

# New and Improved Remotely Sensed Products and Tools for Agricultural Monitoring Applications in Support of Famine Early Warning

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## Background

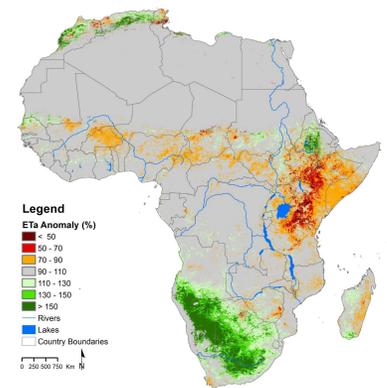
The high global food prices in 2008 led to the acknowledgement that there is a need to monitor the inter-connectivity of global and regional markets and their potential impacts on food security in many more regions than previously considered. The crisis prompted an expansion of monitoring by the Famine Early Warning Systems Network (FEWS NET) to include additional countries, beyond those where food security has long been of concern. Scientists at the U.S. Geological Survey (USGS) Earth Resources Observation and Science (EROS) Center and the University of California Santa Barbara Climate Hazards Group have provided new and improved data products as well as visualization and analysis tools in support of this increased mandate for remote monitoring. We present a new product for measuring actual evapotranspiration (ETA) based on the implementation of a surface energy balance model and site improvements of two standard FEWS NET monitoring products: normalized difference vegetation index (NDVI) and satellite-based rainfall estimates. New tools for data visualization and analysis are highlighted and a brief case study on the 2011 drought in eastern Africa is presented.

## New and Improved Monitoring Products

### Actual Evapotranspiration (ETA)

FEWS NET uses the Simplified Surface Energy Balance model (Senay et al. 2007, 2010) to produce operational actual evapotranspiration (ETA) anomalies for Africa. The ETA anomaly for a given period expresses the surplus or deficit ET compared to the same period historically. During the growing season, ETA anomalies express surplus or deficit crop water use, which is directly related to crop condition and biomass.

Cumulative Evapotranspiration (ETA) Anomaly  
Jan 01 - Jul 03, 2011



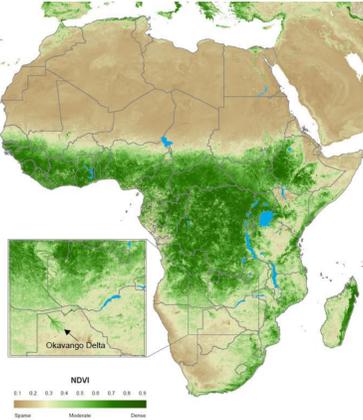
#### ETA Data Characteristics

- Inputs:**
- MODIS 8-day LST, Ref ET, NDVI, Albedo, and Air Temperature.
- Compositing Period:**
- 8-day seasonal cumulative and monthly cumulative
- Spatial Resolution:**
- 1 kilometer
- Product Latency:**
- 2–5 days after then end of a composite period
- Regions:**
- Africa, U.S.

### eMODIS Normalized Difference Vegetation Index (NDVI)

FEWS NET has implemented the operational use of the expedited Moderate Resolution Imaging Spectroradiometer (eMODIS) NDVI data (Jenkinson et al. 2010) for Africa. The data set provides an unprecedented improvement in spatial resolution (see inset below), more consistent and timely processing, and a better compositing scheme for early warning applications.

eMODIS Normalized Difference Vegetation Index (NDVI)  
November 1 - 10, 2011



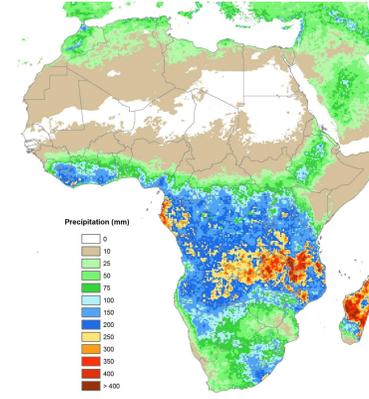
#### eMODIS NDVI Data Characteristics

- Inputs:**
- LANCE / LAADS Level 2 Surface Reflectance
- Compositing Period:**
- 10-day composite updated every 5 days (pentadal)
- Spatial Resolution:**
- 250 meter
- Product Latency:**
- < 12 hours for raw data; 24-36 temporally smoothed
- Regions:**
- Africa, Central America, Caribbean, Central Asia

### FEWS NET TRMM IR Precipitation (FTIP) Estimate

FTIP integrates Tropical Rainfall Measuring Mission (TRMM) rainfall estimates and infrared (IR) temperature data with a long term rainfall climatology developed by FEWS NET (FCLIM). The FCLIM captures the historical spatial variability of rainfall by combining monthly mean rainfall measured at stations, elevation parameters, and satellite precipitation estimates.

FEWS NET TRMM IR Precipitation (FTIP) Estimate  
Monthly Rainfall Estimate - March, 2011



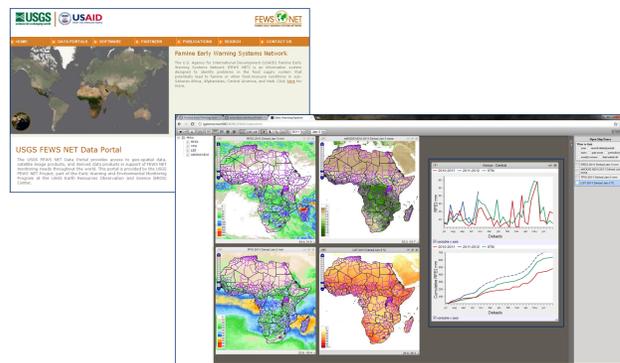
#### FTIP Estimate Data Characteristics

- Inputs:**
- TRMM rainfall, IR temperature, FEWS NET Climatology
- Compositing Period:**
- 5-day (pentadal), 10-day (dekadal), and monthly
- Spatial Resolution:**
- 0.05 degree; ~ 5 kilometer
- Product Latency:**
- 24–48 hours
- Regions:**
- Global

## Visualization and Analysis Tools

### Early Warning Explorer (EWX)

- User interface to dynamically compare standardized anomalies
- Allows rapid identification of significant anomalies across diverse regimes
- Available to (FEWS NET) analysts for comparison to "normal" conditions
- FEWS NET convergence of evidence approach
- Framework to incorporate NASA data into routine analysis



### Decision Support Interface (DSI)

- Utilizes remote sensing data in an automated fashion to flag areas of drought concern.
- Ranks drought severity at crop zone and admin levels using US Drought Monitor rules.
- Data are summarized at continental and national scales to identify areas of concern.
- Seasonal weighting of input variables targets specific parts of the growing season during which crop stress could have negative impacts on crop production (and food security).



## Case Study – Greater Horn of Africa Drought

### Famine Declaration July 2011

The severity of the drought that impacted the Greater Horn of Africa in 2011 was illustrated in a June FEWS NET report that analyzed 2010/11 rainfall, for selected areas of Kenya and Ethiopia, relative to comparable data for the last 60 years. The report showed the 2010/11 season to be one of the driest on record. While parts of Somalia were also severely affected, historical data was too limited to be included in the analysis. However, the impacts were soon realized. In July of 2011, evidence of severely reduced food access, acute malnutrition, and crude mortality indicated that a famine was ongoing in two areas of southern Somalia. The crisis was driven by a combination of factors. The total failure of the 2010 October-December Deyr rains and the poor performance of the 2011 April-June Gu rains resulted in crop failure and poor pasture condition. Tools and products presented here were instrumental in providing evidence for the famine declaration and have been used extensively to monitor the 2011 Deyr season.



## References

Jenkinson, C.B., Maier-Sperger, T.K., and Schmidt, G.L. (2010). eMODIS—a user-friendly data source: U.S. Geological Survey Open-File Report 2010-1055, 10 p. (Also available online at <http://pubs.usgs.gov/usgspubs/ofr/ofr20101055/>)

Senay, G.B., M. Budde, J.P. Verdin, and A.M. Melesse. (2007). A coupled remote sensing and simplified surface energy balance approach to estimate actual evapotranspiration from irrigated fields. Special Issue: Remote Sensing of National Resources and the Environment. SENSORS, 1, 979-1000.

Senay, G.B., M. Budde, J.P. Verdin. (2010). Enhancing the Simplified Surface Energy Balance (SSEB) approach for estimating landscape ET: Validation with the METRIC model. Agricultural Water Management, 98:606-618.