



Remote Sensing in Food Security Analysis

WFP – World Food Programme, ODXF, Food Security Analysis Service

UNOOSA Meeting, 09 March 2012



World Food Programme

Usage of Remote Sensing Data at WFP

Earth Observation (EO) data has assumed growing importance for WFP over the past decade

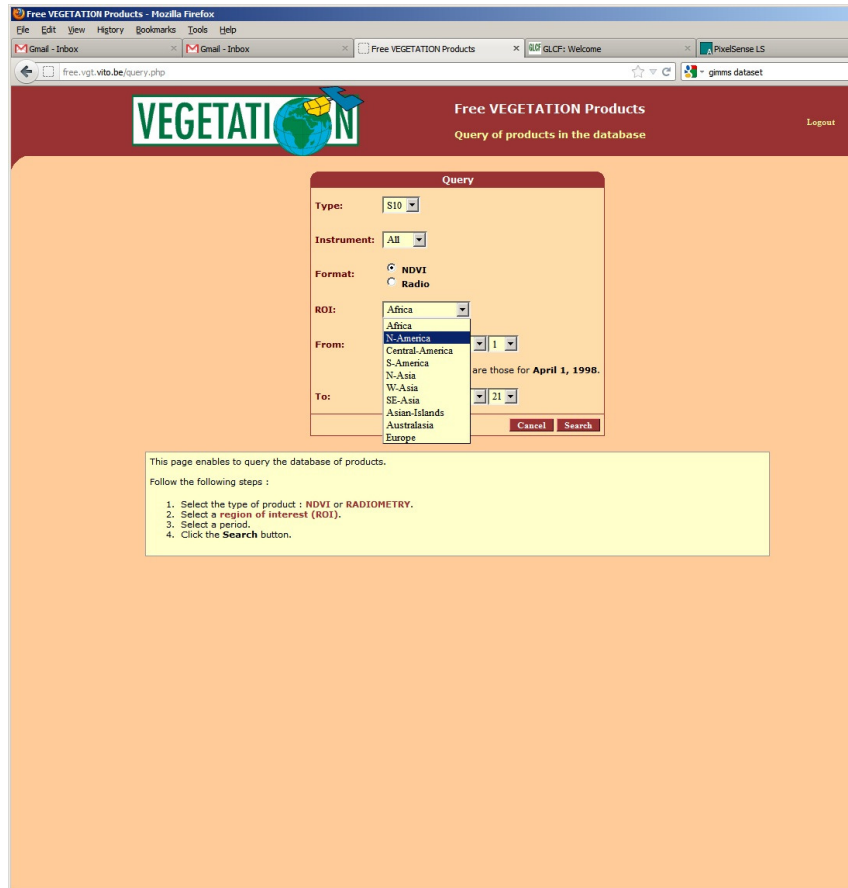
Relevance :

- Provision of food assistance to beneficiaries – early warning, impact assessment
- Contribution to baseline Food Security surveys (climatology, zoning, history of shocks – extent, frequency, magnitude)
- Support to the design of WFP interventions

Food Security Analysis Service (ODXF/VAM) and Emergency Preparedness (ODEP)



GIMMS NDVI: Global 1981 - 2006



Free VEGETATION Products - Mozilla Firefox

Free VEGETATION Products
Query of products in the database

Query

Type: S10

Instrument: All

Format: ☒ NDVI ☐ Radio

RDI: Africa

From: N-America, Central-America, S-America, N-Asia, W-Asia, SE-Asia, Asian-Islands, Australasia, Europe

To: 1, 21

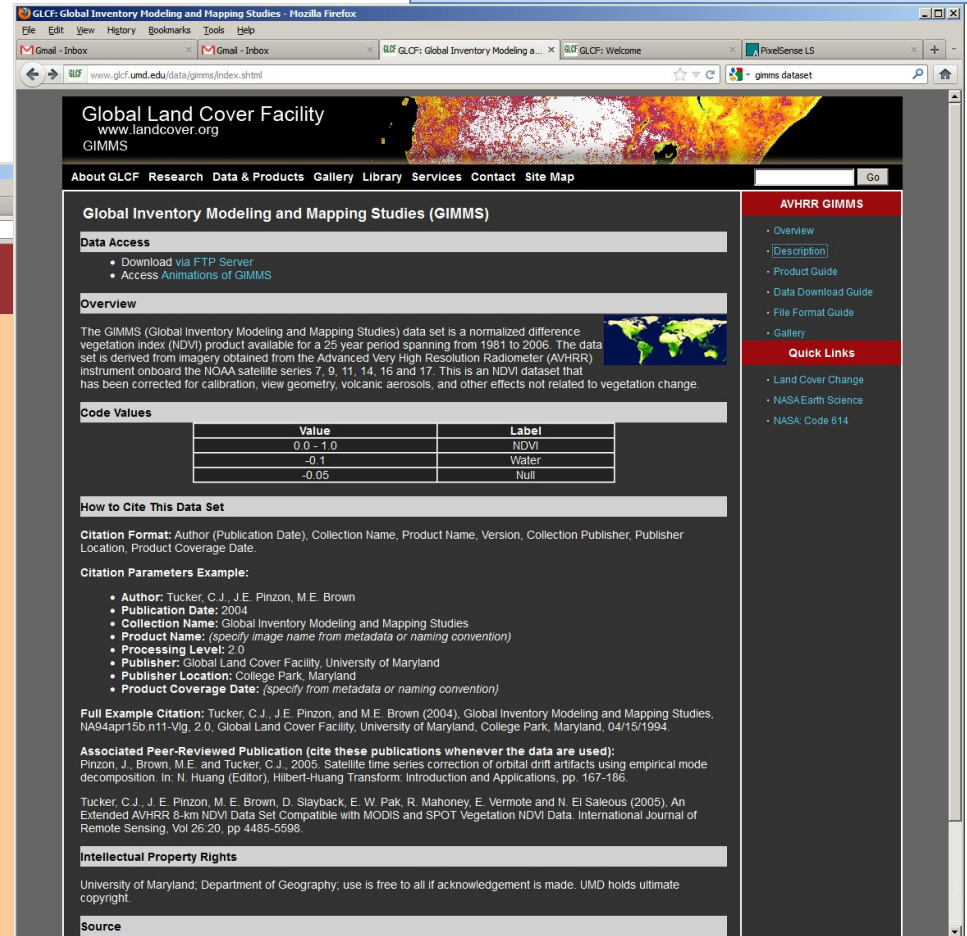
are those for April 1, 1998.

Cancel Search

This page enables to query the database of products.
Follow the following steps :

1. Select the type of product : NDVI or RADIOMETRY.
2. Select a region of interest (RDI).
3. Select a period.
4. Click the Search button.

SPOT-VGT Data: Global 1998 - present



Global Land Cover Facility
www.landcover.org
GIMMS

About GLCF Research Data & Products Gallery Library Services Contact Site Map

Global Inventory Modeling and Mapping Studies (GIMMS)

Data Access

- Download via FTP Server
- Access Animations of GIMMS

Overview

The GIMMS (Global Inventory Modeling and Mapping Studies) data set is a normalized difference vegetation index (NDVI) product available for a 25 year period spanning from 1981 to 2006. The data set is derived from imagery obtained from the Advanced Very High Resolution Radiometer (AVHRR) instrument onboard the NOAA satellite series 7, 9, 11, 14, 16 and 17. This is an NDVI dataset that has been corrected for calibration, view geometry, volcanic aerosols, and other effects not related to vegetation change.

Code Values

Value	Label
0.0 - 1.0	NDVI
-0.1	Water
-0.05	Null

How to Cite This Data Set

Citation Format: Author (Publication Date), Collection Name, Product Name, Version, Collection Publisher, Publisher Location, Product Coverage Date.

Citation Parameters Example:

- Author: Tucker, C.J., J.E. Pinzon, M.E. Brown
- Publication Date: 2004
- Collection Name: Global Inventory Modeling and Mapping Studies
- Product Name: (specify image name from metadata or naming convention)
- Processing Level: 2.0
- Publisher: Global Land Cover Facility, University of Maryland
- Publisher Location: College Park, Maryland
- Product Coverage Date: (specify from metadata or naming convention)

Full Example Citation: Tucker, C.J., J.E. Pinzon, and M.E. Brown (2004), Global Inventory Modeling and Mapping Studies, NA94apr15b.n11-Vgt, 2.0, Global Land Cover Facility, University of Maryland, College Park, Maryland, 04/15/1994.

Associated Peer-Reviewed Publication (cite these publications whenever the data are used):

Pinzon, J., Brown, M.E. and Tucker, C.J., 2005. Satellite time series correction of orbital drift artifacts using empirical mode decomposition. In: N. Huang (Editor), Hilbert-Huang Transform: Introduction and Applications, pp. 167-186.

Tucker, C.J., J. E. Pinzon, M. E. Brown, D. Slayback, E. W. Pak, R. Mahoney, E. Vermote and N. El Saleous (2005). An Extended AVHRR 8-km NDVI Data Set Compatible with MODIS and SPOT Vegetation NDVI Data. International Journal of Remote Sensing, Vol 26:20, pp 4485-5598.

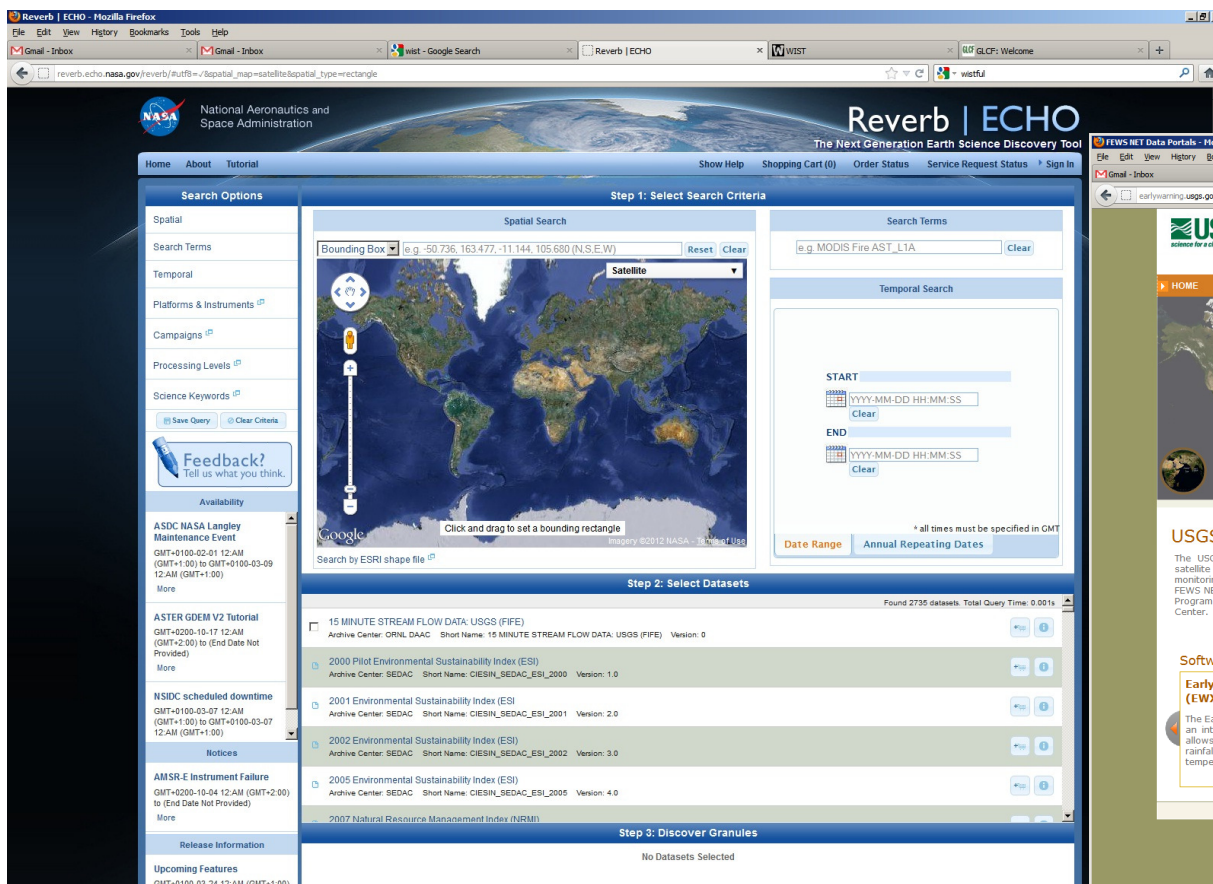
Intellectual Property Rights

University of Maryland, Department of Geography, use is free to all if acknowledgement is made. UMD holds ultimate copyright.

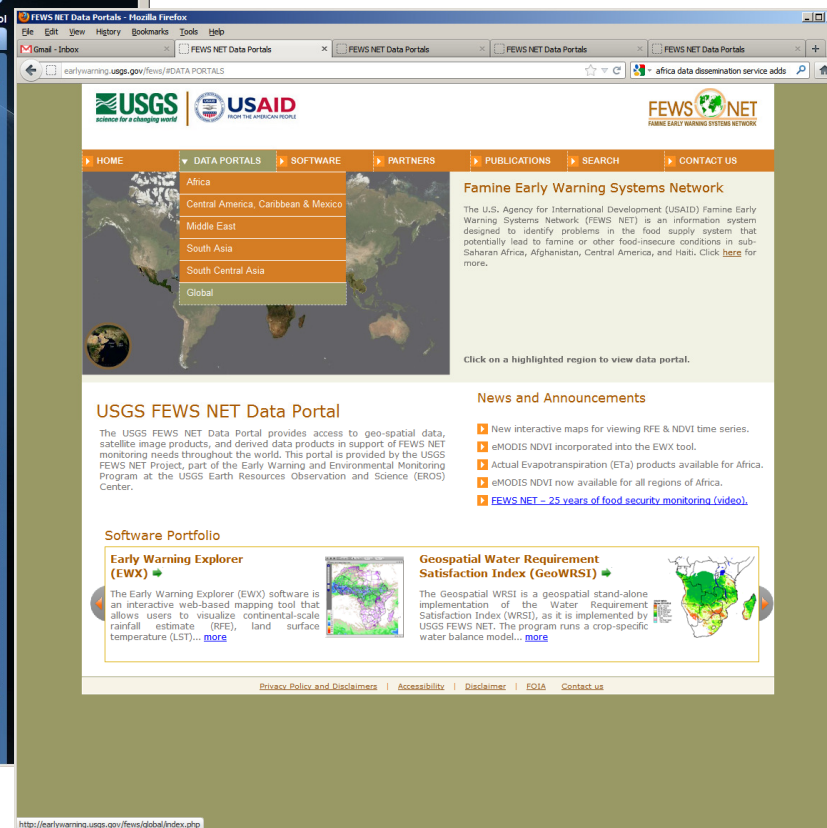
Source

Vast repositories of free access data





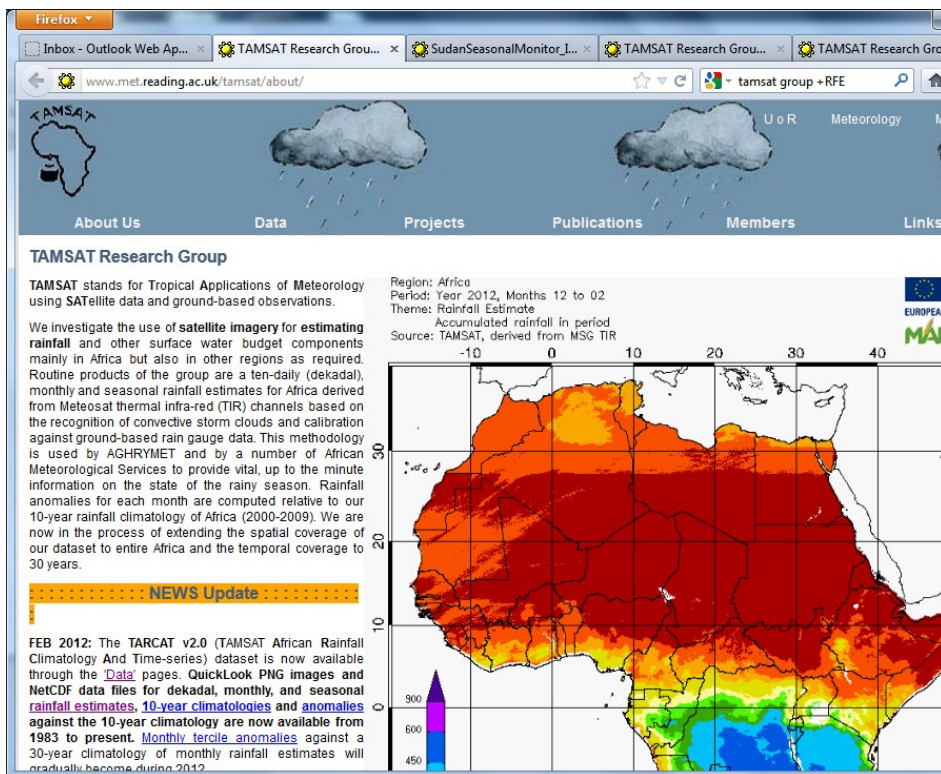
Reverb: access tool for NASA ESDIS ECHO



USGS FEWS-Net Data Portals

Vast repositories of free access data





TAMSAT: RFE, 1983 - present

esa data user element European Space Agency

ESA DUE HOME Users Projects Companies

Search project

Information

- User Partnership
- User Consultations
- News
- Tenders
- FAQ

User Directory 2010 [30 MB .pdf]

DUE User flyer [3.9 MB .pdf]

Available on the App Store

DUE Data

- ATSR World Fire Atlas
- Culture-MERIS
- GlobCorine
- GlobCover

Culture-MERIS

An ESA weekly service for agriculture

Summary

- Geographic covered: Europe & Africa, since 07/03/2011
Global, since 12/09/2011
- Products: Weekly MERIS FR (300m) surface reflectance

Additional information

- Product Description Manual
- References

NRT Data Access

Weekly surface reflectance composites are freely available through the following FTP site:
<ftp://culturemeris@ionia2.esrin.esa.int>

[username: culturemeris]
[password: culturemeris]

Periodicity of product data generation

Culture-MERIS weekly product (Monday to Sunday) is generated every Tuesday at around 10pm, with a latency of less than 48 hours after the reception of latest input data. This delay is due to the generation process of needed ancillary data and our own processing system.

For additional information please contact due@esa.int

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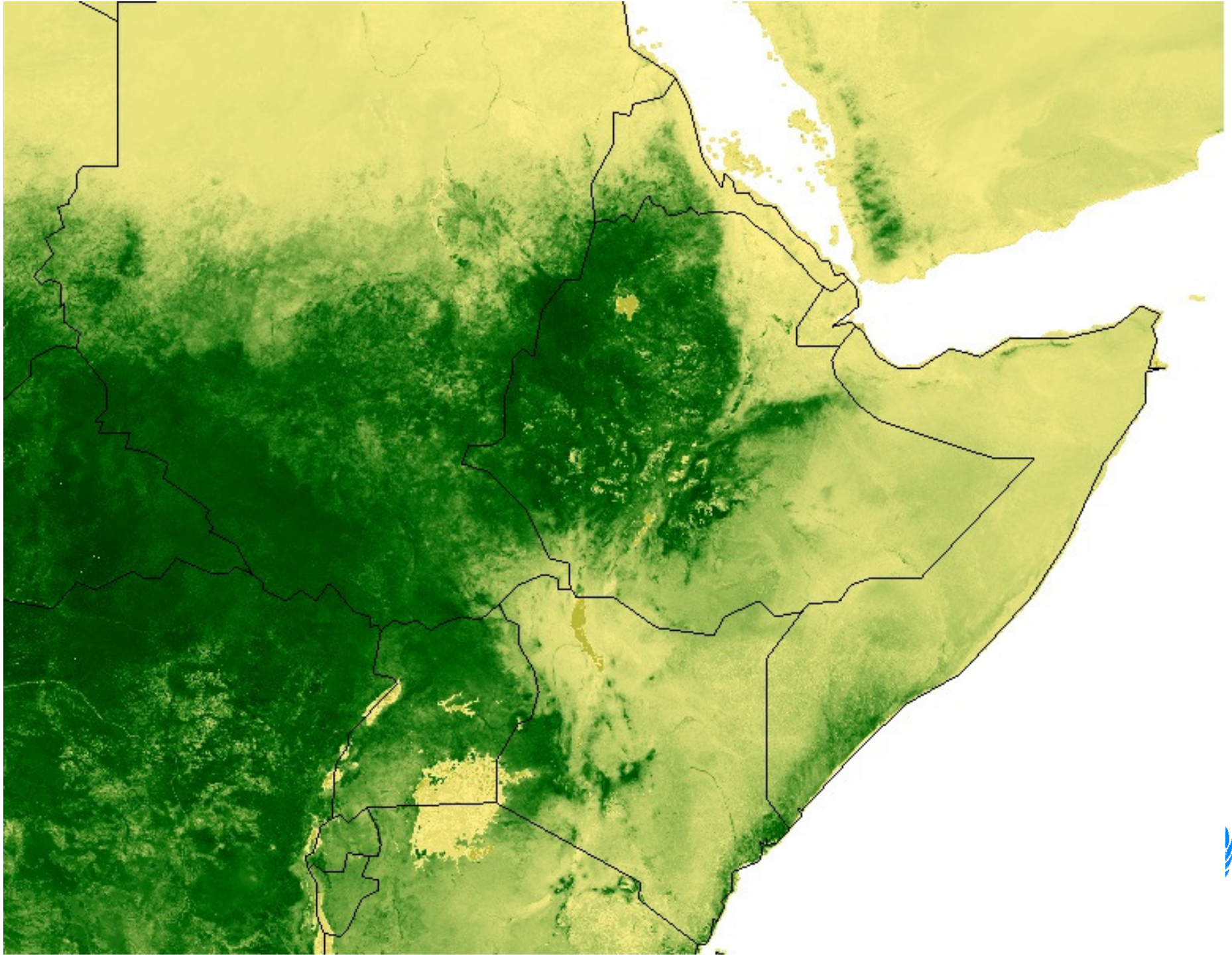
ESA

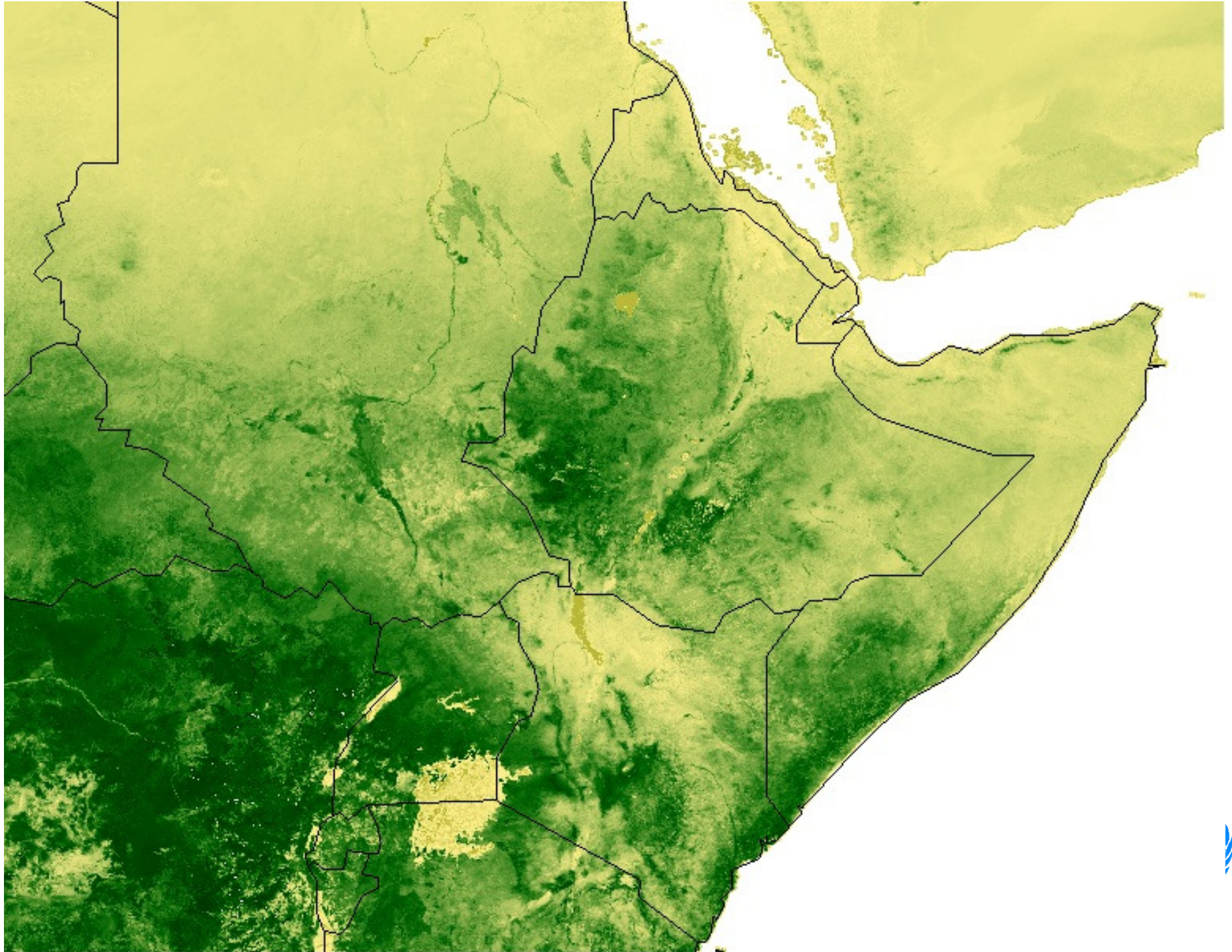


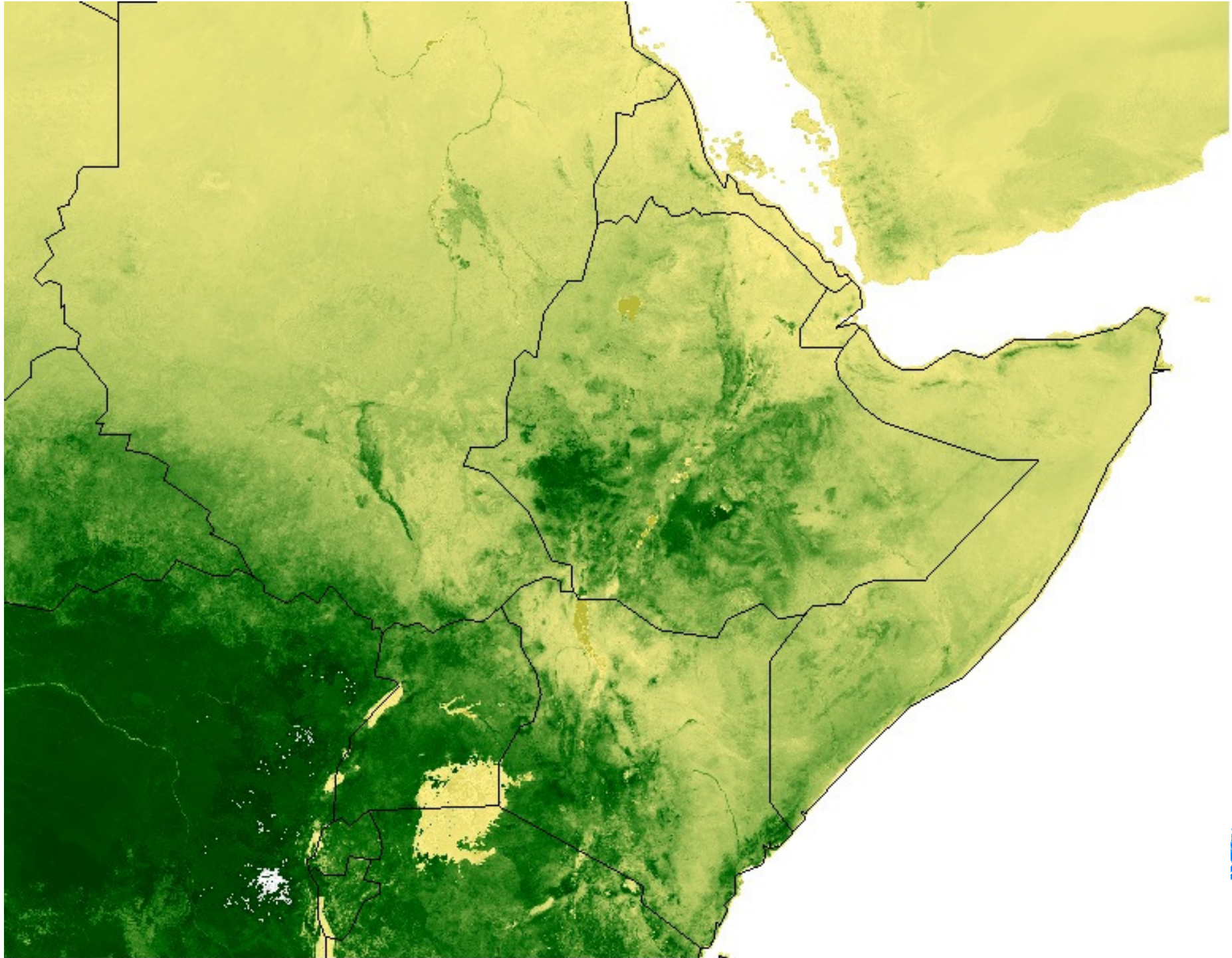
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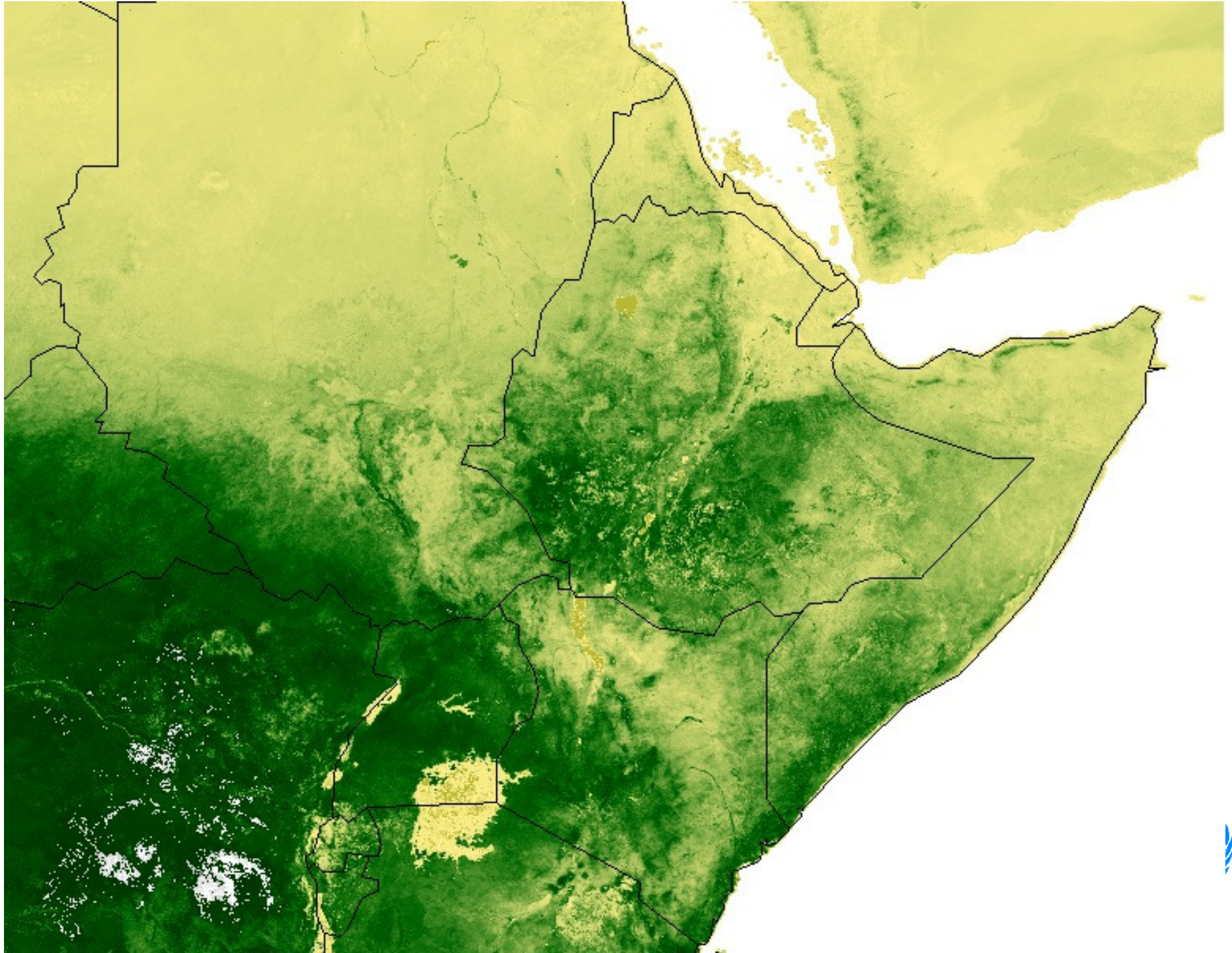
Data Sources

- Staple Data : RFE and NDVI.
 - RFE: Key driver for crop performance – USGS, U of Reading
 - NDVI: Direct indicator of vegetation status – (SPOT-VGT, MODIS)
 - Proxy for household resources (crop and pasture production)
 - Fine resolution, performance over irrigated areas
- Analysis of large number of images (36 / calendar year)
- Spatial – temporal information
- Long historical time series (reference scenarios)







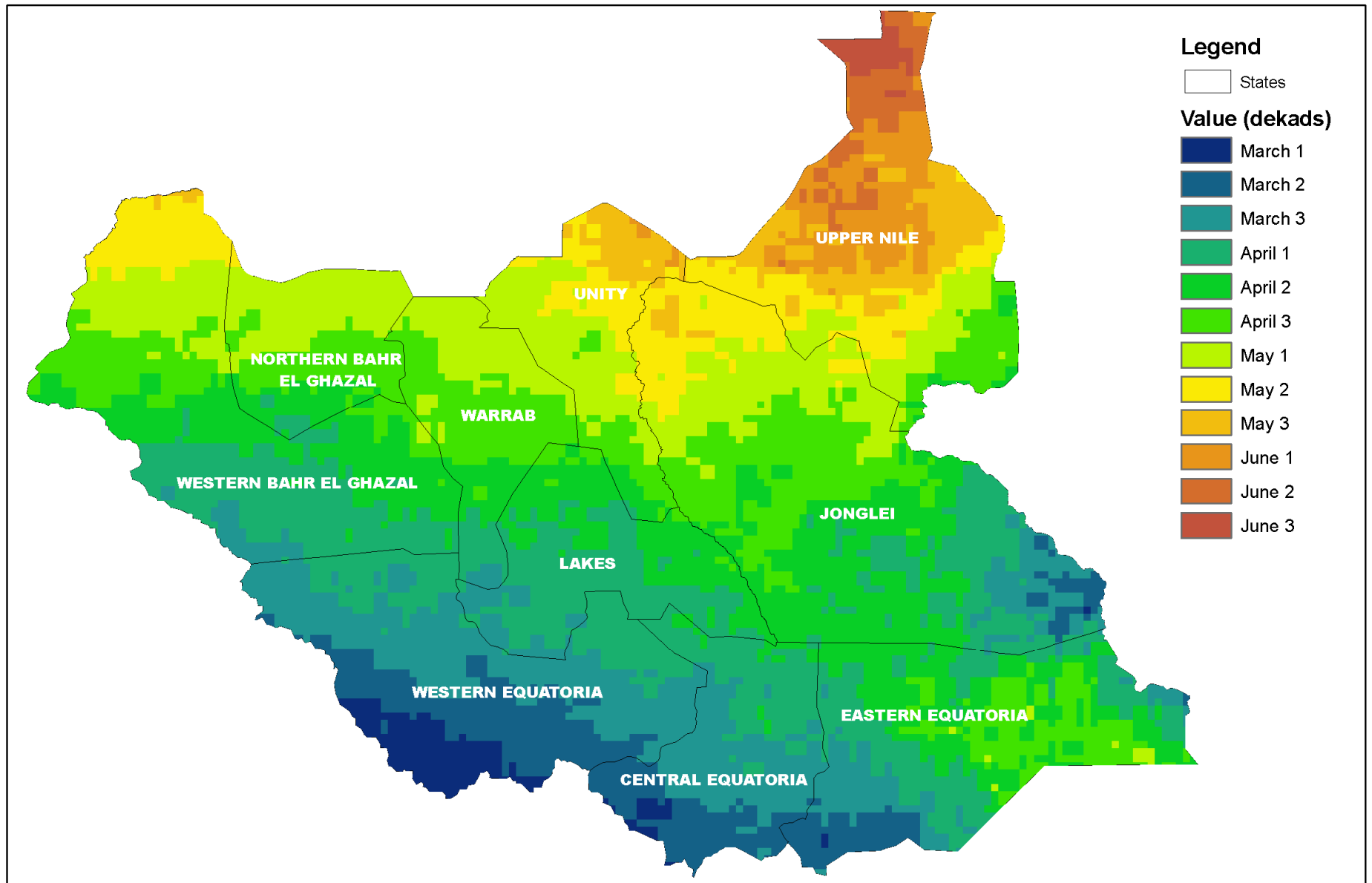


Applications

- Characterization of countries and regions
- Early Warning and impact assessment
- Crop production estimation
- The long term view

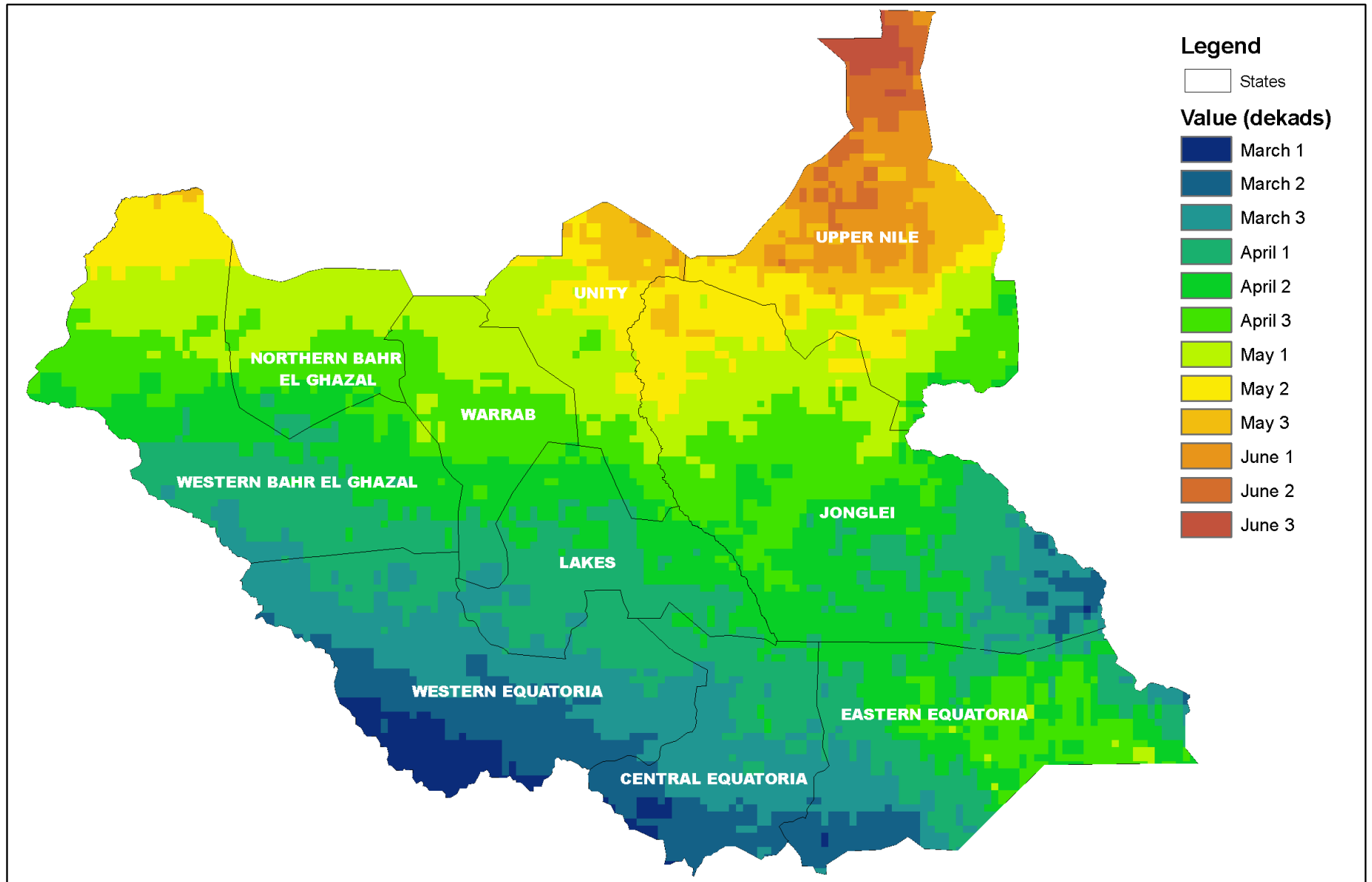
Applications - Characterization

South Sudan: Average date of beginning of growing season (1996 - 2010)



Applications - Characterization

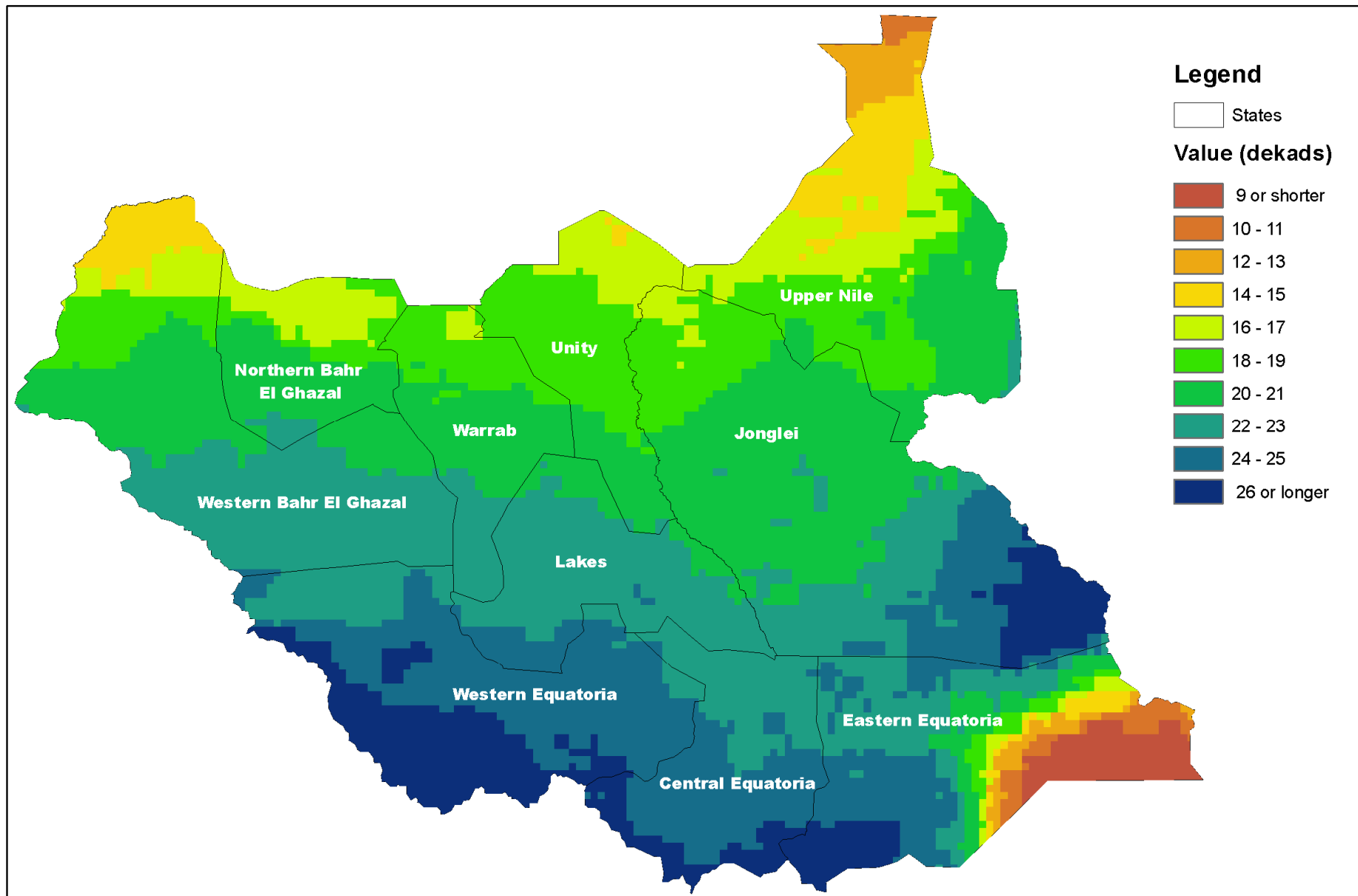
South Sudan: Average date of beginning of growing season (1996 - 2010)



Applications - Characterization

South Sudan: Average length of growing period

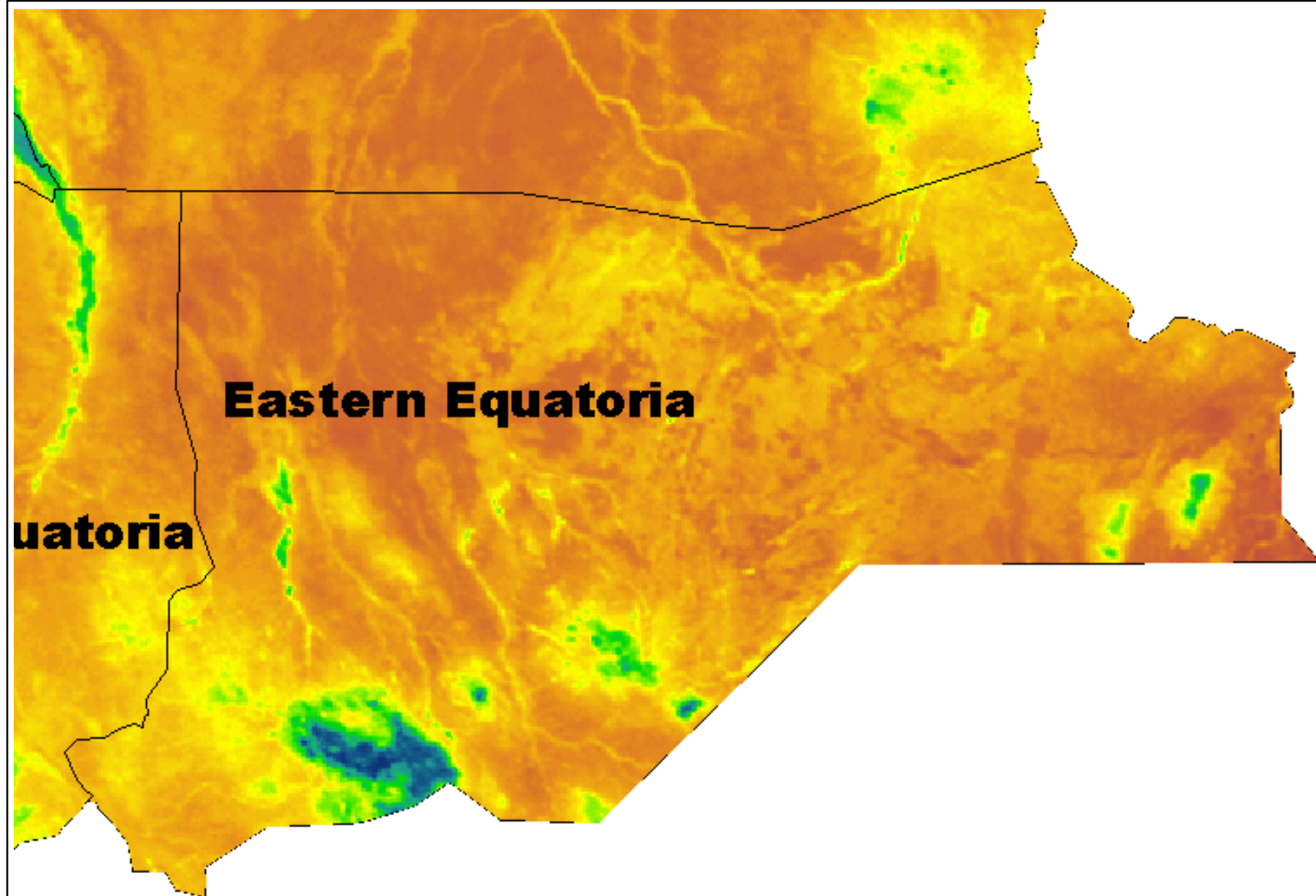
(1996 - 2010)



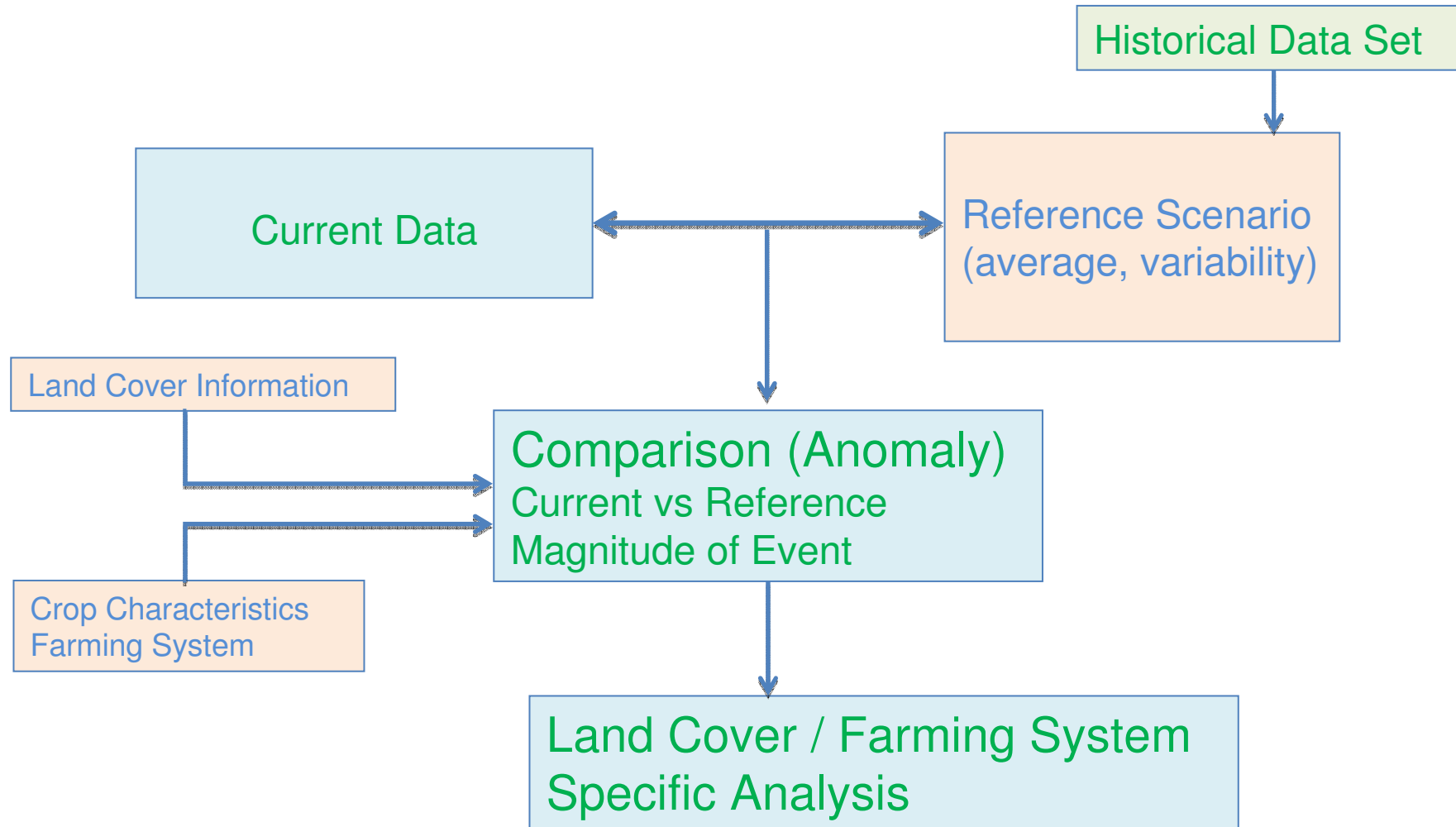
Applications - Characterization

South Sudan: Average NDVI - Late February

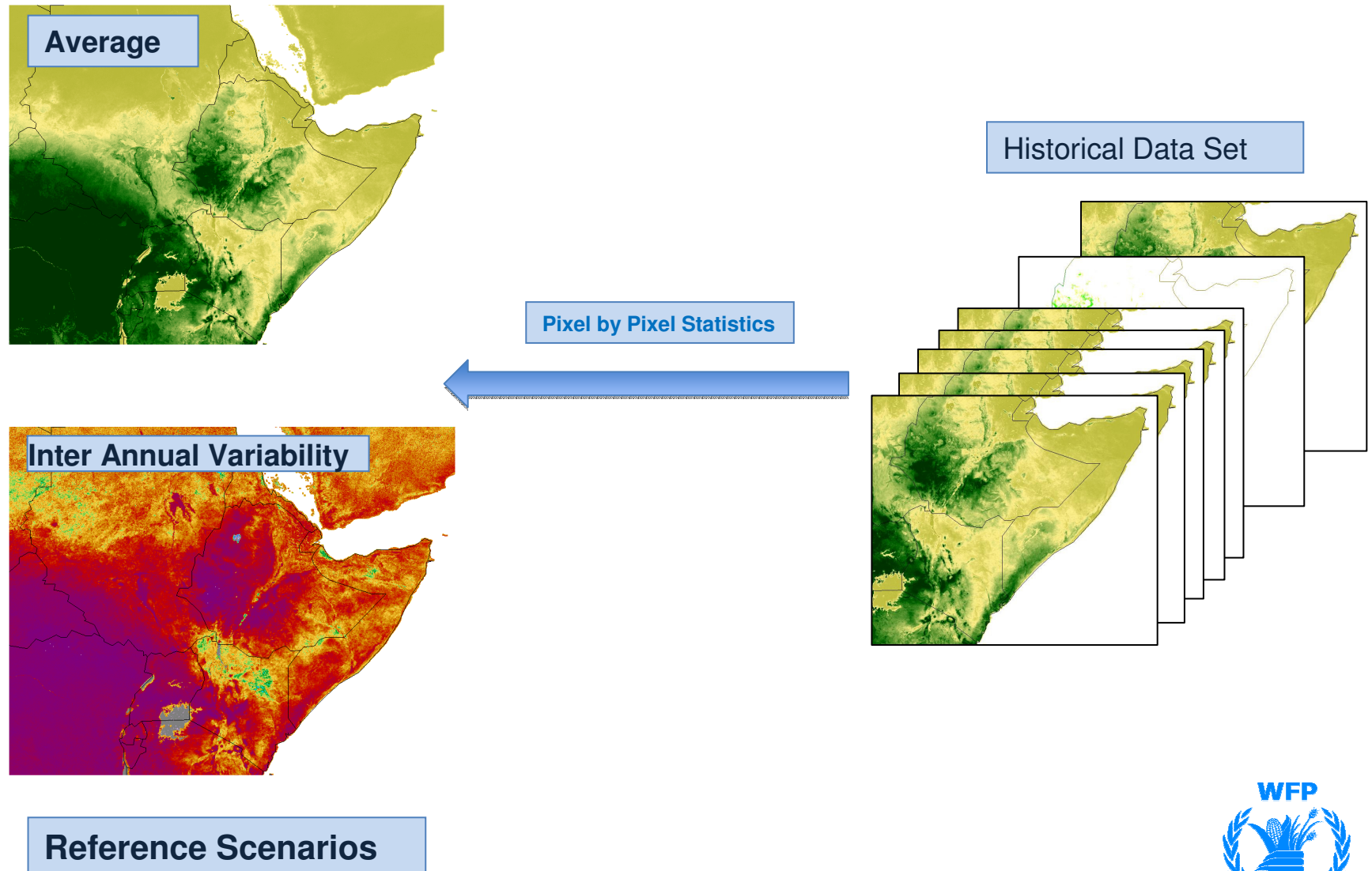
(1998 - 2010)



Early Warning – Impact Assessment

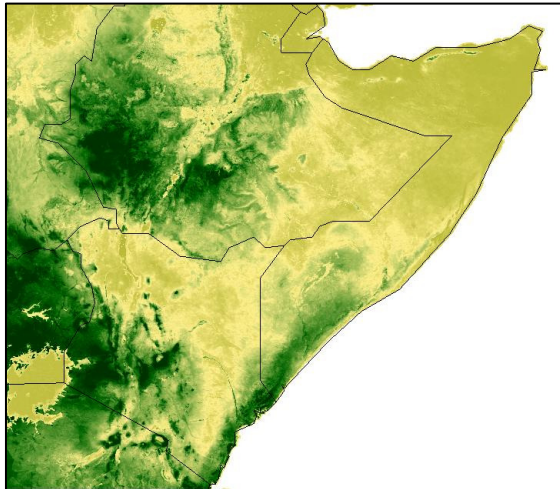


Build Reference Scenarios

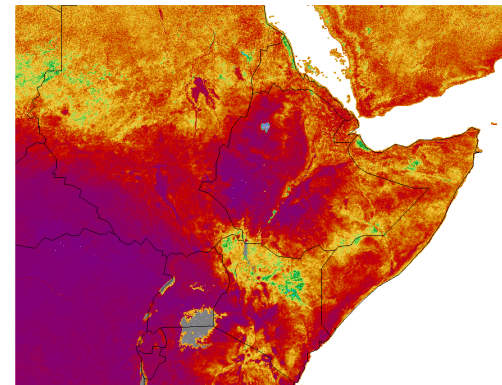
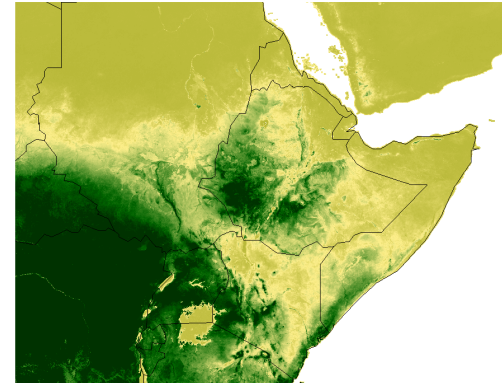


Comparison Current-Reference

Current Season Data



Reference Parameters

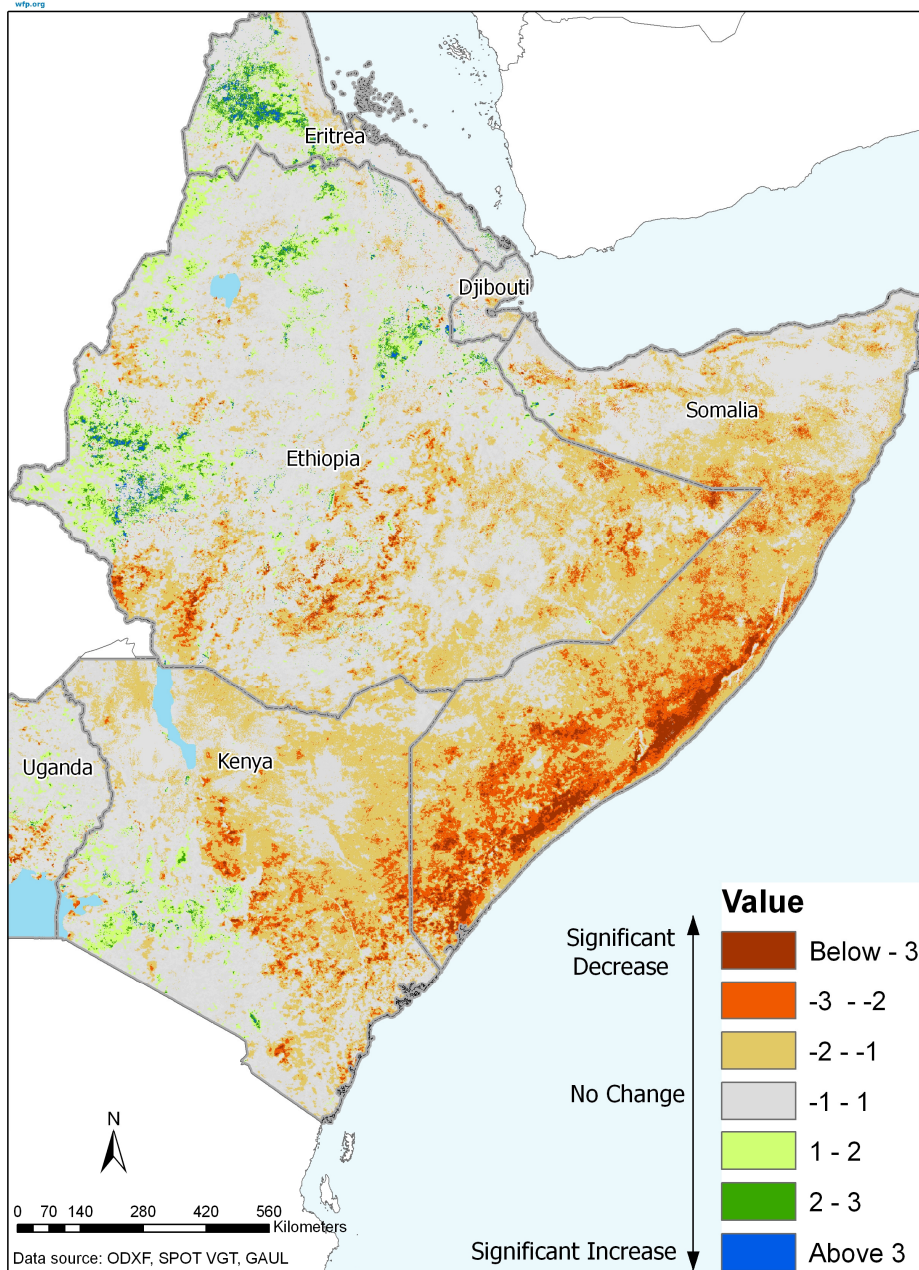


$$Z_{NDVI} = \frac{NDVI_t - \overline{NDVI}}{\sigma_{NDVI}}$$

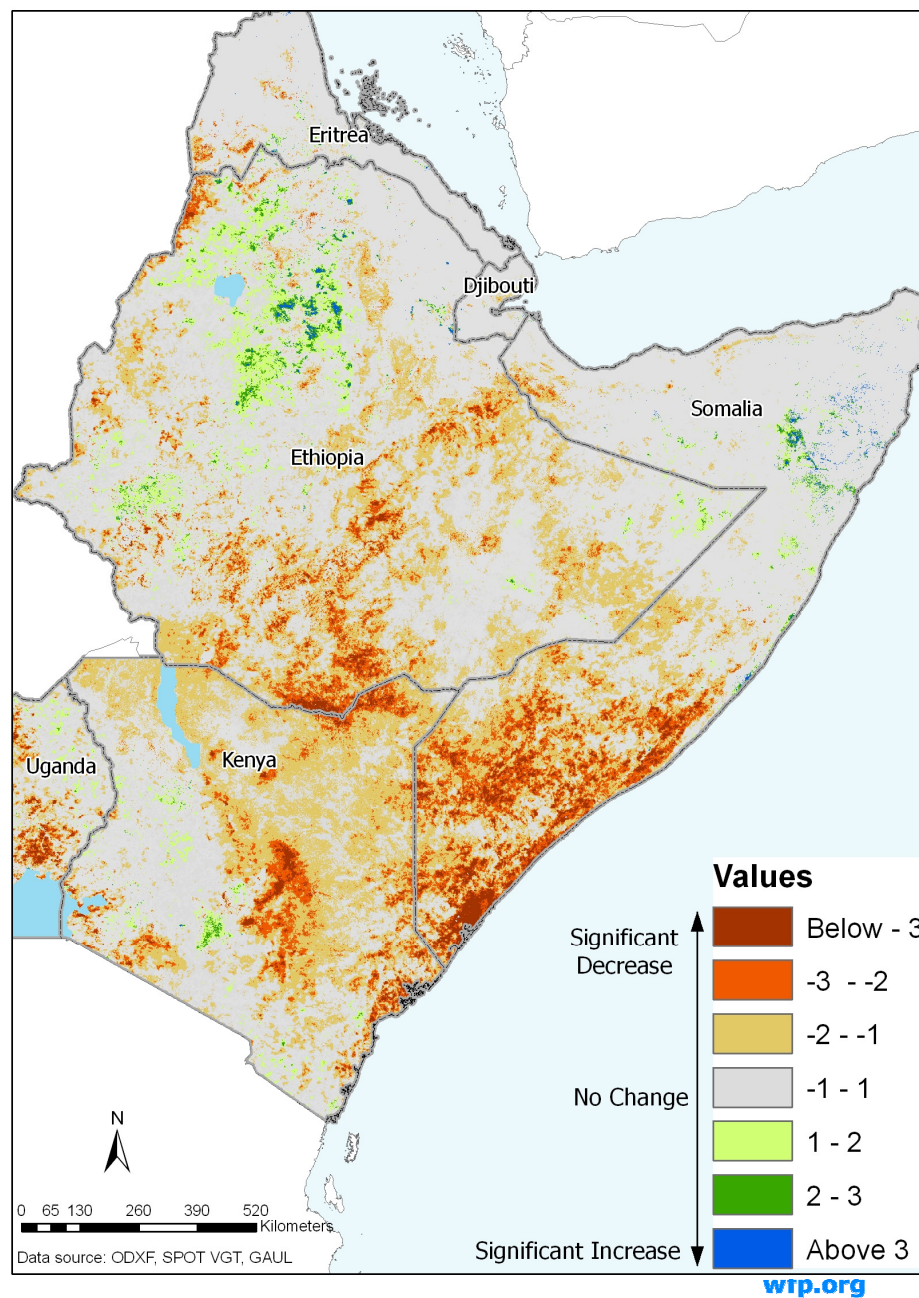
Standardized Anomaly



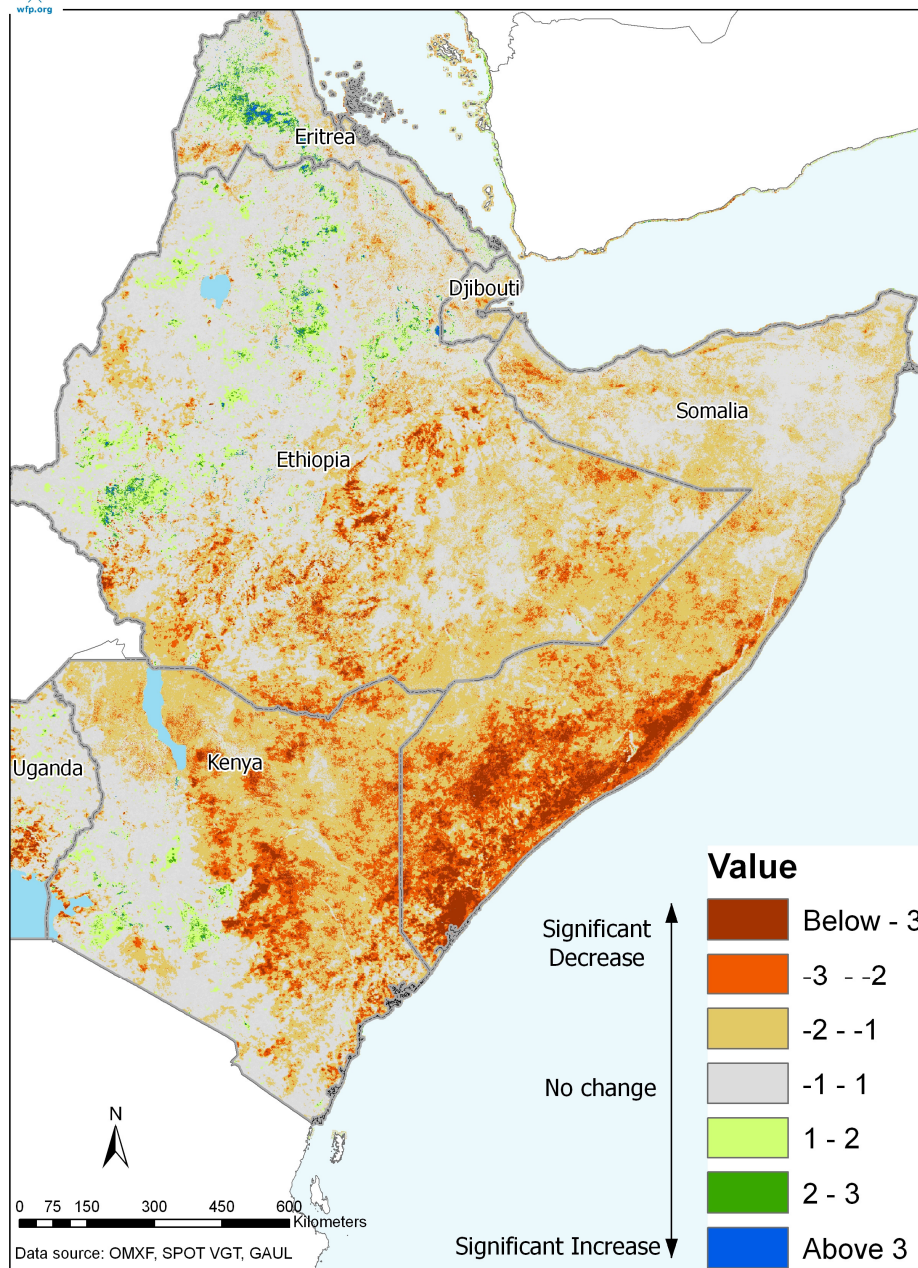
Horn of Africa: NDVI Oct 2010 to Feb 2011 Comparison to Average



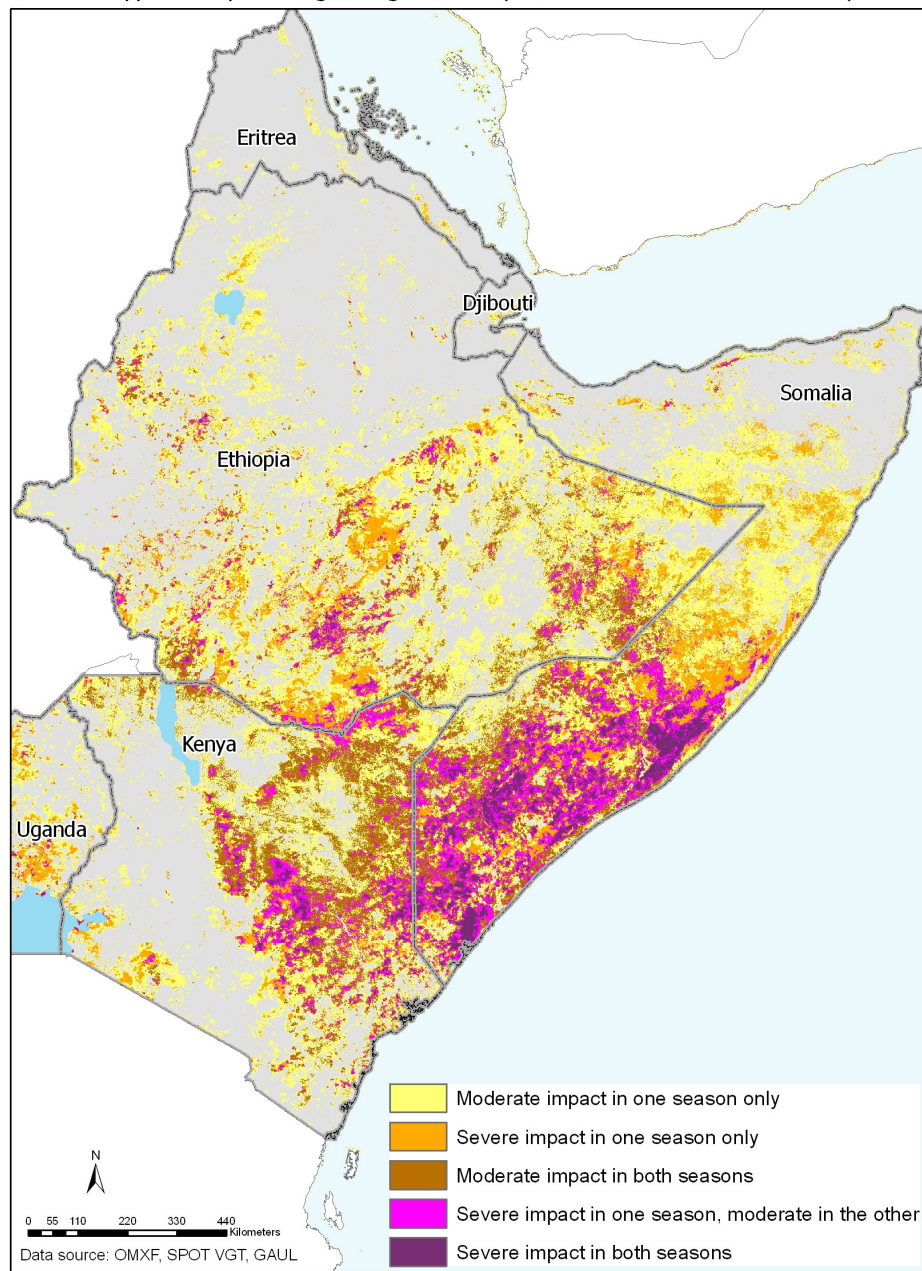
Horn of Africa: NDVI March to July 2011 Comparison to Average



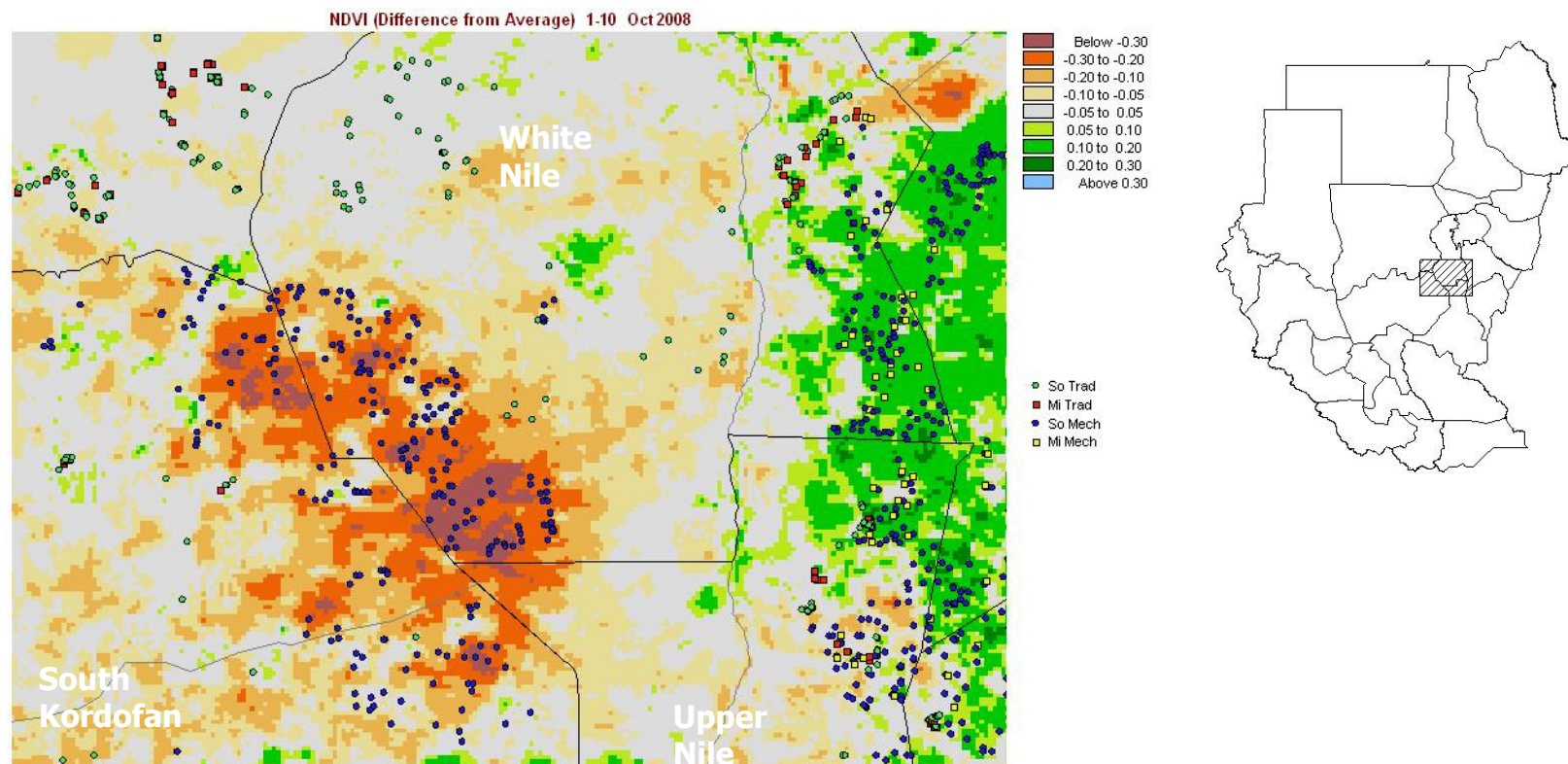
Horn of Africa: NDVI Oct 2010 - Jul 2011 Comparison to Average



Horn of Africa Affected Areas: Type of Impact on growing seasons (Oct-Feb 2010 and Mar-Jul 2011)



Central Sudan NDVI anomaly, semi-mechanized areas



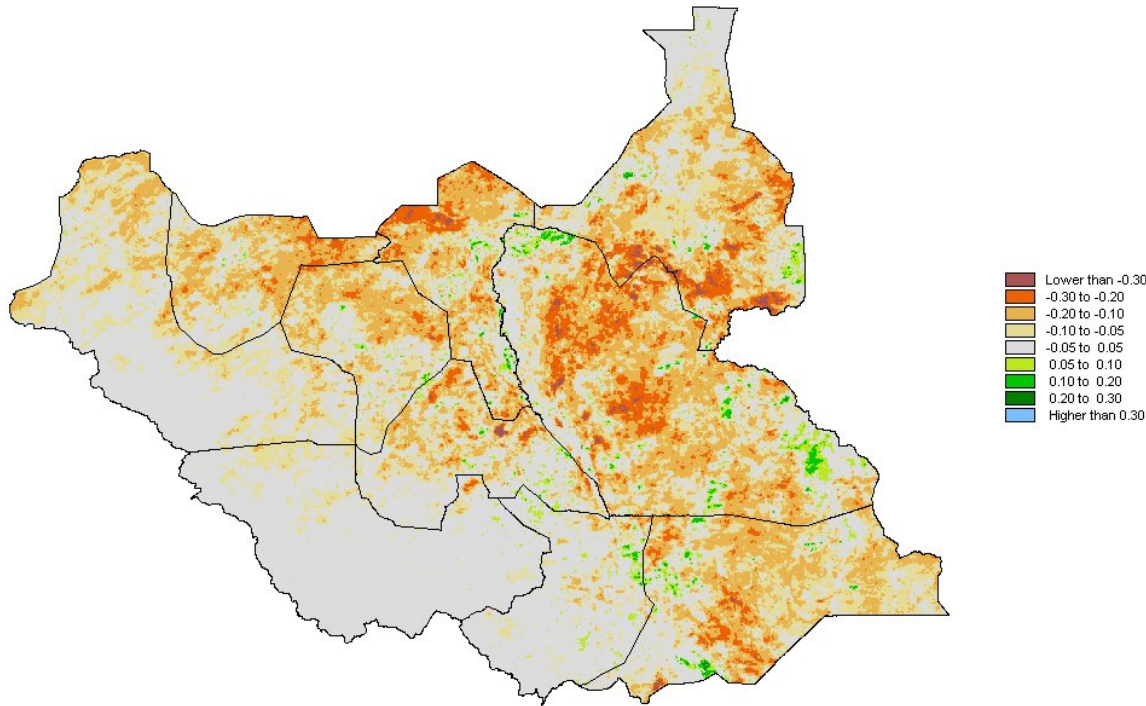
Central Sudan NDVI anomaly – land cover information defines this as a semi-mechanized agriculture region.

Impact of crop failure on the rural subsistence households of the region is not through impacts on their own production but through the loss of labour income.

Magnitude of impact is evaluated against household income profile

South Sudan early season RFE/NDVI anomaly

NDVI (Difference from Average) 21-30 of Jun 2009



How is this translated into information of value for WFP? Know-how of farming systems and crop calendars :

Short maturing sorghum is planted early so as to yield the first grain harvest of the season.

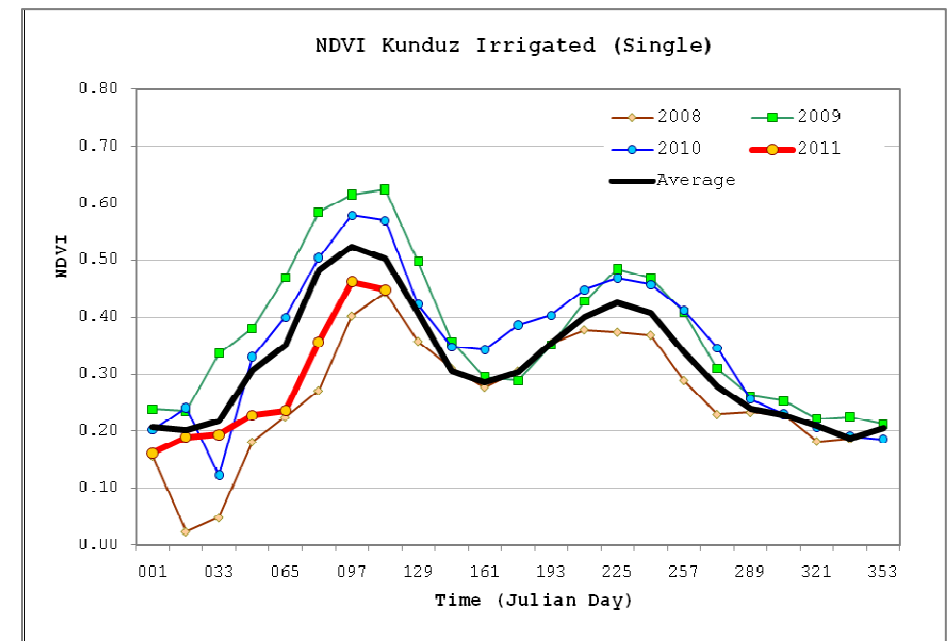
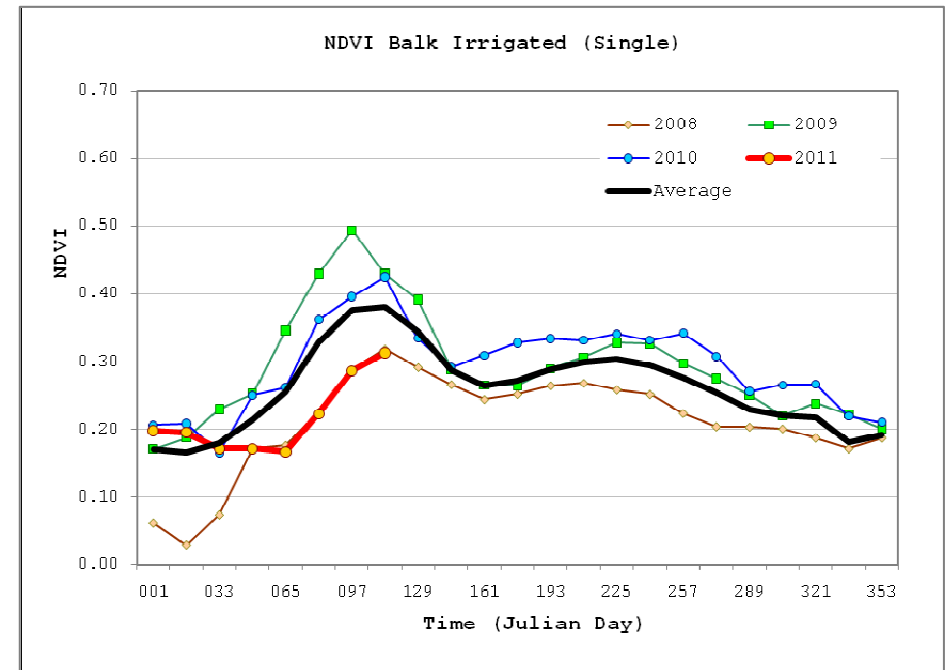
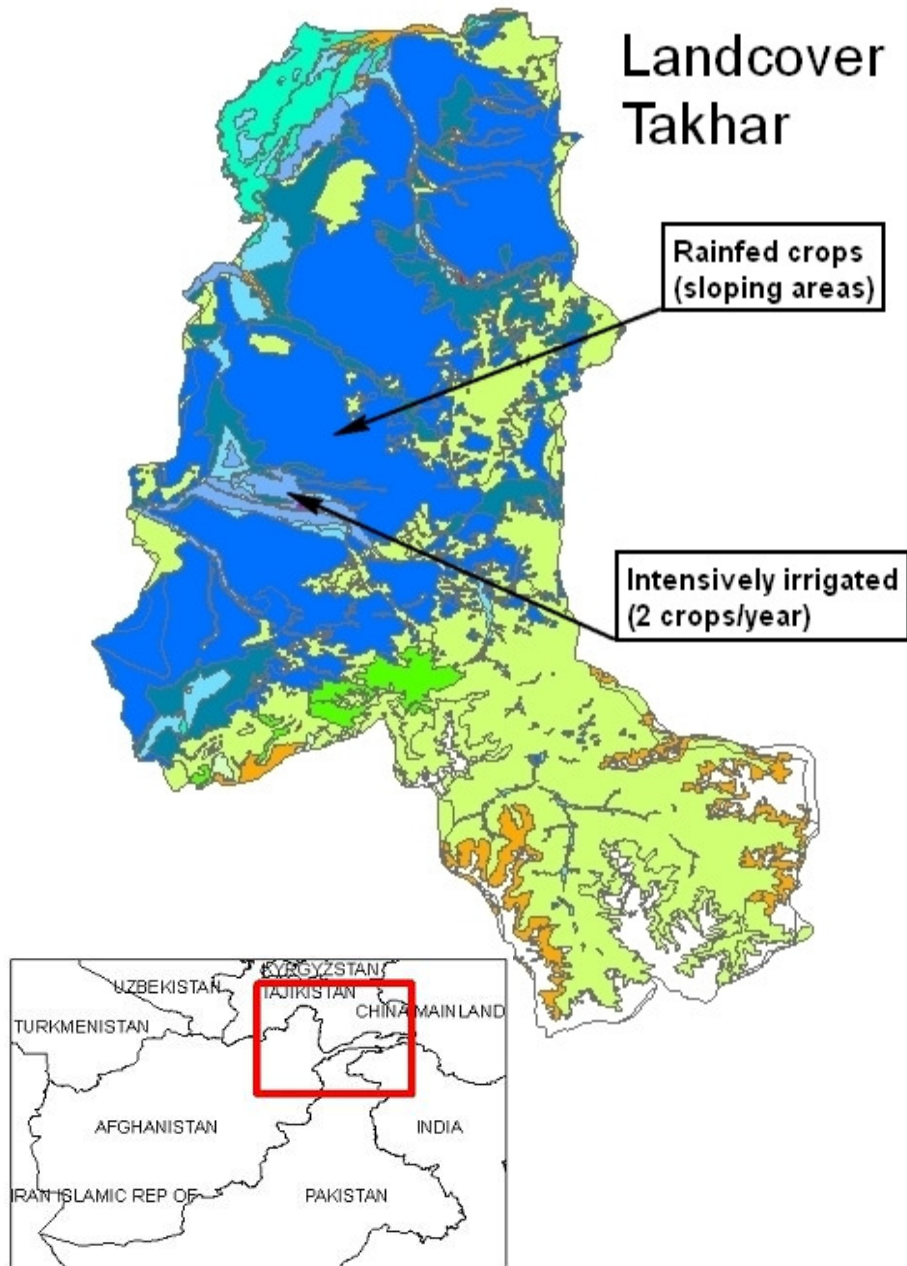
The NDVI anomaly translates into a “hunger gap” longer by 4 to 6 weeks.

Impact of this has to be judged against status of household stocks, itself mostly a function of previous season’s production

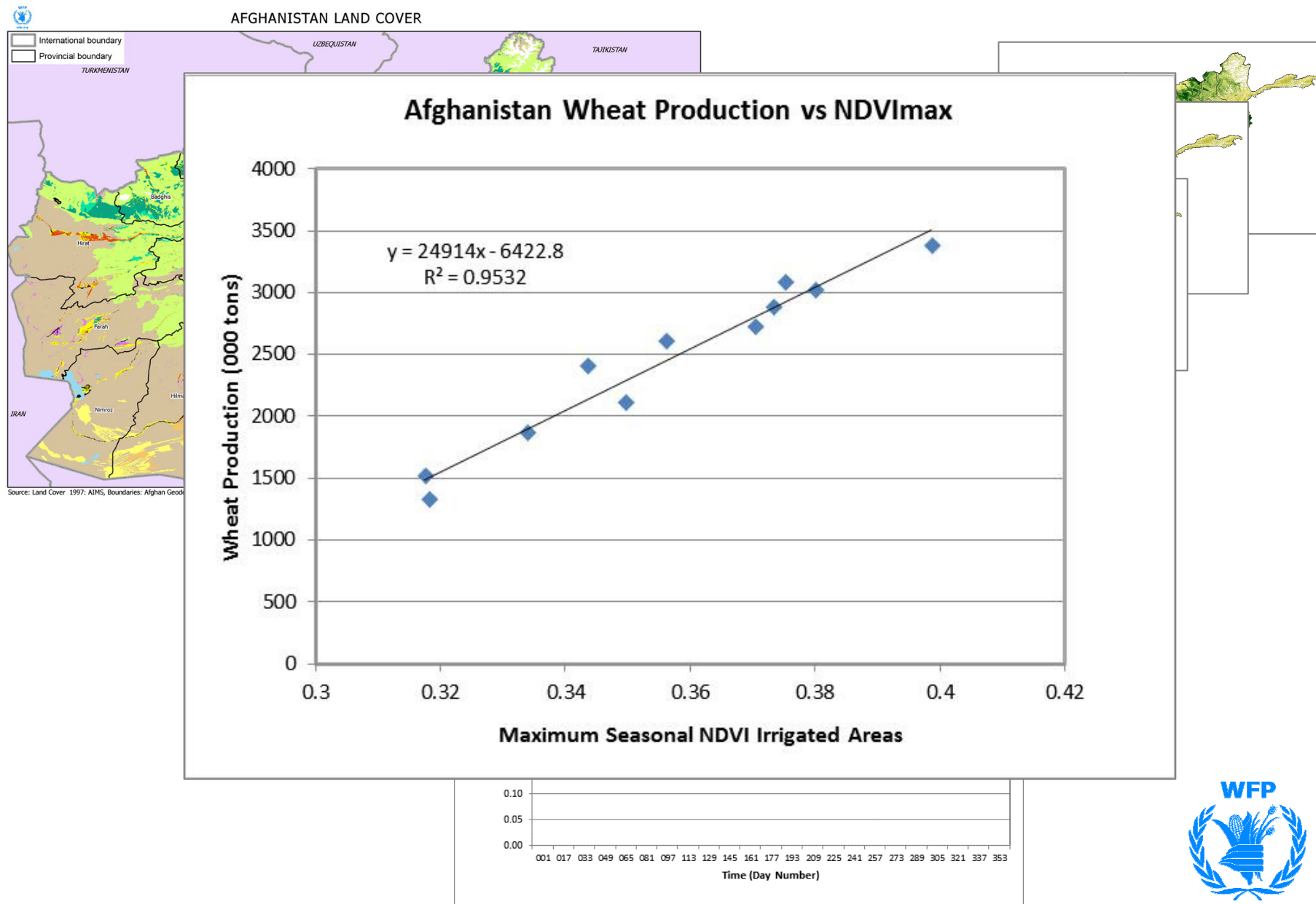
Estimating Crop Production : Afghanistan Winter Wheat



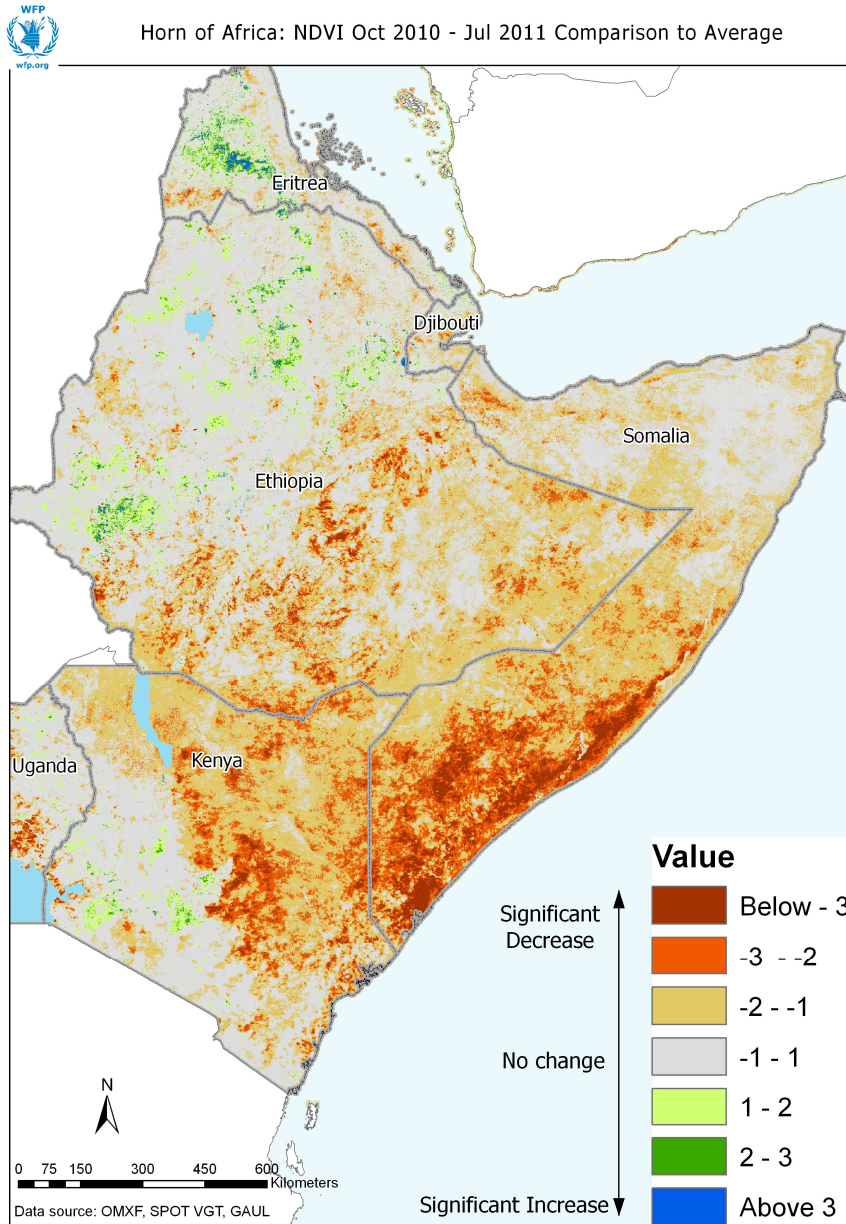
Afghanistan NDVI profiles over Cultivated Areas



Afghanistan Winter Wheat Production Estimates



The Temporal Context: a long term view of the Horn



How does the recent drought event compare with the historical record? How exceptional? Part of a trend or just natural variability?

Experiment: Combine NDVI datasets with slightly different characteristics, covering different time spans

Inter-calibrate

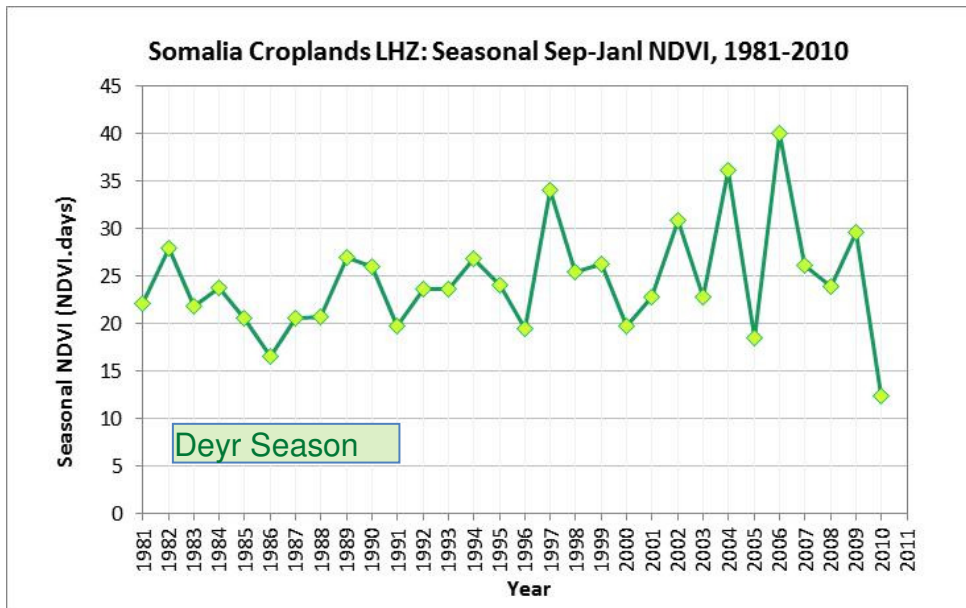
GIMMS NDVI 1981-2008

SPOT-VGT 1998-present

to obtain a tentative synthetic dataset 1981-present

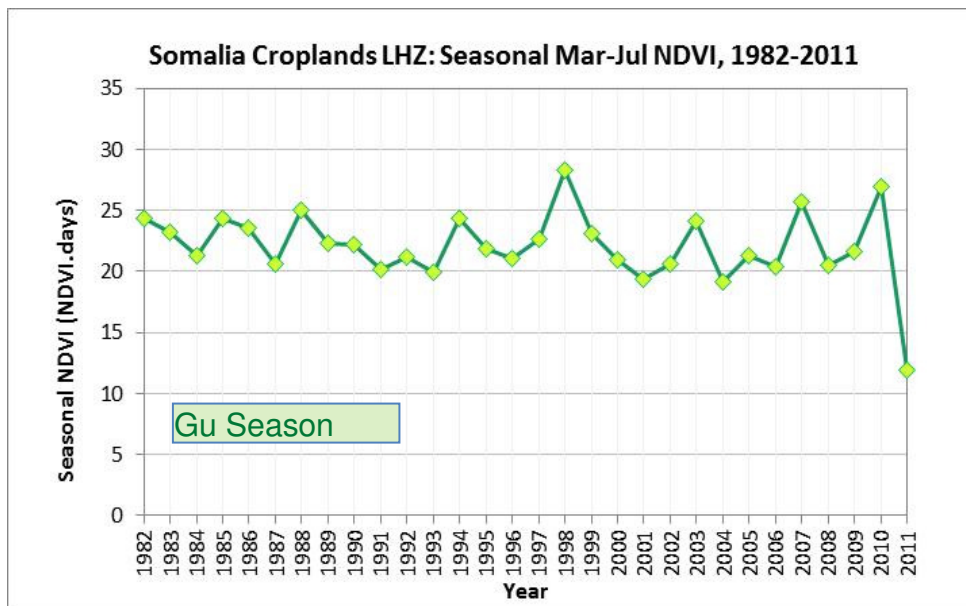


Temporal Context – Somalia Croplands

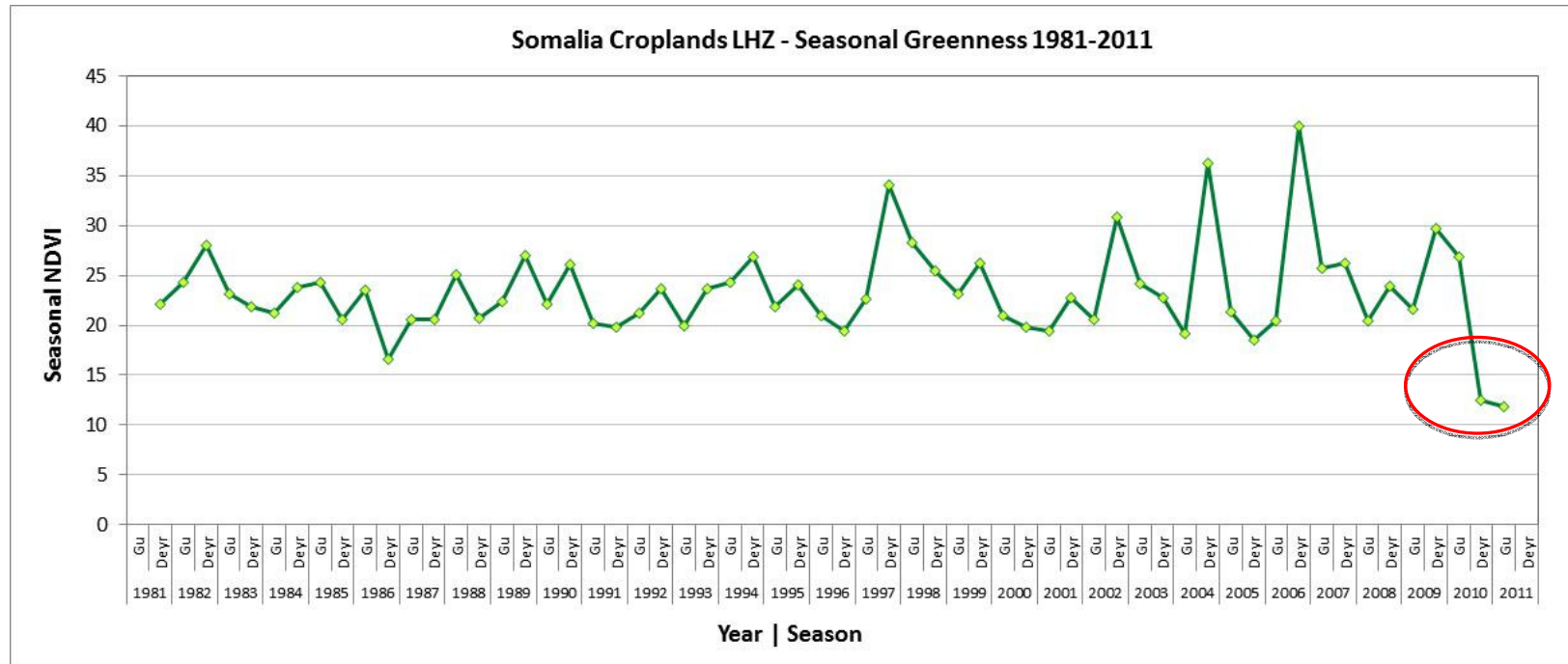


Agricultural livelihood areas :
Deyr season (Oct-Dec, short rains)
much more variable than Gu season
(Apr-Jun, long rains)

2010-2011 event exceptional in the
30 year timeframe



Temporal Context – Somalia Croplands



Agricultural livelihood areas :

No apparent trend, but increasing variability?

2010-2011 event : two consecutive exceptional failures in the 30 year record

Wrap up

EO data products increasingly visible and used with higher demand fuelled by greater awareness of their potential.

- Increasing availability and wider variety of datasets
- Standard approach
- Usage of land cover/livelihood information
- Need to integrate with household/livelihood information and crop/farming calendars.
- Information in long-medium term data sets

World Food Programme

Via C.G. Viola, 68/70 - 00148 Rome, Italy



World Food Programme

Analysis for the Horn of Africa

Integrated view over two seasons:

Z anomaly for aggregated NDVI October 2010 – July 2011

Classify each season Z image into severe (or worse), moderate, normal, cross tabulate and re-group into key groups :

- Severe impact in both seasons
- Severe impact in one season, moderate in other
- Moderate impact on both seasons
- Severe impact in one season, normal in other
- Moderate impact in one season, normal in other

Rough, but allows quick identification of areas with consecutive significant impact (relative to past behaviour)

Descriptive legend convenient for non technical readers

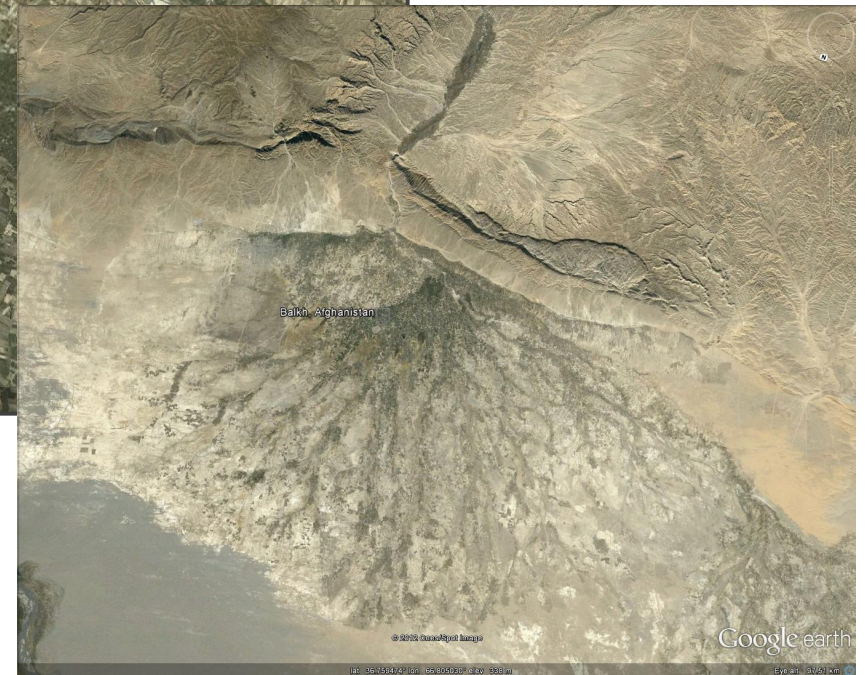


Analysis for the Horn of Africa

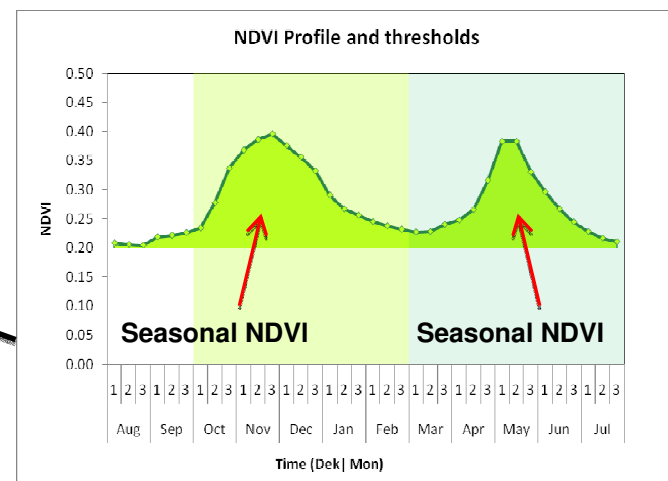
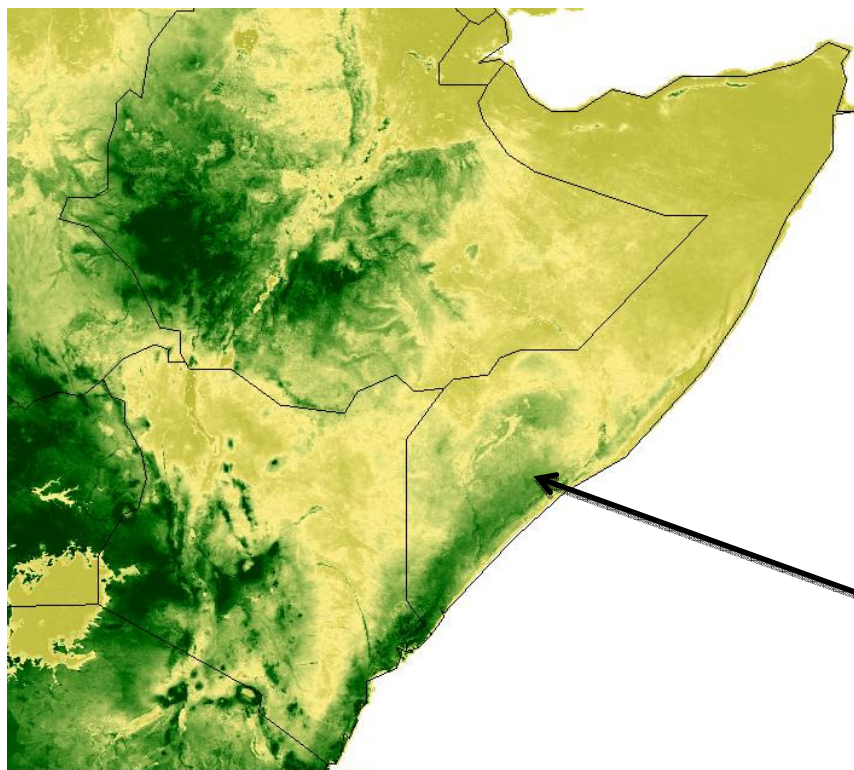
Rationale :

Past variation in NDVI assumed to contain the range of variation in seasonal resources that the household has had to cope with.

- Z btn [-1 to +1]: **normal** season to season variation
- Z btn [-1 to -2]: **moderate** variation assumed to enclose the limits of the usual coping capacities of agricultural households.
- Z btn [-2 to -3]: **severe** variation, stretching coping capacity beyond what many households could achieve. Significant impacts.
- Z < -3: **extreme** variation, well outside the coping capacity if not the experience / living memory of households. Extreme impacts, once in a generation events (?)

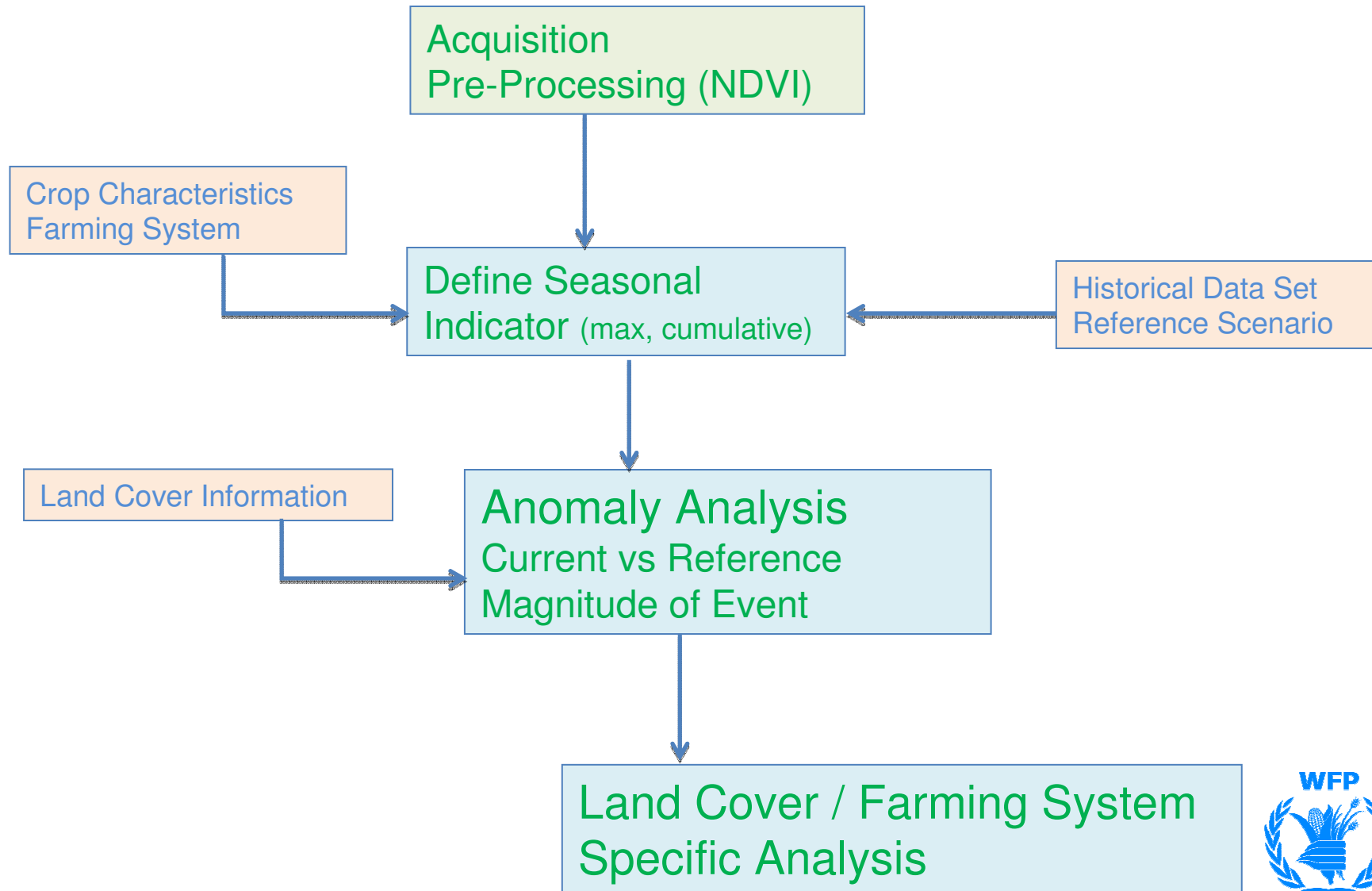


Evaluate Seasonality

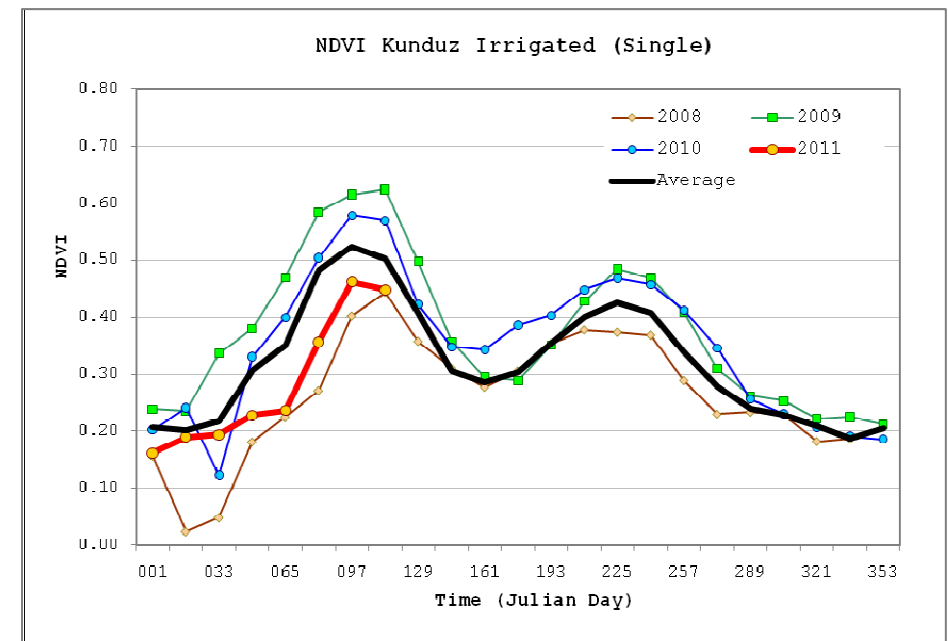
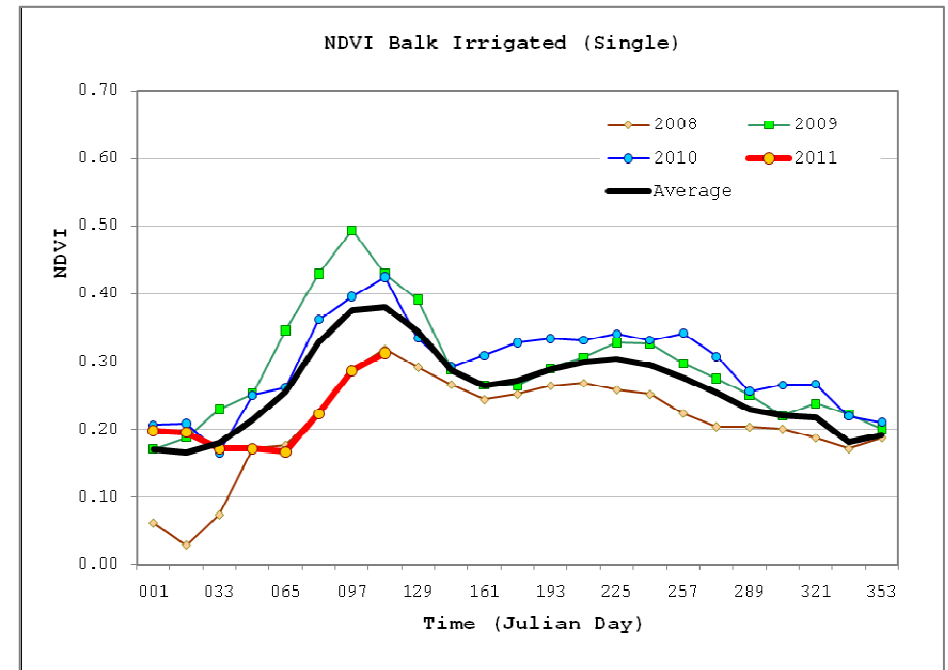
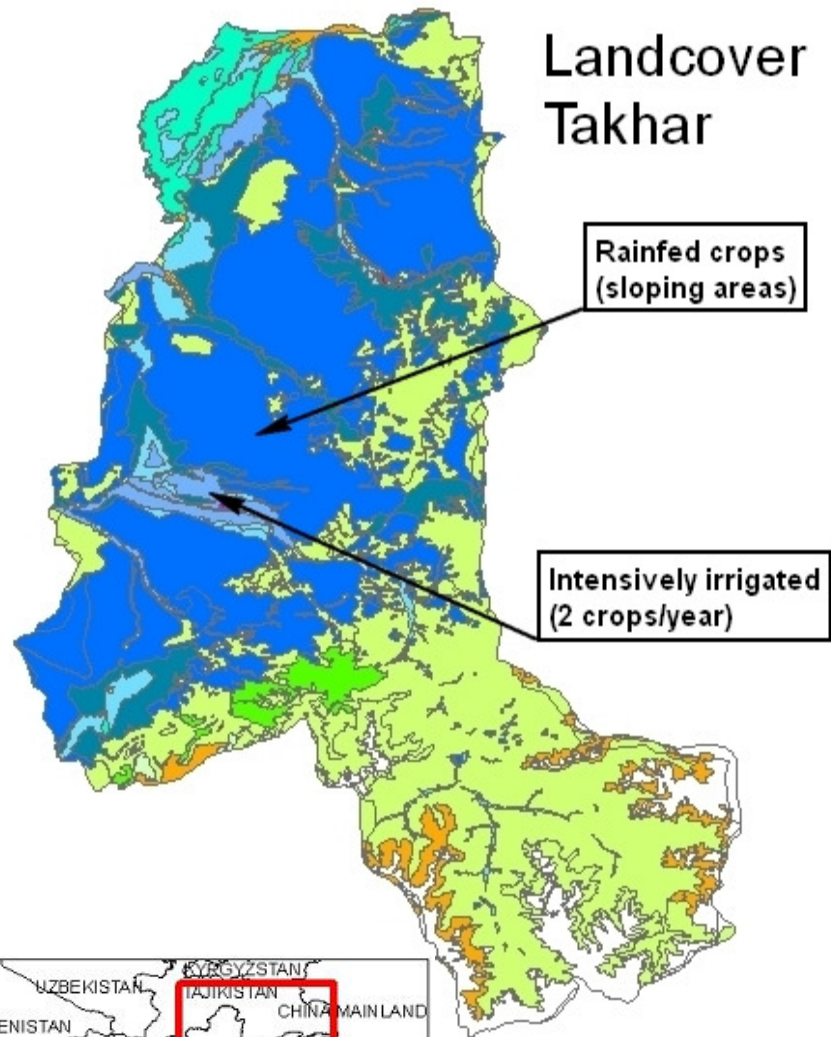


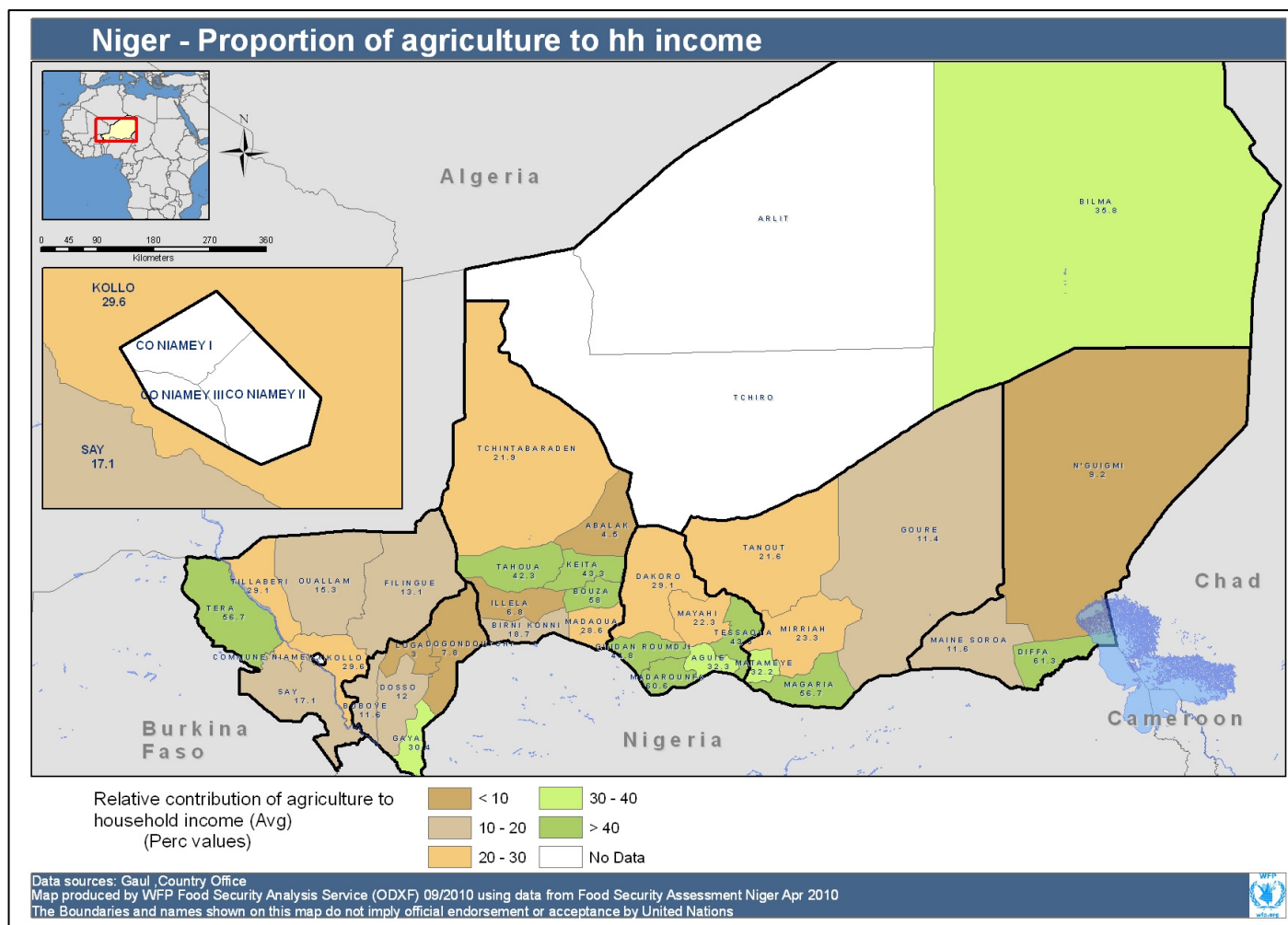
Bimodal Regime (2 seasons)
Seasonal NDVI within each individual growing period

Analysis Framework

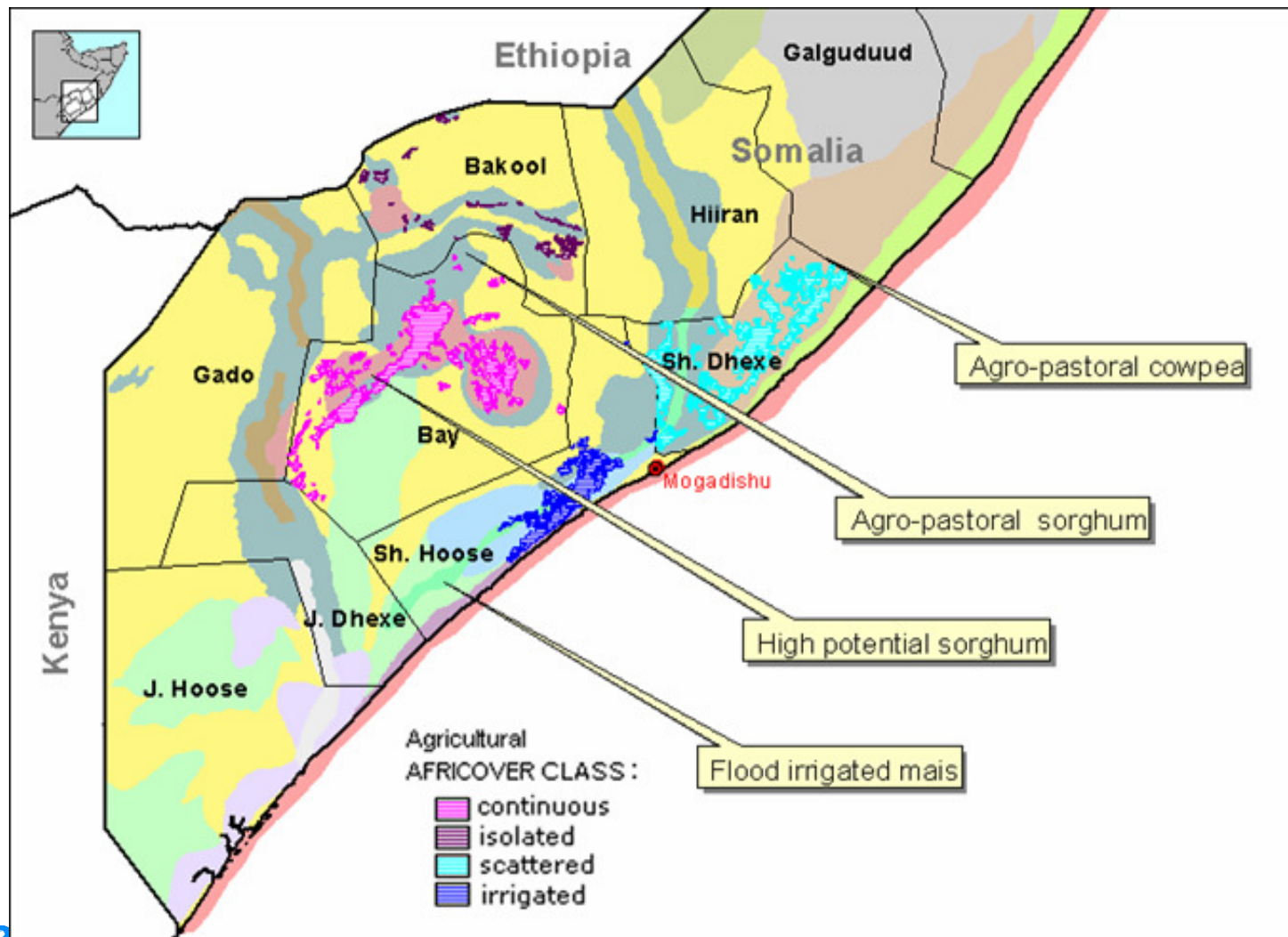


Afghanistan NDVI profiles over Cultivated Areas

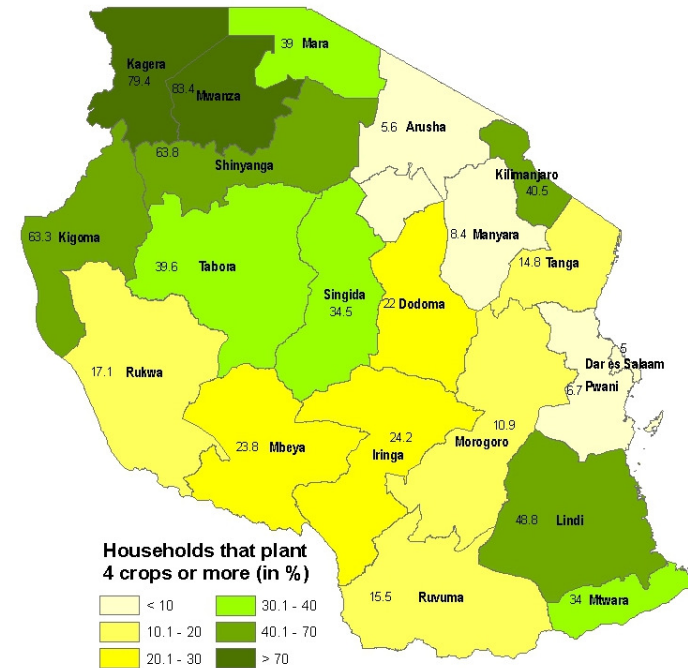
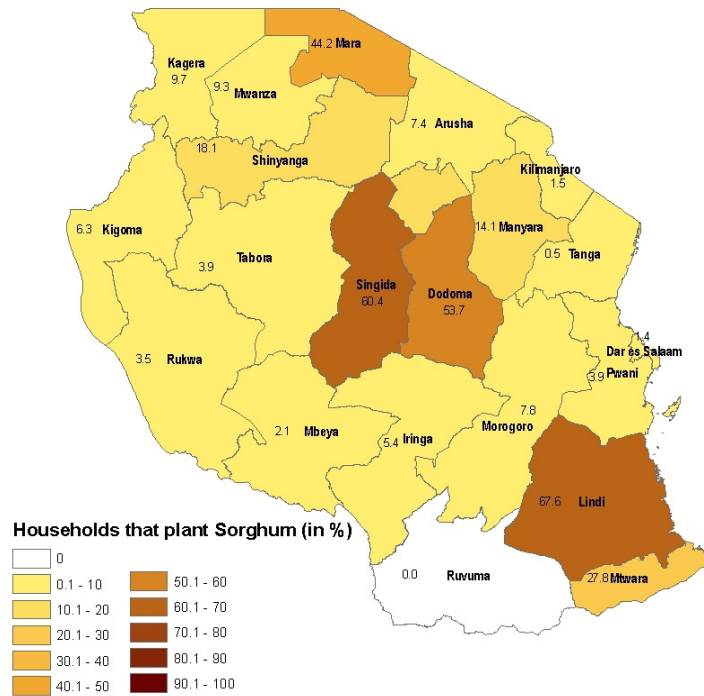




Key information to evaluate impacts of fluctuations in crop production



Agricultural Characterization

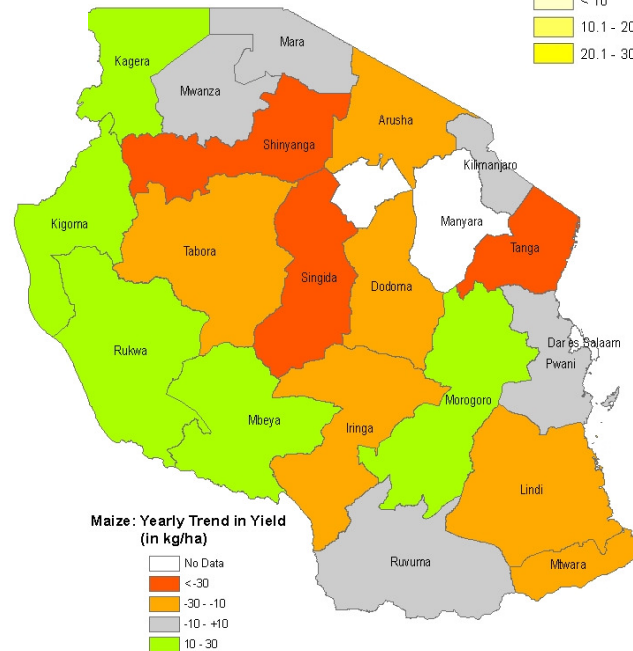


Tanzania

Crop Prevalence

HH Crop Diversity

Trend in Crop Yield



Analytical Framework

Anomaly analysis, i.e. comparison of current vs reference scenario

Reference scenario – Long Term Average.

- Identify affected areas and intensity of impact
- Describe their characteristics
- Place in temporal context
- Input/context to market and trade analysis

NDVI (SPOT-VGT) based

- Proxy for household resources (crop and pasture)
- Reasonably long records
- Fine resolution, performance over irrigated areas

Analysis for the Horn of Africa

A look at the situation post-event. Objective can be described as establishing a drought baseline.

- Identify affected areas and intensity of impact
- Describe their characteristics
- Place in temporal context
- Input/context to market and trade analysis

NDVI (SPOT-VGT) based

- Proxy for household resources (crop and pasture)
- Reasonably long records
- Fine resolution, performance over irrigated areas

Conclusions

EO data products increasingly visible and used with higher demand fuelled by greater awareness of their potential.

- Long-medium term data series vs new products
- Usage of land cover/livelihood information
- Integration of monitoring outputs with Food Security and Market information

Linkages with local providers of monitoring information

Analysis for the Horn of Africa

Requirement : spatial extent and magnitude of impacts in a single map

Common problem – derive a single seasonal summary from the growing season NDVI profile

Maximum. Cumulative/integrated NDVI. Others?

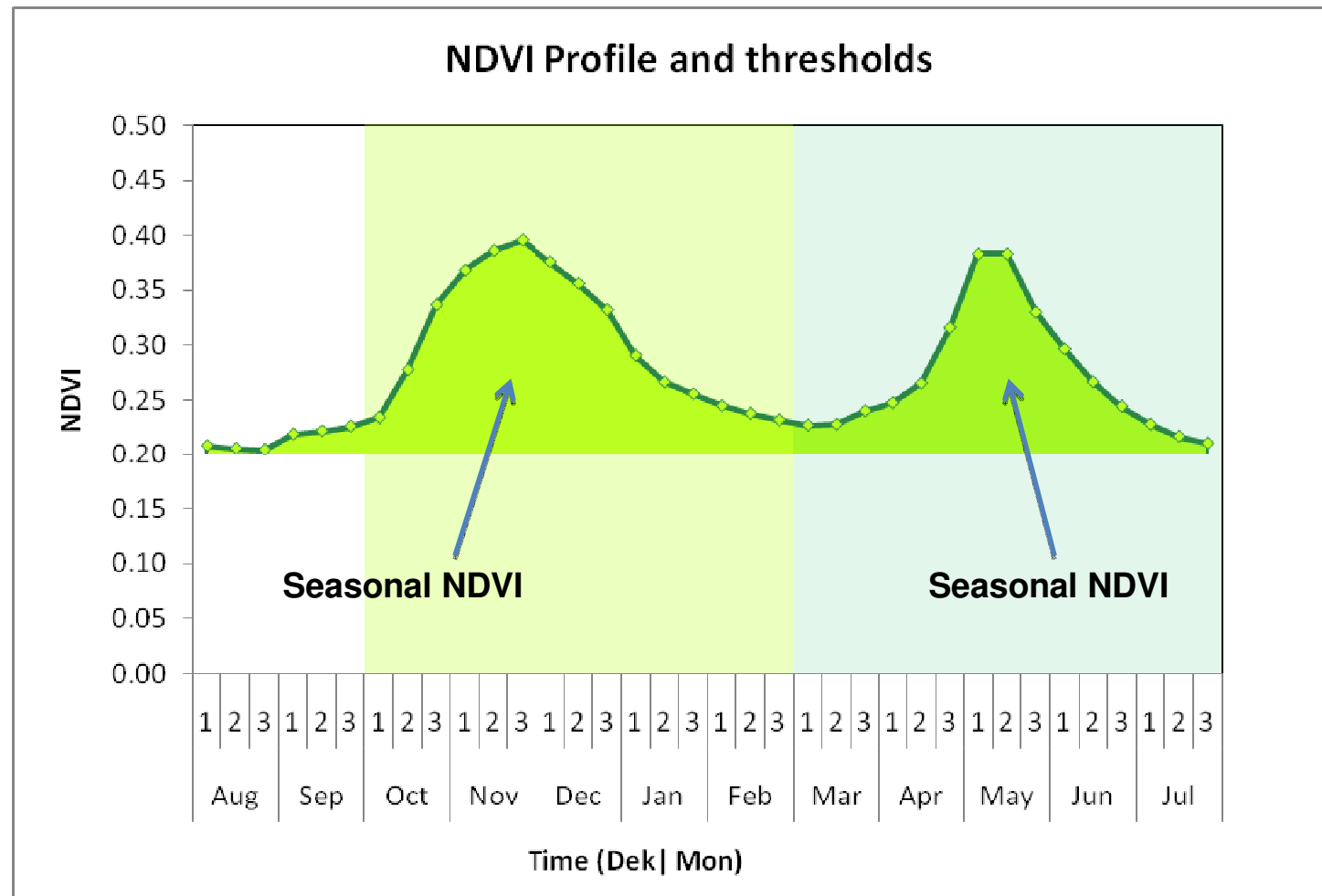
Approach : **Seasonal NDVI** - Cumulative NDVI above a dry season threshold (preceding minimum up to 0.2).

Separate calculation for each season and joint:

October-February / March-July / October-July



Analysis for the Horn of Africa



Analysis for the Horn of Africa

Once seasonal parameter defined, how do you evaluate the 2010-2011 seasons?

NDVI Anomalies: Difference, Ratio

Approach : Standardized Anomaly

$$Z_{NDVI} = \frac{NDVI_i - \overline{NDVI}}{\sigma_{NDVI}}$$

Current season behaviour scaled by past variability (variation from average as number of std deviations).

Same Difference or Ratio may correspond to very different Z values, depending on past variation

Analysis for the Horn of Africa

Rationale :

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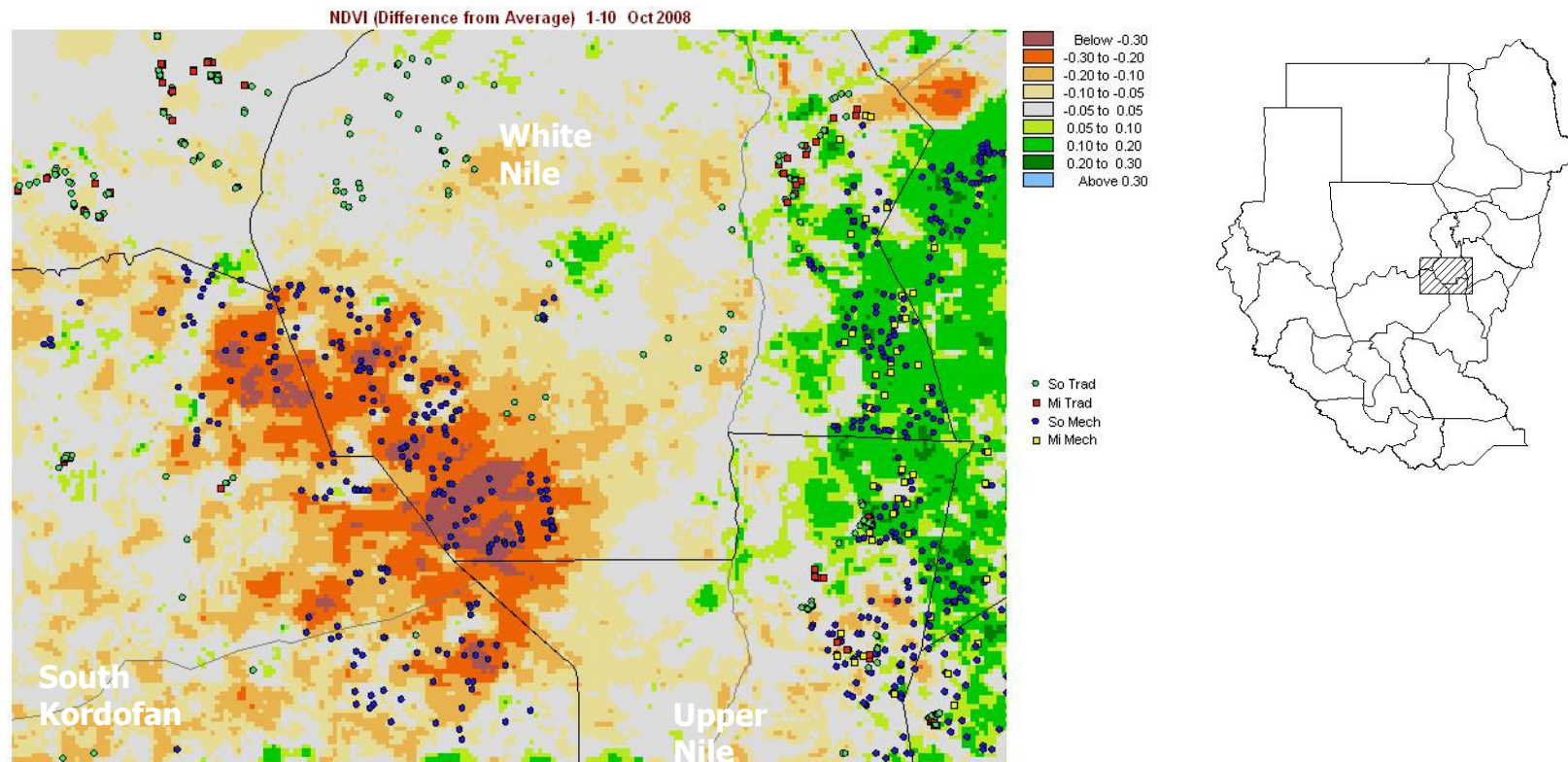
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Analysis for the Horn of Africa

Results:

- The impacts were very strong (extremely strong in places), were spatially very widespread and extended over two consecutive growing seasons which is in itself quite unusual.
- The area most affected both in terms of spatial extent and magnitude of the event was by far Southern Somalia, where both seasons registered extremely poor performance.
- Other impacted areas were central and north-eastern Kenya and areas of Southern Ethiopia but to a lesser degree, as impacts during the late 2010 growing season were much less marked than for Southern Somalia.
- All livelihood zones in Somalia were affected given the extent of the drought impact. In some areas, in particular agricultural areas of the Shabelle, Bay and Juba regions, the values of the standardized anomaly reached below -5 – the simplest way to translate this is that in these regions there would have been no one old enough to remember an event of such magnitude.

Central Sudan NDVI anomaly, semi-mechanized areas



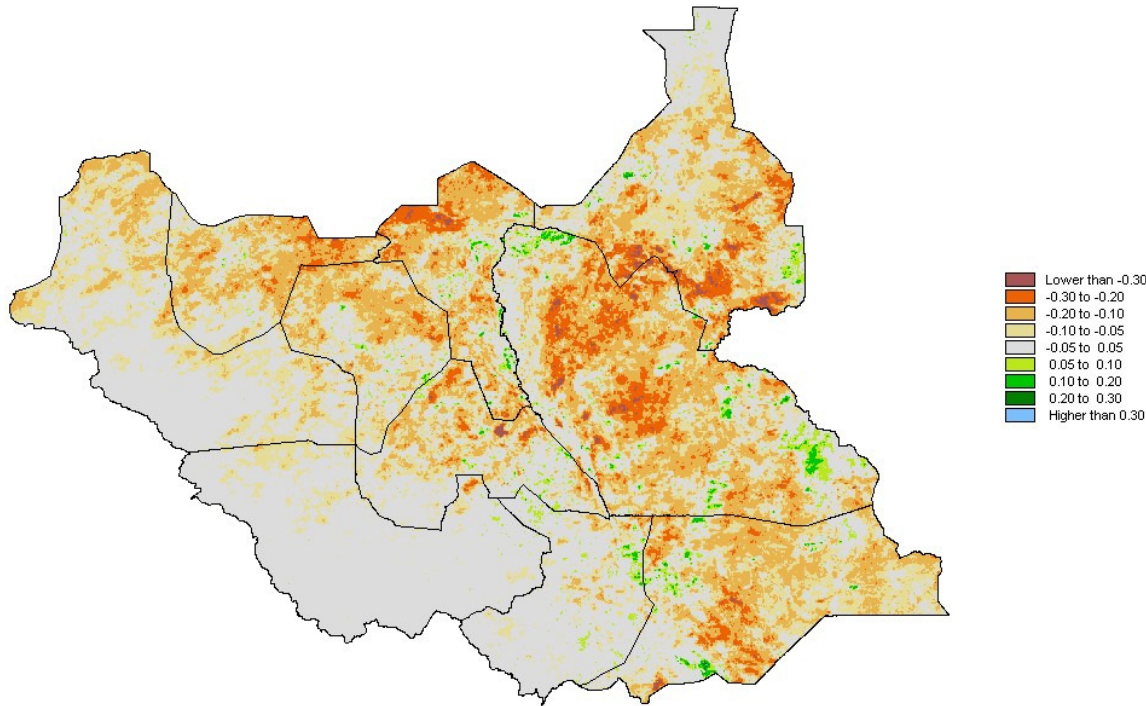
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Application of Remote Sensing Data

- Monitoring and assessment of agricultural season performance in priority areas/countries [early warning, impact assessment]
- Analysis of past events – frequency, magnitude and spatial distribution.
- COs frequently initiate a request (cf. Niger, Yemen). Mostly analysis carried out at HQ.
- Frequently rely on good relationships with in-country partners (FEWS-Net) and inter-institutional FS fora.
- WFP-VAM and ODEP (Emergency Preparedness) coordination

Usage of Remote Sensing Data at WFP

Food Security :

- Availability

- Access

- Utilization

- Stability

Relevance of Remote Sensing :

- Availability dimension

Some initial steps on commodity price analysis