Climate Information Applications in Famine Early Warning and Decision Making Systems

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INTRODUCTION
The Climate Hazards Group (CHG) explores the impacts of climate change and variability on food security in the developing world, primarily in sub-Saharan Africa and Central America. As part of this work, the CHG seeks to quantify variations in temperature and rainfall and to contextualize those variations in terms of their impact on crop production. The resulting deliverables vary, but typically include a fact sheet or report from the U.S. Geological Survey (USGS), which details the impacts on a particular country or region. Outputs may also include stand-alone software, complementary rainfall estimates, or statistical support for analysis being performed at partner institutions. The work completed by the CHG is targeted to meet the needs of the United States Agency for International Development’s (USAID) Famine Early Warning System Network (FEWS NET), as well as non-governmental organizations (NGOs) and in-country decision makers, when applicable. These agencies are critical in the dissemination of CHG results.

FEWS NET scientists are based in countries of interest, where their proximity to key partners, such as in-country meteorological or agricultural services, facilitates distribution of CHG products to decision makers. This network of partners contributes to CHG efforts by providing a framework for analysis, feedback, and assistance in validation. In the end, these partners provide added credibility and help ensure that decision makers are acting with the best available information. Such actions include estimation of the crop production under different climatic conditions, identification of the population size and locations most vulnerable to a changing climate or the definition of the crop type best suited to changing growing variables.

SOCIOECONOMIC BACKGROUND
Mainly due to insufficient water availability, roughly 50 nations around the world currently face chronic food shortages; on average 20 percent or more of the populations of these countries are undernourished. By 2050, most of the planet could face acute, persistent water shortages. Caught between increasing demand and shrinking opportunities, many of the world’s poor will be forced to adapt, trapped by displacements and unsustainable agricultural practices that contribute to a downward spiral of land degradation. In this context, effective climate change adaptation will determine the fate of billions of people; effective adaptation requires knowing where increasingly scarce rains will fall and where lack of precipitation will render specific locales uninhabitable.

Meanwhile, too much water may also bring disaster. Diseases associated with wet conditions, such as malaria and Rift Valley Fever, exact a tremendous toll on people and their livelihoods, taking thousands of lives and costing billions of dollars. Today, flood-induced epidemics already account for 19 percent of all infectious disease-related deaths. In a single week, flooding can eradicate years of slow economic advances, gained through fiscal discipline and hard work. Climate-smart planning and decision-making informed by climate information can help communities to prepare for these impacts and diminish the threat of flood damage on the developing world.

TARGET AUDIENCE
The CHG has developed a close relationship with FEWS NET, a USAID-funded collaboration of international, regional, and national partners with a stake in early warning and vulnerability information regarding food security issues. FEWS NET is the primary audience receiving information produced by the CHG, though it transmits the information to various partner organizations including the UN and other groups such as the Agronomy-Hydrology-Meteorology (AGRHYMET) Regional Center in Niamey, Niger; the Drought Monitoring Center in Nairobi, Kenya; and the Regional Center for Mapping for Resource Development in Nairobi, Kenya.

CLIMATE AND CONTEXTUAL INFORMATION
Socioeconomic information on land use and livelihoods is utilized to identify regions that are particularly sensitive to climate shocks. For example, FEWS NET livelihood zones illustrate how people obtain and maintain fundamental nourishment. Land use information derived from the classification of satellite data is used to identify areas of land degradation and assist in identifying key agricultural zones.

The locations targeted by CHG research are usually tropical zones, with much of the rainfall for a given year falling in three or four months, defined by the movement of the Inter-tropical Convergence Zone. Average rainfall during these peak months may range from 50 to 500mm and is determined by latitude, elevation, proximity to coasts or lakes, and a number of other factors. While the mean rainfall may be spatially and temporally estimated, the amounts for a particular year may vary wildly from these mean conditions, highlighting the need for a nuanced understanding and detailed monitoring.

The CHG aims to reduce the impact of flooding and famine in the developing world using the statistical climatology, hydrology, Geographic Information Systems (GIS), remote sensing, and geostatistical capacities of the University of California Santa Barbara’s Geography Department (UCSB). The CHG generally uses free data products available from sources such as the National Ocean and Atmospheric Administration’s (NOAA) Climate Prediction Center (CPC), the Food and Agriculture Organization (FAO), and the World Meteorological Organization (WMO). Weather station data from Global Telecommunication System (GTS) are also used, along with limited data acquired or purchased from national meteorological services.
These datasets are used to establish long-term means, variance, or trends in climate records. Station data may be used to validate what is seen in model outputs, or define trends independently of models. The information used by the CHG typically consists of standard generic binary data grids, or ASCII data for stations. Very little, if any, data are tailored for CHG applications.

A few months before the rainy season, the CHG may publish general trends to help stakeholders anticipate likely rainfall or temperature changes. CHG information may also give insight into the food production expected from staple crops according to climatology. A month before the onset of rains, analysis focuses on prevailing sea surface temperature (SST) anomalies and what that indicates for the seasonal conditions with respect to rainfall and temperature. Finally, monitoring during the season focuses on putting the current year into a historical context, through anomalies, z-scores and analog years. All of this requires historical data for analysis.

IMPLEMENTATION

PROCESSES AND MECHANISMS

STAKEHOLDER AND ISSUE IDENTIFICATION

Stakeholders are engaged in this project at various levels. USAID/USGS are involved as funders, while the FAO, WMO, GTS, and national meteorological offices provide raw data. This data is then processed by the CHG using the capacities of UCSB. While FEWS NET can be considered the CHG’s primary information recipient, both organizations work together to identify, initiate contact with, and help determine the needs of other stakeholders. This identification process is sometimes carried out by FEWS NET representatives in the field, or by new stakeholders who approach them with requests to get involved.

Depending on the project and the capacities of partners, stakeholders may be directly involved in the scientific climate analysis, or they may only participate in framing results in a way that is useful to them. In the past, FEWS NET has worked with various UN organizations including the Agronomy-Hydrology-Meteorology (AGRHYMET) Regional Center in Niamey, Niger; Drought Monitoring Center in Nairobi, Kenya; Regional Center for Mapping for Resource Development in Nairobi, Kenya; and the Southern Africa Development Community’s Regional Remote Sensing Unit in Harare, Zimbabwe. Domestic services and decision-makers performing food security analyses also rely on the success of the CHG service.

The network of groups involved in producing these climate services first began with USCB professors, researchers, and graduate students working on issues peripherally related to FEWS NET interests, either studying global patterns, which could indirectly relate to African applications, or executing science in locations other than Africa, which could be easily translated to the continent. Encouraged by researchers at USGS, the CHG was formed and began working to support FEWS NET, and this relationship continues to develop to better meet its objectives.

STAKEHOLDER INVOLVEMENT

The CHG, which consists of government and UCSB researchers, obtains its climate information from institutions such as NOAA, WMO, FAO, GTS, and national meteorological offices. It then delivers that information to FEWS NET and where applicable, to various NGOs and in-country decision-makers.

The FEWS NET team comprises scientists working in the United States and abroad. Researchers in the United States, with full access to the needed technology, are well situated to rapidly develop new theories and tools. Meanwhile, regional scientists stationed in developing countries can translate new theories and tools rapidly into practice. Through FEWS NET, information reaches UN organizations, domestic services, and decision-makers performing food security analysis. FEWS NET is both a critical link and valuable avenue for exchange, allowing information to be transmitted from the scientific community to the target audiences.

Communication between the CHG and its stakeholders is typically open, whether they are directly a part of FEWS NET, a different US agency, or an in-country agency. This allows the CHG to benefit from stakeholder experience in the region, provide data to help analysis, build trust, and strengthen the credibility of our results. This collaborative approach increases the impact and acceptance of CHG research, which is illustrated by the fact that it is often included in FEWS NET analysis. For example, the standardized precipitation index (SPI) developed at CHG, was transferred to USGS, and is now widely available on the USGS Africa Data Portal. FEWS NET scientists contribute to reports distributed on their website, such as the East Africa Food Security Outlook. CHG researchers also support field scientists contributing to regional meetings such as the climate outlook forums. In this example the analysis would include details about how existing SSTs have historically related to rainfall for a region, and this information will then be passed on to local meteorological services, such as the Kenyan Meteorological Department.

The CHG’s collaborative approach to the development of its service also allows it to tune its analysis of the projected impacts of the climate research to the needs of its partners. For example, a recent study by some CHG researchers published in the Journal of Applied Geography looks at rainfall and temperature trends in Mali. While rainfall was generally stable, there were increases in temperature and a related increase in crops’ demand for water during some key growing months. This change, while felt around the country as a whole, will actually only impact crop production over a narrow band where rainfall is not sufficient to overcome the anticipated increase in water demand. Identifying this region, and assessing the population there, provides a result tailored specifically for the interest of the food security community.

FUNDING MECHANISM

The CHG program is primarily supported by USAID, via the USGS. As a research endeavor, the CHG has been able to be fairly flexible with staffing by hiring post-doctoral researchers who use their time in the CHG as a launching point to more senior-level positions. This has been an effective model thus far, and has allowed the organization to adapt to funding conditions. The sustainability of the project is primarily dependent on USAID’s continued support of FEWS NET.

2 http://v4.fews.net/docs/Publications/EA_Outlook_2012_03_final.pdf
receiving only a small fraction—less than 10%—of other funds from other organizations such as NOAA.

**MANAGEMENT AND DECISION MAKING**

Institutions such as the WMO, FAO, NOAA, and in-country national meteorological offices provide climate information to the CHG, which is in charge of processing it, using UCSB resources. The CHG passes the information on to FEWS NET, which distributes it to UN organizations, other NGOs, domestic and in-country services, and decision-makers performing food security analysis. In providing information to partner institutions, the CHG tries to meet all demands for cooperation. When feasible, requests for cooperation may be organized so that all agencies can receive the same data. This approach is effective because it disseminates information as widely as possible and allows the CHG to identify the organizations that are best suited to add value to existing products.

Climate information is used to support decision-making in a number of ways. A better understanding of changing conditions may lead local agricultural services to recommend that producers use different varieties of seeds suited to new conditions. Crop yield can also be increased by shifting planting by a few weeks to better align peak rainfall with the plants’ need for water. In cases such as these, CHG results may get distributed to agricultural services, which use it to send messages to farmers.

As climate change is a spatial process, CHG seeks to identify the locations that are more or less suited to crop production and to analyze the populations within these zones. USAID and NGOs may use such information to help them anticipate future needs and determine where to allocate their limited resources.

**EVALUATION**

As part of the process for funding renewal, USAID conducts an annual review of the CHG’s productivity. This provides the CHG with feedback on whether its research has been able to effectively meet the needs of its funding agency, regarding the needs of the various stakeholders and decision-makers who are an integral part of the FEWS NET system. The evaluation of the CHG’s work considers the implementation of its recommendations and is performed by both USGS and USAID. Peer-reviewed publications also serve as another form of evaluation and have been abundant in recent years. These include journal articles, book chapters, and USGS reports (please see the following examples3).

**CAPACITIES**

**EXISTING CAPACITIES**

The institutional structure of UCSB is an essential part of the CHG’s foundation. This support allows for administrative capacities at all levels, but is most important in supplying the human resources necessary for hiring and providing benefits to CHG employees and field scientists working in Africa and Central America. Currently the CHG consists of four staff researchers (two government employees and two university employees), two computer programmers and four graduate students studying climate change topics. Further, four field scientists, based in Africa and Central America provide a direct link to in-country institutions and partners. These field scientists perform trainings on specific tools and software, give presentations on current research activities, and provide a contact point for information exchange between regional experts and US-based scientists.

**CAPACITY GAPS**

Certain infrastructural capabilities are typically outside of the capacity of the CHG’s African partners, particularly a fast and reliable Internet connection. Yet specific software applications, such as GeoWRSI and FACT, have allowed the CHG and its partner institutions to overcome other infrastructural obstacles. Using such software, the CHG has been able to share computer-programming expertise and provide tools to users or institutions, which can then utilize them in the development of their own analysis.

**LOOKING TOWARD THE FUTURE**

**GOALS**

The CHG will continue working towards monitoring, characterizing, anticipating and reducing the impacts of seasonal rainfall, especially with regards to food production. Far down the line, it envisions a system that updates the projected food production shortfalls based on weather and climate months in advance, giving government and international agencies advanced warning and time to position relief to minimize or eliminate food shortfalls.

**PROJECT EXPANSION**

The nature of rainfall, food production, and vulnerable populations is such that it can’t be captured at a global scale given current infrastructural constraints and scientific understanding. Efforts are currently underway to produce rainfall estimates everywhere from 50-degrees south to 50-degrees north. These types of products could prove critical to the scaling up of CHG activities to analysis of rainfall in areas beyond the food insecure developing world. Soliciting feedback and working with partners at a global scale could prove to require resources beyond the scope of what is feasible, or at least beyond what is currently in place.

**THE WAY FORWARD**

The main challenges moving forward involve identifying the conditions in a changing environment, and learning to better understand how this impacts food security issues. Our current understanding is far from complete, but we are making progress, and this progress must continue so that we can provide decision makers with the best available information in assessing food conditions.

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PRINCIPLES OF THE GFCS

The principles of CHG group is particularly reflected in principles 1, 2, 4, 6, 7, and 8.

Principle 1: All countries will benefit, but priority shall go to building the capacity of climate-vulnerable developing countries.

Principle 2: The primary goal of the Framework will be to ensure greater availability of, access to, and use of climate services for all countries.

Principle 3: Framework activities will address three geographic domains; global, regional and national.

Principle 4: Operational climate services will be the core element of the Framework.

Principle 5: Climate information is primarily an international public good provided by governments, which will have a central role in its management through the Framework.

Principle 6: The Framework will promote the free and open exchange of climate-relevant observational data while respecting national and international data policies.

Principle 7: The role of the Framework will be to facilitate and strengthen, not to duplicate.

Principle 8: The Framework will be built through user – provider partnerships that include all stakeholders.