Evaluating the Use of Remote Sensing data in the USAID Famine Early Warning Systems Network

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Abstract

The US Agency for International Development (USAID)'s Famine Early Warning System Network (FEWS NET) provides monitoring and early warning support to decision makers responsible for responding to food insecurity emergencies on three continents. FEWS NET uses satellite remote sensing and ground observations of rainfall and vegetation in order to provide information on drought, floods and other extreme weather events to decision makers. Previous research has presented results from a professional review questionnaire with FEWS NET expert end-users whose focus was to elicit Earth observation requirements. The review provided FEWS NET operational requirements and assessed the usefulness of additional remote sensing data. Here we analyzed 1342 food security update reports from FEWS NET. The reports consider the biophysical, socioeconomic, and contextual influences on the food security in 17 countries in Africa from 2000-2009. The objective was to evaluate the use of remote sensing information in comparison with other important factors in the evaluation of food security crises. The results show that all 17 countries use rainfall information, agricultural production statistics, food prices and food access parameters in their analysis of food security problems. The reports display large scale patterns that are strongly related to history of the FEWS NET program in each country. We found that rainfall data was used 84% of the time, remote sensing of vegetation 28% of the time, and gridded crop models 10%, reflecting the length of use of each product in the regions. More investment is needed in training personnel on remote sensing products to improve use of data products throughout the FEWS NET system.

1. Introduction

The Famine Early Warning Systems Network (FEWS NET), funded by the US Agency for International Development (USAID), works to improve global food security through the provision of actionable and early information to policy makers of populations at risk of malnourishment. Food security, which occurs when all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy and active life (FAO 2009), is a critical concern in the largely subsistence farming economies of sub-Saharan Africa. Rural populations, which rely on rain-fed agriculture and pastoralism for their livelihoods, are particularly susceptible to shifts in climate conditions (Verdin, 2005). Monitoring growing conditions using remote sensing information is currently part of early warning that can mitigate or even prevent the loss of lives and livelihoods associated with food security crises (Barrett and Maxwell 2005; Boudreau 1998).

This paper extends research published by Ross et al (2008) that focused on eliciting FEWS NET's data requirements. Using a professional review questionnaire with FEWS NET expert end-users, the study provided FEWS NET operational requirements and assessed the usefulness of additional remote sensing data for the system. Here, we examine FEWS NET's food security reports themselves to determine how remote sensing information is used in the system.

Communication of information about food security crises in FEWS NET occurs through a system of reports that are written each month in the country office by the country FEWS NET Representative and then sent to a central office in Washington DC for posting on an internet database (www.fews.net). These reports provide critical information upon which USAID makes decisions to where to send assistance and in what form. To identify the onset of food security crises, FEWS NET analysts use a "convergence of evidence" approach to combine biophysical and climate information with local and regional socioeconomic household livelihood analysis. Specifically, in-country analysts construct an assessment of food availability using production statistics as well as rainfall, temperature, and vegetation data derived from local measurements and from remote sensing to identify abnormally wet and dry periods (Brown 2008).

The analysts also evaluate market conditions, threats to pastoral resources, availability of wild food, and, ultimately, the agricultural economy as a whole to understand what impact these growing conditions may have on overall food security. Contextual livelihood information is then used to understand how these market and environmental conditions will impact specific groups in each community in the country (Boudreau 1998).

Here, we evaluate 1342 monthly food security update reports that were produced by FEWS NET's 17 African field offices for a ten year period from 2000 to 2009 (Table 1). The focus of this study is to evaluate the how food security analysts use satellite data as measures of environmental variability in the primary reporting mechanism of FEWS NET, the country report. By examining the actual reports, we can increase our understanding of how physical science data are used within the FEWS NET system. We quantified the utilization of data types across 14 categories, containing a total of 72 keywords (Table 2). We analyzed the reporting of data spatially by region (Table 4, Fig. 3) and temporally over the course of the decade (Fig. 2, Fig. 4). We then compared the frequency of data usage during growing and dry seasons (Fig. 5, Fig. 6) and in the context of agricultural production surplus and deficits (Fig. 5).

3. Data

Our primary source of information for this research consisted of 1342 monthly FEWS NET update reports from 17 countries in three regions of Africa (Table 1 and Figure 1). These reports were written by FEWS NET country representatives in each country during the period directly before each report date and sent to the Head Office in Washington D.C.

The reports represent analysis, information and description of ongoing problems without benefit of revision or amendment in hindsight. Once received by the Washington D.C. head office, the reports are posted on-line and hard copies are distributed widely within the affected country and in USAID within one month of the report date. We analyzed all available English language reports posted on the FEWS NET website from January 2000 to December 2009.

We use the locally determined growing and dry seasons as specified in each FEWS NET country in the 'Seasonal Calendar and Critical Events Timeline' section (www.fews.net). This information provides the growing period, harvest and dry periods for each country by month. We hand-coded this information for each country for the ten years of the analysis.

To estimate the high and low agricultural production periods in each of the 17 countries, we used annual production statistics from the Foreign Agricultural Service (FAS) Production, Supply, and Distribution (PSD) Online data for cereal and pulse commodities published in the World Agricultural Supply and Demand Estimates (WASDE) Report and listed in Table 3. The production data was obtained from agricultural attachés, FAS commodity analysts, and United States Department of Agriculture (USDA) Economic Research Service (ERS) commodity analysts. The variability of food production data during the period of 2000 through 2009 was measured using the coefficient of variation to determine the extent of the agricultural production deficits. Reports were grouped by country and agricultural years and categorized as production surplus or production deficit conditions.

4. Methodology

To analyze the data, we used a computer program to count the number of instances of each keyword in each document. The program reported zero if the word was not mentioned in the document. We began with 72 keywords and aggregated them by synonymy and parallelism to the 14 categories listed in Table 2. We categorized the data inputs into three broad divisions: Biophysical, Socioeconomic, and Contextual.

The Biophysical division focuses on the environmental influences on food security in the categories of: NDVI, RFE, WRSI, and Rainfall. The socioeconomic indicators include: Livestock, Production, Prices, Food Access, and Terms of Trade. The contextual livelihood parameters measured in this study are: Pests, Civil Insecurity, Disease, Refugee, and Malnourishment. These keywords were chosen as being important for food security assessment in the broader literature (Frankenberger 1992; Maxwell et al. 1999), and are critical in the ability of FEWS NET to understand the impact of production declines.

We confirmed the use of satellite remote sensing images in all 1342 reports through visual inspection of report figures. If a satellite-derived image of vegetation, rainfall or WRSI crop model output was present in the report, the time period for that country was given a one, if not, it was given a zero.

We then created a matrix with all possible months from January 2000 to December 2009 (120 months), 14 keywords and 17 countries. If an update report mentioned a keyword, we put the number of times the keyword was mentioned in the appropriate month-location. If it did not mention the word, a zero was placed there. If no report was generated that month, a 'missing data' term was put in that month-country-keyword location (Brown 2006).

Drawing from ten years of food security update reports, we compared the reporting of the types of data to the seasonal environmental variability and the annual agricultural production declines. These are measured using the FAS commodity production data. We categorize each year as a net positive or negative production year based on the 10-year mean and analyze the contents of the report given this information. The percent of positive anomaly years are listed in Table 1.

5. Results

The analysis shows that FEWS NET has a consistent approach to reporting across all 17 countries on the topics of rainfall, agricultural production, food prices. There are significant differences, however, in the use of remote sensing and other technical information between East, West and Southern regions. The West African analysts use vegetation data more than rainfall, and Southern African analysts use rainfall data almost exclusively, using very little vegetation data. Significantly more discussion of biophysical information was seen during the growing season than during the dry season across all regions. In contrast, there is little discrepancy between the use of satellite products during periods of agricultural production deficits as opposed to periods of adequate or surplus agricultural production.

Analyzing the reports by region for the presence of each category across all time periods, we found the highest levels of reporting of parameters that directly influence food supply and access. Rainfall information, agricultural production, food prices, and food access parameters are discussed consistently with reporting greater than 85% of the time for all regions. Table 4 shows livestock data are reported with greater than 95% consistency in West and East Africa, but are only mentioned in 55% of the Southern Africa reports. In addition, satellite-derived RFE data are incorporated with greater than 98% consistency in East African reports. Overall, East Africa has the most consistent levels of reporting of metrics across all 14 categories, and Southern Africa has the least consistent reporting of these data.

When we examine the magnitude of mentions per region, we similarly find the highest level of reporting for parameters that directly influence food security. Figure 2 shows that greater than 95% of all reports mention "Prices," "Production," and "Rainfall" more than one time per report. Food Access keywords are mentioned at least 40% of the time for all three regions. By comparing these consistently and frequently reported parameters, we find very similar distributions in the magnitude of mention of the market categories of "Prices," "Production," and "Food Access" across all three regions (Fig. 2). In contrast, the peak quantity of usage of the "Rainfall" keywords varies significantly by region, with East Africa discussing rainfall the most and Southern Africa discussing rainfall the least. This suggests that while agroclimatic conditions are important to the assessment of food security in general, the magnitude of reporting of rainfall data may reflect more general environmental differences specific to each region. The distribution of "Livestock" magnitudes of mention in Figure 2 also varies by region with over 80% of the reports from West and East Africa containing multiple mentions and only 25% of Southern African reports.

We were interested in broadening our examination of the reports beyond the remote sensing information, to see if other important analytical terms for food security had similar trends as the remote sensing. Figure 3 reports the absolute number of terms through time for the broad groupings of environmental, socioeconomic, and contextual keywords. The figure shows the number of times each category of keywords is mentioned per group of countries per month, with 180, 210 and 120 possible mentions per West, East and Southern Africa respectively. As expected, the reports show that socio-economic parameters are utilized with greater frequency than biophysical and contextual data sources for all three regions. Since food security is caused by broader economic and political contexts, these factors are likely to be more important than environmental conditions.

While the presence of "Rainfall" keywords was nearly ubiquitous in the reports, the frequency of mention of "Rainfall" demonstrated marked annual oscillations (Fig. 4). The timeseries plot for the magnitude of "Rainfall" mentioned in Malawi, Ethiopia, and Mali follows a cyclical frequency of reporting where the peak coincides with the respective growing seasons of January through April, June through October, and August through September. In contrast, the oscillations in the mentions of "Prices" do not seem to be as variable as “Rainfall”. The breaks in the lines reflect the absence of update reports for the corresponding months.

The seasonality of "Rainfall" mention is made more obvious when we divide the reports by Growing or Dry season for all countries (Fig. 5). The regional histograms clearly show a rightward shift between the number of mentions of "Rainfall" during the growing periods as compared to the dry periods. In contrast, the histograms for the usage of "Rainfall" did not respond as dramatically to high and low agricultural production years. The exception occurs in East Africa where there exists a notably high proportion of greater than 100 mentions per report of "Rainfall" during dry seasons. Overall, these data suggest that the reporting of environmental conditions is responsive to seasonal variability.

5.1 Remote Sensing Results

As the reporting of "Rainfall" reflects seasonal and regional variations of discussions of rainfall broadly, we sought to understand if the utilization of satellite-derived remote sensing information about environmental conditions was similarly responsive. Figure 6 shows both the country-level and regional reporting of NDVI, RFE and WRSI.

Overall, satellite remote sensing of vegetation (NDVI) was used 28% of the time, rainfall imagery (RFE) 84% and gridded crop models (WRSI) 10%. As demonstrated in Table 4, NDVI data are included in 46% of East African reports and are nearly absent with only 3% of Southern African reports. RFE is reported in 99% of reports from East Africa and least reported in West Africa, where it is present in only 74%. WRSI data are utilized in 17% of West African reports, but only 6% of Southern Africa reports.

East Africa most frequently uses satellite-derived biophysical data to assess food security. However, studying the data by country reveals that the distribution within each East African country is the most disparate among the regions (Fig. 6). Specifically, we find NDVI data are highly incorporated into reports from the East African countries of Somalia, Sudan, and Uganda, but are rarely used or absent in reports from Djibouti, Ethiopia, Kenya, and Tanzania. The data for RFE, however, is much more broadly used across all countries.

Despite regional distinction in the frequency of reporting, satellite-derived data from all three regions are sensitive to seasonal variation. FEWS NET analysts report NDVI, RFE, and WRSI data with a notably higher frequency during the growing seasons over the dry seasons. The discrepancy in reporting rates is most pronounced in the seasonal utilization of remote sensing data for the countries of West Africa (Fig. 6). In contrast, there is little response in the utilization of remote sensing data to agricultural production deficits.

6. Discussion

FEWS NET must balance multiple influences on food supply, such as changes in precipitation patterns and changes in agricultural productivity, with long-term systemic patterns of food access, including chronic poverty, insufficient public infrastructure and services, in the relevant political and economic contexts (Eilerts, 2006). Effective early warning for food security crises requires that the FEWS NET analysts are asking the right questions, using the most effective datasets, within the appropriate time frames. Remote sensing information enables earlier early warning of weather-related production declines (Brown et al. 2007), and can be a critical tool for areas that have a weak in-country presence.

The need for accurate, efficient, and actionable food security assessments remains important, particularly as economic and environmental pressures on developing countries are changing (Table 2). Over the next two decades, shifting precipitation patterns, rising temperatures, and more extreme weather events associated with climate change are projected to reduce the agricultural yields of corn, wheat, rice and other primary crops (Lobell 2008, Brown and Funk 2008). With the predicted increase in demand for food assistance, there will be an ever-greater need for rapid and targeted responses to food security crises that are driven by drought (Funk and Brown 2009). Biophysical data, coupled with contextual information, has the potential to accelerate response when there is a consensus that assistance is required (Brown 2007). As USAID expands its financial commitment to an improved resilience to climate change in Africa, remote sensing data is a valuable and underutilized tool for projecting future environmental conditions and agricultural production.

Our analysis shows the gridded crop model WRSI, which incorporates rainfall estimates from the current growing season to forecast a spatially specific projected crop yield at the end of the season, has been incorporated into less than 15% of African FEWS NET update reports in the last decade. Not only does WRSI provide a projection of food supply to policy makers *early*, it also provides a directive of the location and the extent of the problem that can enable a more efficient response. While gridded crop models have the potential to provide decision makers both within the USAID and local governances with actionable and defendable data to inform budgetary and policy mandates, realizing this potential will require additional training and efforts to make the data more usable to non-scientists.

Similarly, while the general concepts of "Food Access" and "Prices" were prevalent within the reports, there was limited reporting of primary determinants of market accessibility, such as measures of household purchasing power and terms of trade. To provide more specific and actionable information, future analysts should incorporate an analysis and description of the impact of a changing price regime, the likelihood of the regime changing and the consequences of higher (or lower) prices for food security. Moving simple presentation of data into analysis, which can be understood and acted upon by policy makers in Washington DC, is challenging and requires continuous interaction between the food security analyst and stakeholders who read the reports.

To provide actionable early warning information, FEWS NET analysts need not only to improve the specificity of their analysis of food supply and food access, but also to assess food security in the broader context of long-term nutrition patterns. "Malnourishment" was discussed in fewer than half of the food security assessment reports for Africa over the last decade. This was because little quantitative information on nutrition is usually available, and it is a lagging indicator of food security as it is the consequence rather than the cause of hunger. Thus, increasing the information available regarding nutrition analysis is important for diagnosing the impact of crises when they occur.

Overall, we find that the indicators of food security assessed by FEWS NET analysts are consistent with Sen's model of food security; however, the reports tend to be more responsive than predictive. To expand the *early warning* utility of remote sensing data, a large effort should be allocated towards making the language and figures of food security assessments comprehensible to a wide-ranging audience of policy-makers, economists, scientists, and non-profit administrators in both the United States and the targeted country. To achieve these goals, greatly increased training of the FEWS NET Representatives will be necessary to improve the accessibility of remote sensing based information about the weather and climate.

Demand-driven reporting

Food security update reports lie at the confluence between the observations of the in-field analysts and the demands of the governmental decision makers. In this study, we find a demand-driven utilization of data in the food security assessments that reflects the seasonal environmental variability observed by the analysts and the budgetary demands of the policy makers.

The discrepancy in reporting of biophysical data between the growing and dry seasons presents a logical demand-driven reporting of data. During the dry seasons, vulnerable communities rely on the harvest from the previous agricultural year. Biophysical data is a relevant metric during growing season that can provide insight to predict future food supply in the next harvest, thus discussion of remote sensing information during the growing season is expected. In contrast, this study found that FEWS NET analysts' utilization of biophysical data is not responsive to agricultural production deficits. This is because both high and low levels of food production are important for food security conditions.

While the update reports are largely shaped by the tangible seasonal observations of the environment by analysts in field, the reporting patterns are also driven by the fiscal allocations of food assistance. Overall, this study demonstrates the highest level of reporting for all metrics is in East Africa, which has also received the highest gross food assistance over the last decade and has the largest number of food insecure people. Clear variations in the level of reporting were seen due to a reduction in funding of FEWS NET during times of government uncertainty or political change in the United States (Figure 3). Remote sensing information can be a critical tool during times of fiscal uncertainty, as they provide inexpensive, early and ongoing coverage even when funding for direct monitoring and response is reduced.

8. Conclusions

Analysis of FEWS NET’s reports demonstrate the ongoing importance of remote sensing information to food security monitoring. We analyzed rainfall, vegetation and crop model use in 17 FEWS NET countries and found underutilization of crop models, a critical tool for understanding the impact of weather on agricultural conditions. The most important factor in use of the data seems to be the familiarity to remote sensing information of the FEWS NET representatives responsible for reporting, and the history of the country’s FEWS

NET office. As the demand for early warning information grows to more countries in different ecosystems, there is likely to be an increased need for the effective utilization of remote sensing, market, and livelihood data, which can be achieved only through effective training and movement of personnel and therefore expertise from one region to another to increase institutional knowledge of all available tools.

In this meta-analysis, we reviewed the reporting patterns for 14 unique indicators of food security in 1342 food security assessments from the 17 African FEWS NET-monitored countries. Our results indicate that FEWS NET analysts most consistently utilize socioeconomic parameters when assessing food security. The efficacy of the early warning information could be improved by expanding the use of specific and predictive remote sensing models. Overall, this study demonstrates demand-driven variability in the monitoring and reporting of food security indicators that is reflective of environmental variability and irrespective of agricultural production variations. Understanding these historical trends in data usage by country will better inform early warning food security analysis in the future.

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Figure 1. Map of the 17 countries analyzed, designated by region

Figure 2. Frequency of mention of consistently reported categories by percent of reports in each region. Axes scaled to data.

Figure 3. Timeseries of reporting of each data type by region, 2000-2009. Y-axis maximum reflects the maximum possible reporting of each data

Figure 4. Timeseries overview of the absolute number of mentions of "Rainfall" and "Prices" in Malawi, Ethiopia, and Mali, 2000-2009.

Figure 5. Comparative mention of "Rainfall" by region in reports from High Production versus Low Production agricultural years and Growing Seasons versus Dry Seasons.

Figure 6. Bar graphs for reporting of satellite-derived data in growing and dry seasons and in high and low agricultural production years, by country.

Table 1. Overview of food security reporting by country.

Country	Region	Percent Reporting	Percent of 120 months with positive Agricultural production
Burkina Faso	West	50 %	43 %
Chad	West	60 %	50 %
Mali	West	54 %	43 %
Mauritania	West	42 %	48 %
Niger	West	57 %	50 %
Nigeria	West	19 %	43 %
Djibouti	East	40 %	0 %
Ethiopia	East	83 %	42 %
Kenya	East	82 %	50 %
Somalia	East	71 %	60 %
Sudan	East	76 %	60 %
Tanzania	East	80 %	56 %
Uganda	East	78 %	53 %
Malawi	South	83 %	50 %
Mozambique	South	82 %	57 %
Zambia	South	82 %	36 %
Zimbabwe	South	68 %	24 %

Table 2. Categories and constituent keywords assessed for utility.

Category	Keywords	Description
NDVI	NDVI, NDVI Figure in Update Report	The Normalized Difference Vegetation Index, *NDVI*, is highly correlated with photosynthetic biomass productivity (Fuller 1998; Funk and Budde 2009).
RFE	RFE, RFE Figure in Update Report	The satellite-derived and rain gauge-coupled Rainfall Estimates, *RFE*, provide a valuable indicator of water supply problems (Love et al. 2004; Xie and Arkin 1997).
WRSI	WRSI, WRSI Figure in Update Report	The Water Requirement Satisfaction Index, *WRSI*, merges the satellite-derived rainfall quantities with the evapotranspiration levels of specific plants to estimate crop yield (Senay and Verdin 2003; Verdin and Klaver 2002).
Rainfall	Drought, Dryness, Precipitation, Rain, Rainfall	*Rainfall* includes both remote sensing and general precipitation observations.
Livestock	Camels, Cattle, Goat, Herd, Livestock, Pastoralists, Sheep, Transhumant	*Livestock* encompasses information on the health of animals and the pastoralists who depend on the animals for their livelihoods.
Production	Bananas, Barley, Beans, Cassava, Coffee, Cowpeas, Farm, Maize, Millet, Plantains, Potatoes, Production, Sorghum, Teff, Wheat, Yams	*Production* focuses on cereal yields and includes common grain stocks and the farmers who depend on these crops for their livelihoods (Funk and Brown 2009).
Prices	Deficit, Prices, Nominal, Surplus	*Prices* reflect market mechanisms of supply and demand along with the influence of inflation or deflation.
Food Access	Access, Food Access	*Food Access* is a direct determinant of food security and is a product of livelihood factors along with physical infrastructure (e.g. roads) and social barriers (e.g. language, gender) (Maxwell 1996).
Terms of Trade	Purchasing Power, Terms of Trade	*Terms of Trade* represents the relative prices of commodities exchanged at markets and reflects the social welfare of the traders (Jayne et al. 1995).
Pests	Banana Bacterial Wilt, Beetle, Foot and Mouth Disease, Locust, Pests	Fungal, bacterial, and animal *Pests* can strongly affect the yield of nutritious biomass available to subsistence farmers (Debrah et al. 1998; Dreyera and Baumgärtner 1995; Tilman et al. 2002).
Civil Insecurity	Civil Insecurity, Civil Security, Conflict, Fighting, Political Instability, Political Tension	*Civil Insecurity* can challenge food security by limiting the access of subsistence farmers to markets and endangering workers during crop production (Cuny and Hill 1999).
Disease	Diarrhea, Diarrhoea, Disease, Fever, Outbreak, Malaria, Meningitis, Mortality	*Disease* can reduce production by hindering the viability of individual workers and also by occupying the time of caregivers.
Refugee	IDP, Internally Displaced, Migration, Refugee	Internally displaced persons and refugees, collected under the term *Refugee*, decrease the labor forces and increase the demand on food markets (Shipton 1990; Wilson 1992).
Malnourishment	Malnourished, Malnourishment, Malnutrition, Nutrition	As a cause of food insecurity, *Malnourishment* can limit the working capacity of a labor force, and as a consequence, *Malnourishment* reflects the prevalence of the food security crises (Murphy and McAfee 2005).

Table 3. Profiles of 17 FEWS NET-monitored countries in Africa

Country	Average. Population[1] (2000-2009) (in millions)	GDP[2] (2009 est.) (in billions)	Global Hunger Index[3] (2009)	Total amount of aid provided to each country from 2000-2008[4]
Burkina Faso	13.6	$18.79	20.4	$351,490
Chad	9.83	$16.26	31.3	$436,304
Mali	11.7	$15.52	19.5	$234,552
Mauritania	2.95	$6.568	15	$466,586
Niger	13.0	$10.45	28.8	$557,249
Nigeria	139.4	$357.2	18.4	$48,604
Djibouti	0.80	$2.011	22.9	$118,235
Ethiopia	73.9	$76.74	30.8	$9,273,218
Kenya	35.5	$63.73	20.2	$2,158,084
Somalia	8.26	$5.731	..	$908,358
Sudan	38.4	$92.81	19.6	$3,879,814
Tanzania	38.7	$57.89	21.1	$951,577
Uganda	28.4	$43.22	14.8	$1,713,648
Malawi	13.5	$12.81	18.5	$1,034,766
Mozambique	20.6	$20.17	25.3	$1,530,294
Zambia	11.6	$18.50	25.7	$738,585
Zimbabwe	12.5	$0.332	21	$1,648,236

Table 4.

	West Africa	East Africa	Southern Africa
NDVI	36%	46%	3%
RFE	74%	99%	81%
WRSI	17%	10%	6%
Rainfall	100%	100%	100%
Livestock	96%	98%	55%
Production	100%	100%	100%
Pests	37%	16%	14%
Prices	100%	99%	99%
Food Access	88%	91%	89%
Terms of Trade	66%	45%	26%
Civil Insecurity	23%	61%	2%
Disease	63%	85%	53%
Refugee	60%	65%	3%
Malnourishment	43%	64%	32%

[1] PopSTAT, "Annual Time Series" <http://faostat.fao.org/site/550/default.aspx#ancor>. Accessed 19 Aug 2010.
[2] CIA World Factbook, <https://www.cia.gov/library/publications/the-world-factbook/>. Accessed 20 Aug 2010.
[3] *2009 Global Hunger Index The Challenge of Hunger: Focus on Financial Crisis and Gender Inequality* Klaus von Grebmer, Bella Nestorova, Agnes Quisumbing, Rebecca Fertziger, Heidi Fritschel, Rajul Pandya-Lorch, Yisehac Yohannes, International Food Policy Research Institute, <http://www.ifpri.org/publication/2009-global-hunger-index>. Accessed 20 Aug 2010.
[4] From Interfais, World Food Program database of food aid deliveries in metric tons, accessed 29 Aug 2010.

Figure 1. Map of the 17 countries analyzed, designated by region

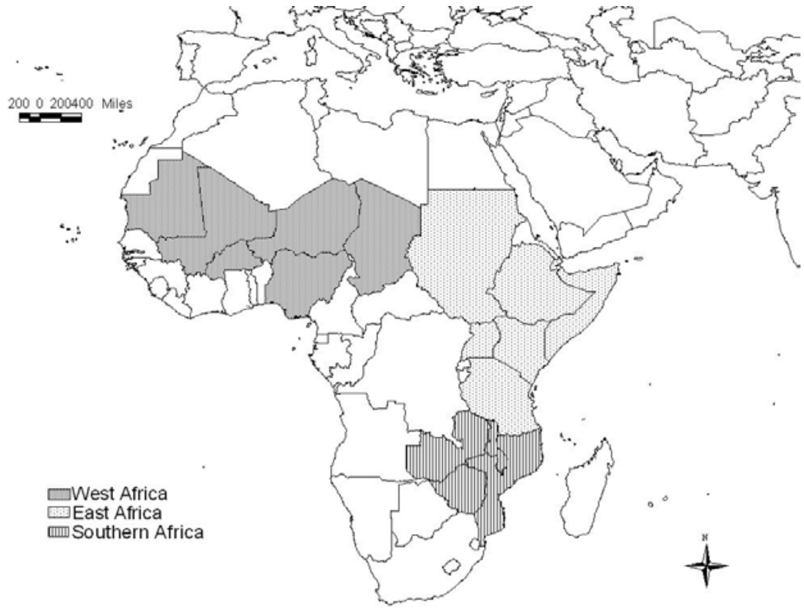

Figure 2. Frequency of mention of consistently reported categories by percent of reports in each region. Axes scaled to data.

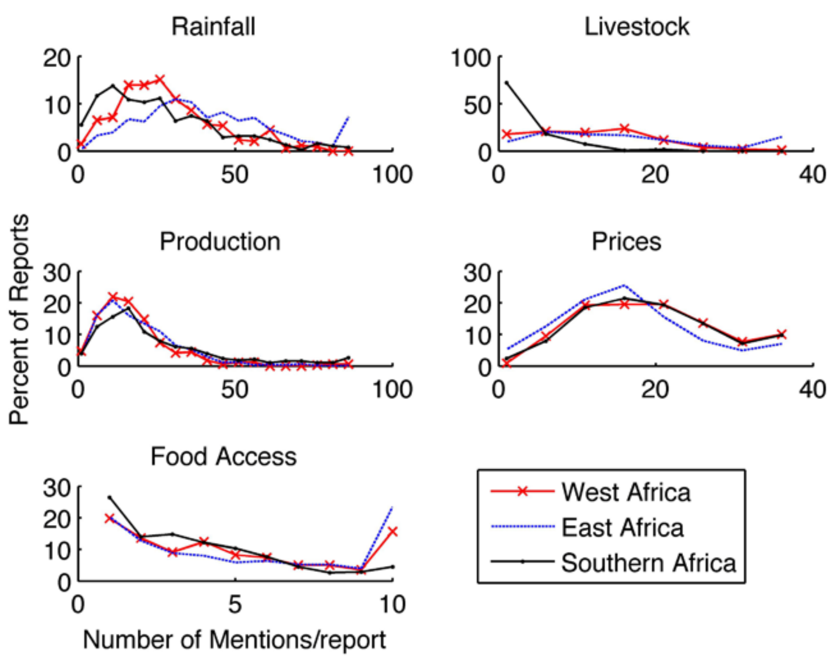

Figure 3. Timeseries of reporting of each data type by region, 2000-2009. Y-axis maximum reflects the maximum possible reporting of each data

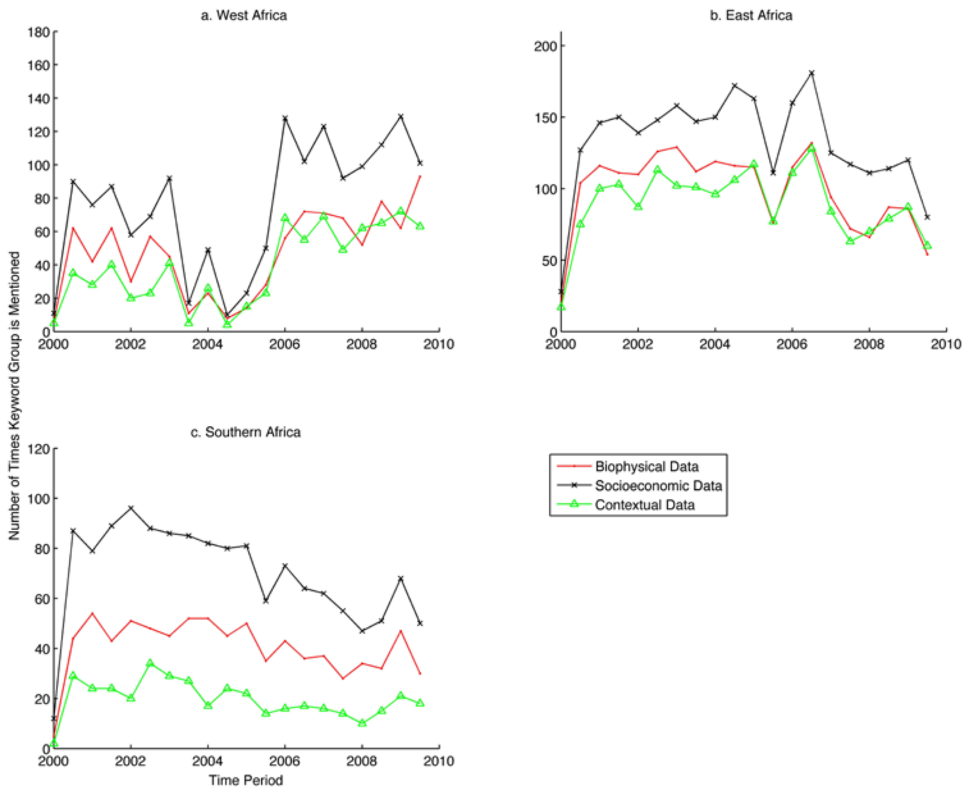

Figure 4. Timeseries overview of the absolute number of mentions of "Rainfall" and "Prices" in Malawi, Ethiopia, and Mali, 2000-2009.

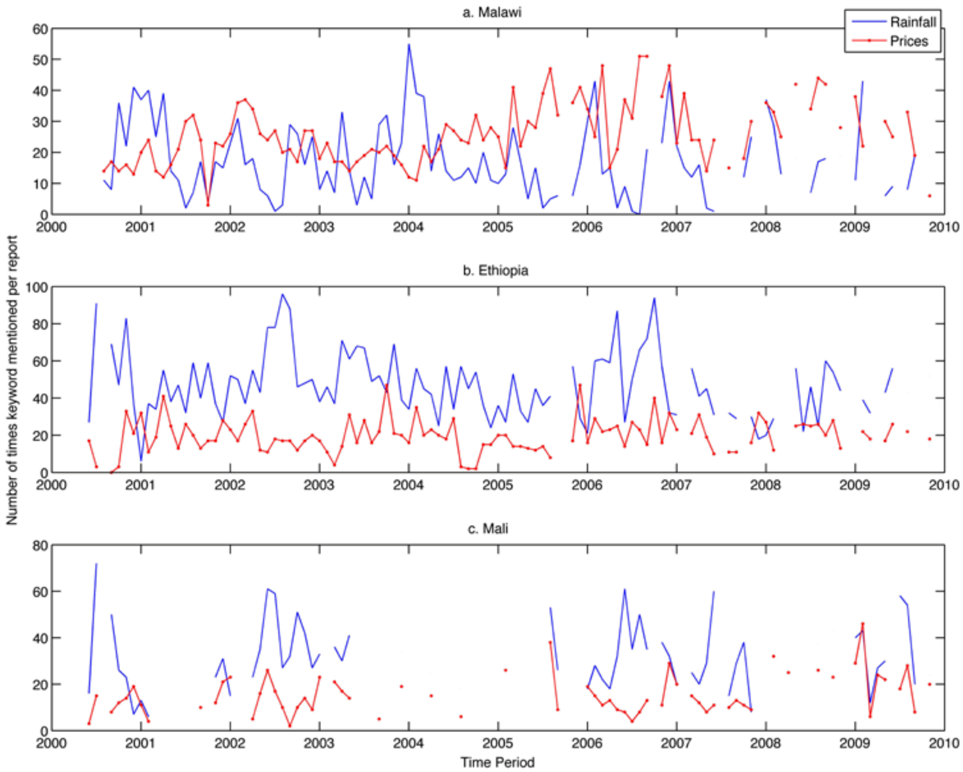

Figure 5. Comparative mention of "Rainfall" by region in reports from High Production versus Low Production agricultural years and Growing Seasons versus Dry Seasons.

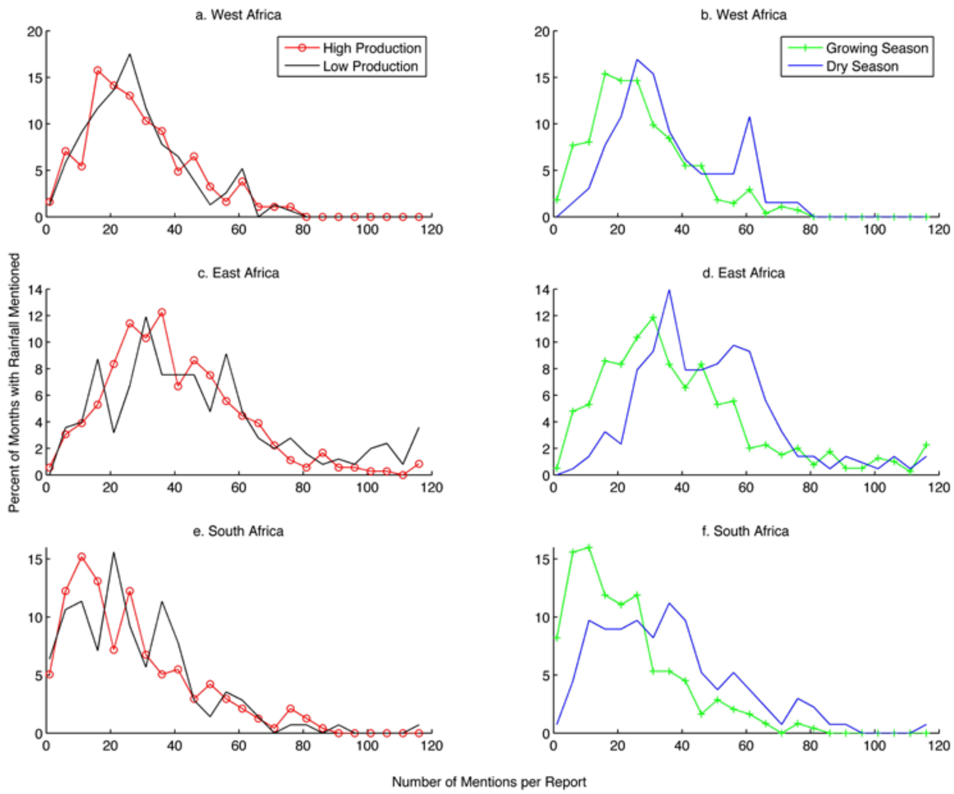

Figure 6. Bar graphs for reporting of satellite-derived data in growing and dry seasons and in high and low agricultural production years, by country.