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Famine Early Warning Systems Network—Informing Climate Change Adaptation Series

FEWS NET FAMINE EARLY WARNING SYSTEMS NETWORK

A Climate Trend Analysis of Burkina Faso

Conclusions

- *Summer rains have remained steady over the past 20 years, but remain 15 percent below the 1920–69 average.*
- *Temperatures have increased by 0.6° Celsius since 1975, amplifying the effect of droughts.*
- *The amount of farmland per person is low, and declining.*
- *Burkina Faso has offset rapid population growth with improved yields.*
- *Continued yield growth would maintain current levels of per capita food production.*

Food Security Context

Burkina Faso is a landlocked country (area: 274,200 square kilometers) with a population estimated at 16.8 million people; it has an annual growth rate of 3.1 percent (CIA, 2011). The agriculture sector engages more than 80 percent of the active population. Agriculture accounts for about 35 percent of the gross domestic product and employs about 90 percent of the labor force. Millet, sorghum, maize, and rice are the principal crops grown for domestic consumption. The livestock sector was once substantial but had declined by 2002. Like other Sahelian countries, Burkina Faso's agriculture is mainly rainfed, making it highly dependent upon rainfall amounts and distribution. In good seasons, the country's coarse grain production covers domestic consumption needs, and cereal imports are limited to rice and wheat. The northern part of the country, namely the regions of Nord, Centre-Nord, and Sahel (see Objectives and Methods section), is characterized by a shorter growing season, higher rainfall variability, and less diversified agriculture. This area, therefore, is the most vulnerable to food insecurity.

This brief report, drawing from a multi-year effort by the U.S. Agency for International Development (USAID) Famine Early Warning Systems Network (FEWS NET), examines recent trends in rainfall and air temperatures. These analyses are based on quality controlled station observations.

Rainfall Recovery Has Stalled

Rainfall in Burkina Faso declined rapidly between 1950 and the mid-1980s, and recovered in the 1990s. Between 2000 and 2009, however, the recovery stalled, and the 2000–2009 average remained about 15 percent lower than the 1920–69 mean average. The recent rainfall increases are probably due

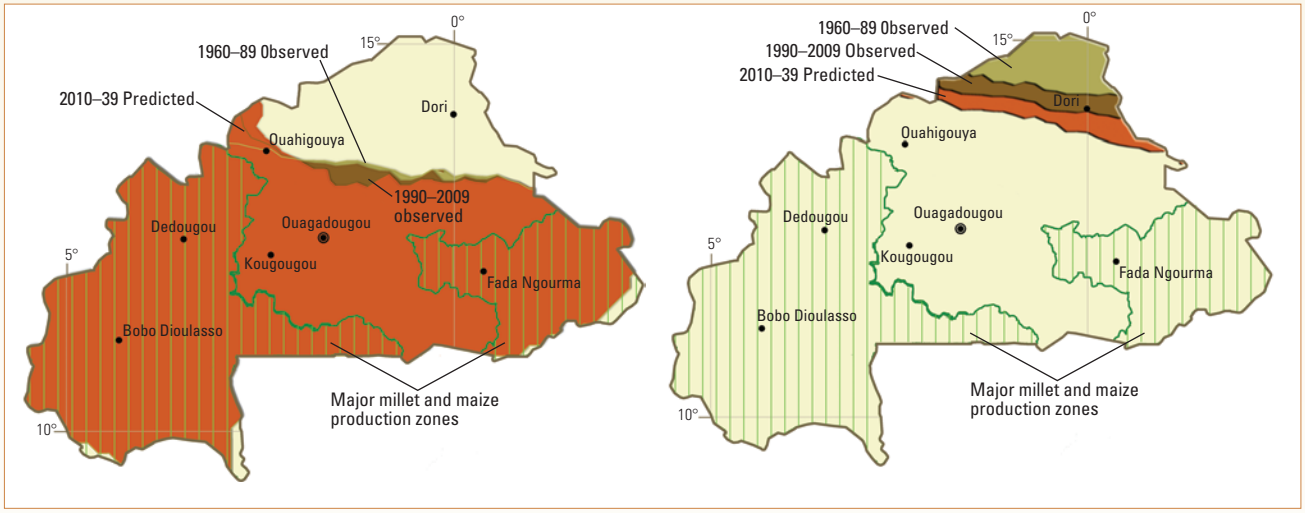

Figure 1. Climate change in Burkina Faso: The left map shows the average location of the June–September 500 millimeter rainfall isohyets for 1960-89 (light brown), 1990–2009 (dark brown), and 2010–39 (predicted, orange). The green polygons in the foreground show the main crop production regions for millet and maize. The right map shows analogous changes for the June-September 30 degrees Celsius air temperature isotherms.

to the warming of the northern Atlantic Ocean (Hoerling and others, 2006); as the northern tropical Atlantic has increased in temperature over this period, this has drawn the summer rains further north, increasing rainfall in the Sahel. These changes can be visualized in three ways: as an expansion of the region receiving adequate rainfall for viable agricultural livelihoods, as maps of anticipated changes in rainfall, and as time series plots.

Burkina Faso receives most of its rain between June and September, and rainfall totals of more than 500 millimeters during this season typically provide enough water for crops and livestock. Between 1960 and 1989, the region receiving (on average) this much rain during June–September is shown in light brown in the left panel of figure 1 and should be understood to lie beneath the dark brown and orange areas. During the past 20 years, this region has remained fairly constant.

Rainfall reductions and temperature increases can be visualized by combining the observed 1960–2009 changes with predicted 2010–39 changes, based on persistence of the observed trends (fig. 2, top panels). Rainfall declines range from -50 to -10 millimeters across most of the country. Observed changes (between 1960 and 2009) account for 63 percent of the change magnitudes.

A smoothed time series (fig. 2, lower panel, 10-year running means) of rainfall from 1900–2009, extracted for crop growing regions in Burkina Faso, indicate that 2000–09 rainfall has been, on average, about 15 percent lower than rainfall between 1920 and 1969. Rainfall recovered since the mid-1980s, but the increase has leveled off during the past decade, and 2000–2009 rainfall remains substantially below its 1920–69 mean. These time series were based on crop growing regions in western Burkina Faso (Nord, Boucle Du Mouhoun, Centre-Ouest, Haut-Bassins, and Sud-Ouest regions) and eastern Burkina Faso (Centre-Nord, Est, Plateau Central, Centre, Centre-Est, and Centre-Sud regions). The Objectives and Methods section gives the population totals for these regions.

Much Warmer Air Temperatures

Since 1975, temperatures have increased by more than 0.6° Celsius (°C) across most of Burkina Faso, with typical rates of warming greater than 0.15°C per decade. Assuming the observed trends persist, a composite of observed and anticipated air temperature changes can be created (fig. 2, top panel). Again, observed changes alone account for 63 percent of the change magnitudes. A time series of air temperature data (fig. 2, lower panel) shows that the magnitude of recent warming is large and unprecedented within the past 110 years. We estimate that the 1975 to 2009 warming has been more than 0.5°C for Burkina Faso during the June–September rainy season. Given that the standard deviation of annual air temperatures in these regions is low (0.4°C), these increases represent a large (+1.2 standard deviations) change from the climatic norm. Burkina Faso is becoming significantly hotter, and such warming, in regions with high average air temperatures, could reduce crop harvests and pasture availability, amplifying the impact of water shortages and droughts.

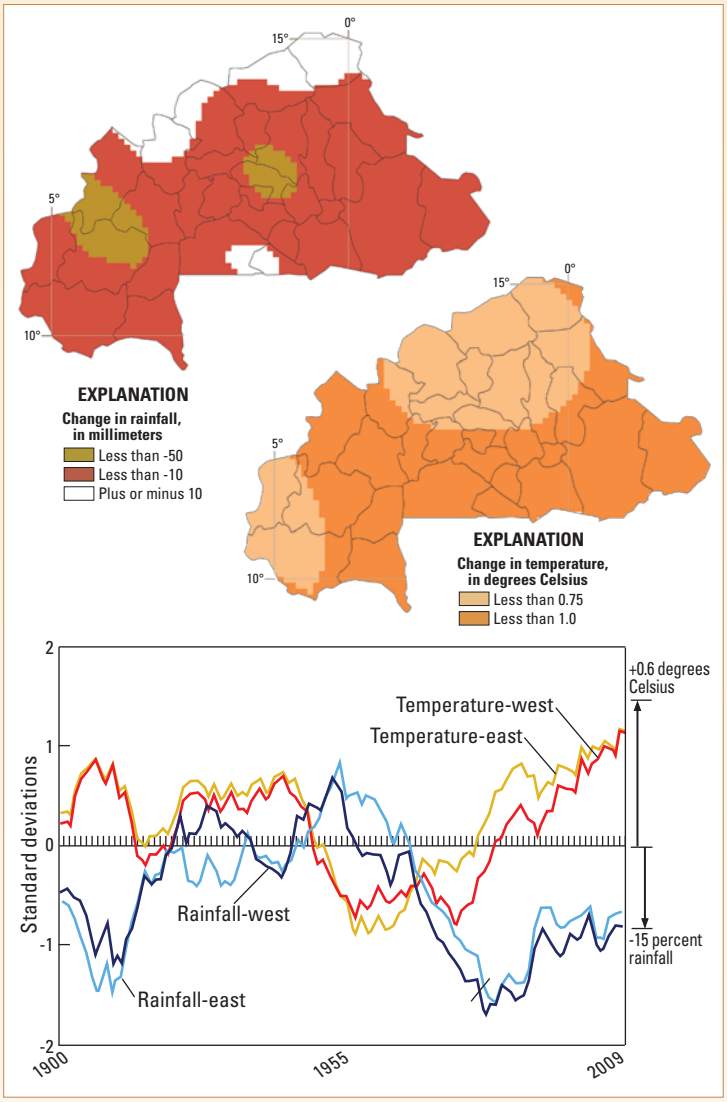

Figure 2. Observed and projected change in June–September rainfall and temperature (top), together with smoothed rainfall and air temperature time series for east and west Burkina Faso. Mean rainfall and temperature are based on the 1920–69 time period.

Divergent Climate Trends

The results presented here point to two divergent climate tendencies: rainfall has increased since the 1970s, while air temperatures have also increased (fig. 2, bottom panel). Historically (before 1970), increasing air temperatures have been associated with less rain and vice versa; therefore, the unprecedented recent warming with increasing rainfall is probably due to a combination of rainfall enhancements caused by changes in Atlantic Ocean sea surface temperatures (Hoerling and others, 2006) and warming related to greenhouse gas and aerosol emissions. These analyses of station-based temperature data indicate large departures from normal, and this warming trend is projected to persist. Continued rainfall increases are much less certain since they seem to be linked to natural decadal variations in the Atlantic Ocean.

Population Growth Has Been Matched by Agricultural Development

In 2011, the estimated population of Burkina Faso was 16.8 million people (CIA, 2011). Burkina Faso has a high birth rate and a high population growth rate (3.1 percent); at this rate the population will double every 23 years. Between 1990 and 2010, Burkina Faso's population increased by 57 percent, with the largest increases in population occurring in Centre-Nord (1.4 million), Nord (0.8 million), and Boucle Du Mouhoun (0.7 million). Given that Burkina Faso is a landlocked, densely populated country, this rapid population expansion will place increasing stress on limited natural resources. Analysis of crop statistics from the Food and Agriculture Organization of the United Nations (FAO, 2011), however, shows that increases in crop yields have kept pace with population growth. Between the 1960s and 2000s, Burkina Faso's crop yields doubled, an increase unmatched in any other Sahelian country. Over the same period, the amount of farmland per person declined by 36 percent; however, the overall trajectory appears favorable, and 2025 projections based on these trends suggest that Burkina Faso will continue to produce about the same amount of cereal crops per person (236 kilograms per person per year).

Some Implications For Food Security and Adaptation

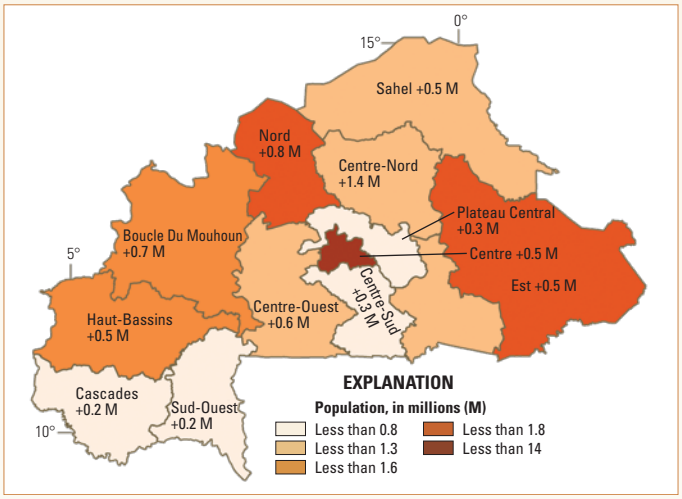

Figure 3. Landscan 2008 population (ORNL, 2010) for Burkina Faso along with Gridded Population of the World (CIESIN, 2010) estimates of 1990 to 2010 population change in millions of people.

The results presented here depict a combination of rainfall and air temperature increases, rapid population growth, and substantial increases in yields. In the past, Burkina Faso has experienced large, natural variations in mean rainfall on decadal time scales. If another natural rainfall decline occurs, the impact of this dryness could be augmented by the effects of warmer air temperatures. Given the potential for such a decline, raising yields in wetter areas may be a more viable option than extending agriculture into more marginal areas. The rapid population expansion in Nord and Centre-Nord, areas not associated with surplus crop production, and affected by the encroachment of very warm temperatures, could lead to increased food insecurity in these regions.

Objectives and Methods

The FEWS NET Informing Climate Change Adaptation series seeks to guide adaptation efforts by providing sub-national detail on the patterns of climate trends already observed in an appropriately documented record. Whether or not these observed trends are related to natural climate variations, global warming, or some combination of the two is less important than knowing where to focus adaptation efforts.

These FEWS NET reports rely on rigorous analysis of station data, combined with attribution studies using observed climate data. This brief report examines Burkina Faso rainfall and temperature trends for the last 110 years (1900–2009) using observations from 36 rainfall gauges and 7 air temperature stations for the primary rainy period, June–September. The data were quality controlled, and the mean 1960–89 and mean 1990–2009 station values calculated. The difference between these means was converted into 1960–2009 trend observations and interpolated using a rigorous geo-statistical technique (kriging). Kriging produces standard error estimates, and these can be used to assess the relative spatial accuracy of the identified trends. Dividing the trends by the associated errors allows us to identify the relative certainty of our estimates (Funk and others, 2005; Verdin and others, 2005; Brown and Funk, 2008; Funk and Verdin, 2009; Funk and others, 2012). Readers interested in more information can find these publications at *http://early-warning.usgs.gov/fews/reports.php*.

This report was written by Chris Funk and Jim Rowland (both USGS), Alkhalil Adoum (UCSB), Gary Eilerts (USAID), and Libby White (UCSB). It builds upon a multi-year research project (see references below) carried out under a USAID-funded FEWS NET agreement with USGS.

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