Synopsis of FEWS NET-related Climate Change and Food Security Trend Analysis

One focus of USGS/UCSB FEWS NET research has been the evaluation of climate change and vulnerability trends in food insecure eastern and southern Africa. This work began with the creation of historical rainfall time series for Africa (C1, C2). In 2003, we evaluated the predictive potential of early growing season rainfall in Ethiopia and provided USAID with food balance projections (C3). This analysis revealed two disturbing tendencies. First, agriculturally critical regions of Ethiopia had experienced substantial precipitation declines. Second, population growth/food balance analyses suggested that Ethiopia would face chronic and increasing food deficits. Unfortunately, 2003 predictions of increasing food insecurity appear warranted (Fig. 1).

We followed up on this study with a careful study of thousands of eastern African rainfall gauge observations. This analysis suggested that a warming Indian Ocean was likely to produce increasing dryness in extremely vulnerable areas of eastern and southern Africa. These results were presented in an extensive Famine Early Warning System Network (FEWS NET) report (C4). This work was also published by the Royal Philosophical Society (C5), and presented in 2005 at meeting on Climate Change and Agriculture. Satellite observations of vegetation greenness also exhibit concerning declines (C6).

Over the past several years, we have continued multi-disciplinary research on this topic. Our recent report in the *Proceedings of the National Academy of Sciences* (C7) suggests that the dangerous warming in the Indian Ocean is likely to be at least partially caused by anthropogenic greenhouse gas emissions. Thus, further rainfall declines across parts of eastern and southern African appear likely. For eastern Africa, these drought projections run counter to the recent 4th Inter-governmental Panel for Climate Change (IPCC) assessment. We have suggested in *Science* that climate change assessments, based on inaccurate global climate precipitation fields, probably understate the agricultural risks of the warming Pacific and Indian Ocean (C8). The interaction of growing populations and limited potential water and cultivated areas increases food and water insecurity, amplifying the impacts of drought. Our most recent work, for a new journal "Food Security", focuses on global risks implied by these tendencies (Fig. 2, C9). While not necessarily a direct result of changing climate, similar analysis applied to seasonal forecasting and monitoring has been recently published in the Earth Observer (C10). Our overarching view is that 'early warning' must embrace both the short term opportunities provided by the timely detection of food shocks, as well as an effective tracking of the slow impacts of our changing climate. A recent book chapter focuses on this integrated approach (C11), documenting both the recent deficits and as well as the long term declines across eastern Kenya.

Work in 2010 focused on improving the basic climate science under laying FEWS NET analyses while pursuing effective distillations of this material for decision makers. In terms of science, a more detailed analysis of the March-June circulation and trends has suggested strongly that warming in the Indian-Pacific has led to a westward extension of the Warm Pool, and an intensification of La Nina-related drought in eastern Africa (C12). At the same time, detailed mapping of the 'local velocity' of climate change, using station and satellite data, confirm strong warming across the Sahel and eastern Africa, and drying across parts of eastern Africa (C13, C14). The first two of a series of national climate adaptation reports, focused on Kenya (C15) and Sudan (C16).

In 2011, USGS/UCSB work is focused on the June-September season, examining changes in the circulation over the Indian Ocean, and surrounding countries, while extending the series of FEWS NET adaptation reports to cover the more countries in the Sahel and eastern Africa. Closer work with NOAA's Earth Science Research Laboratory will provide a deeper set of model-based analyses.

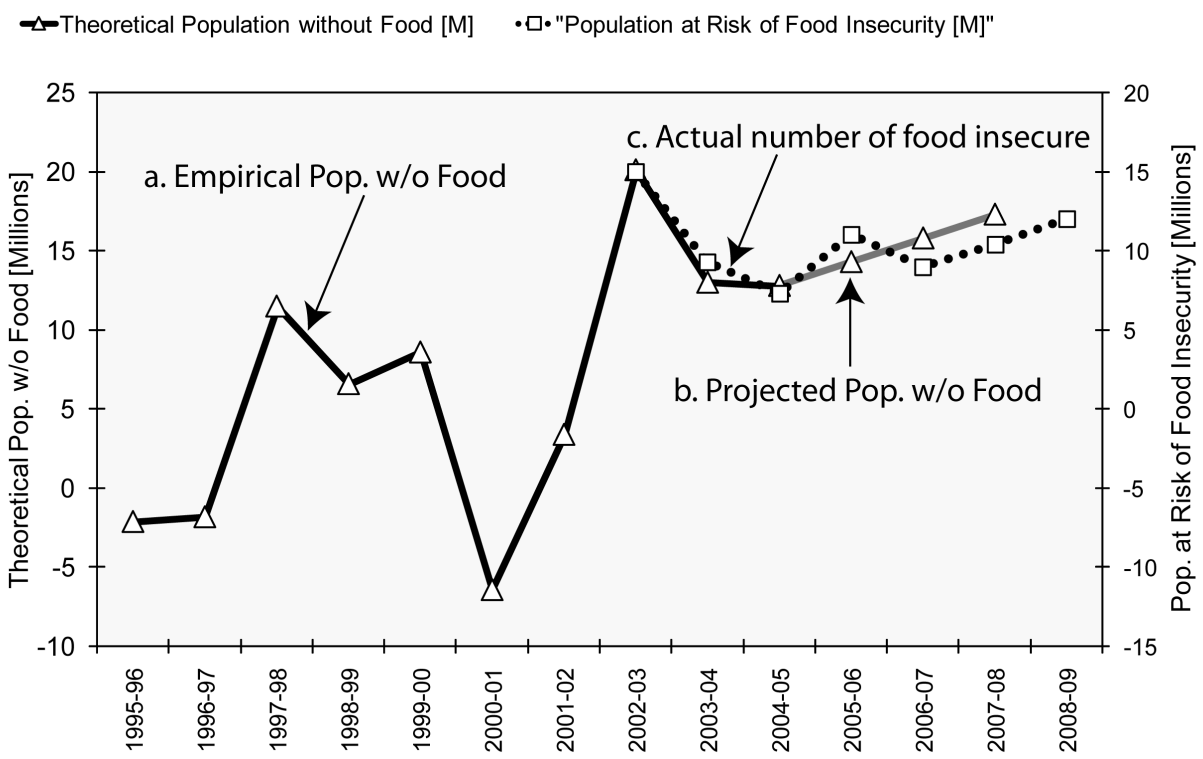

Figure 1. Theoretical food balance results from our 2003 FEWS NET report (1995-2008, left axis), super-imposed with actual historic FEWS NET food insecurity estimates (2002-2008, right axis). Empirical population without food estimates (a) were based on observed crop production and population data. Projected population without food estimates (b) assumed constant crop production and a growing population. The dashed line (c) shows actual FEWS NET estimates of acutely food insecure people.

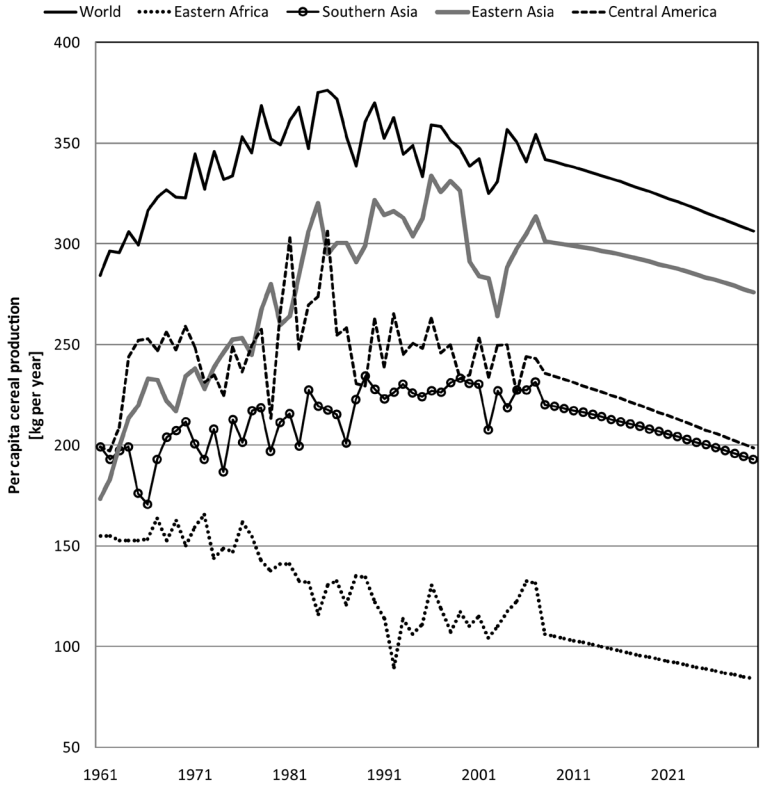

Figure 2. Results from C9. As population grows faster than yields, per capita cereal production is likely to decline over the next 20 years. Our projections suggest a global reduction of 15%. Cereal production in Central America and Southern Asia could drop below 200 kg per person per year. Eastern Africa declines could result in per capita cereal production of less than 100 kg per person per year. Maintaining 2007 levels of per capita cereal production for this region will require a doubling of yields by 2030. This goal may be realistic, given the present very low cereal yields.

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C11. Funk C. and Verdin, J. (2009) Real-time Decision Support Systems: The Famine Early Warning System Network (2009) Chapter 17 for: Satellite Rainfall Applications for Surface Hydrology, by Springer-Verlag. Edited by Gebremichael MeKonnen and Faisal Hossain. In press.
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