.

<https://earthzine.org/utilizing-nasa-eos-to-improve-early-warning-and-mitigation-of-malaria-in-ethiopia/>

<sup>51</sup> Thomson, M. C., Ikawuba, I., Hershey, C. L., Bennett, A., Ceccato, P., Lyon, B., and Dinku, T. 2017. Using Rainfall and Temperature Data in the Evaluation of National Malaria Control Programs in Africa.

<https://www.ajtmh.org/content/journals/10.4269/ajtmh.16-0696?crawler=true>

<sup>52</sup> Grover-Kopec, E. K., Blumenthal, M. B., Ceccato, P., Dinku, T., Omumbo, J. A., and Connor, S. J. 2006. Web-based climate information resources for malaria control in Africa.

<https://malariajournal.biomedcentral.com/articles/10.1186/1475-2875-5-38>

<sup>53</sup> Levy, K., Woster, A. P., Goldstein, R. S., and Carlton, E. J. 2016. Untangling the impacts of climate change on waterborne diseases: A systematic review of relationships between diarrheal diseases and temperature, rainfall, flooding, and drought. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5468171/>

<sup>54</sup> USAID. 2018. Development Food Security Activities: Food for the Hungry/Ethiopia.

[https://www.usaid.gov/sites/default/files/documents/1866/Ethiopia\\_DFSA\\_Fact\\_Sheet\\_FH.pdf](https://www.usaid.gov/sites/default/files/documents/1866/Ethiopia_DFSA_Fact_Sheet_FH.pdf)

<sup>55</sup> EWCA. n.d. The Value of the Ethiopian Protected Area System: Message to Policy Makers.

<https://www.cbd.int/financial/values/ethiopia-valueprotectedareas.pdf>

<sup>56</sup> World Bank. n.d. Ethiopia: Climate Risk Factsheet.

[http://siteresources.worldbank.org/INTAFRICA/Resources/Ethiopia\\_Country\\_Note.pdf](http://siteresources.worldbank.org/INTAFRICA/Resources/Ethiopia_Country_Note.pdf)

<sup>57</sup> Awlache, S. B., Louised, M., Ayana, M., Yilma, A. D., Loiskandi, W., and Alamirew, T. 2007. Water Resources and Irrigation Development in Ethiopia. [https://www.researchgate.net/figure/Ethiopian-river-basins-map\\_fig1\\_42765483](https://www.researchgate.net/figure/Ethiopian-river-basins-map_fig1_42765483)

<sup>58</sup> UNESCO. n.d. Ethiopia World Heritage List. <https://whc.unesco.org/en/statesparties/et>

<sup>59</sup> Sintayehu, D. W. 2018. Impact of climate change on biodiversity and associated key ecosystem services in Africa: A systematic review. <https://www.tandfonline.com/doi/full/10.1080/20964129.2018.1530054>

<sup>60</sup> GEF. 2018. Climate Change Adaptation in Africa: UNDP Synthesis of Experiences and Recommendations. <https://www.thegef.org/sites/default/files/publications/CCA-Africa-Final.pdf>

<sup>61</sup> U.S. EPA. 2019. Adaptation Actions for Water Management and Ecosystem Protection.

<https://www.epa.gov/arc-x/adaptation-actions-water-management-and-ecosystem-protection>

<sup>62</sup> Nkonya, E., Johnson, T., Kwon, H. Y., and Kato, E. 2015. Economics of Land Degradation in Sub-Saharan Africa. [https://link.springer.com/chapter/10.1007/978-3-319-19168-3\\_9](https://link.springer.com/chapter/10.1007/978-3-319-19168-3_9)