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A global drought monitoring system: insights of an approach integrating remote sensing data and vulnerability to food insecurity

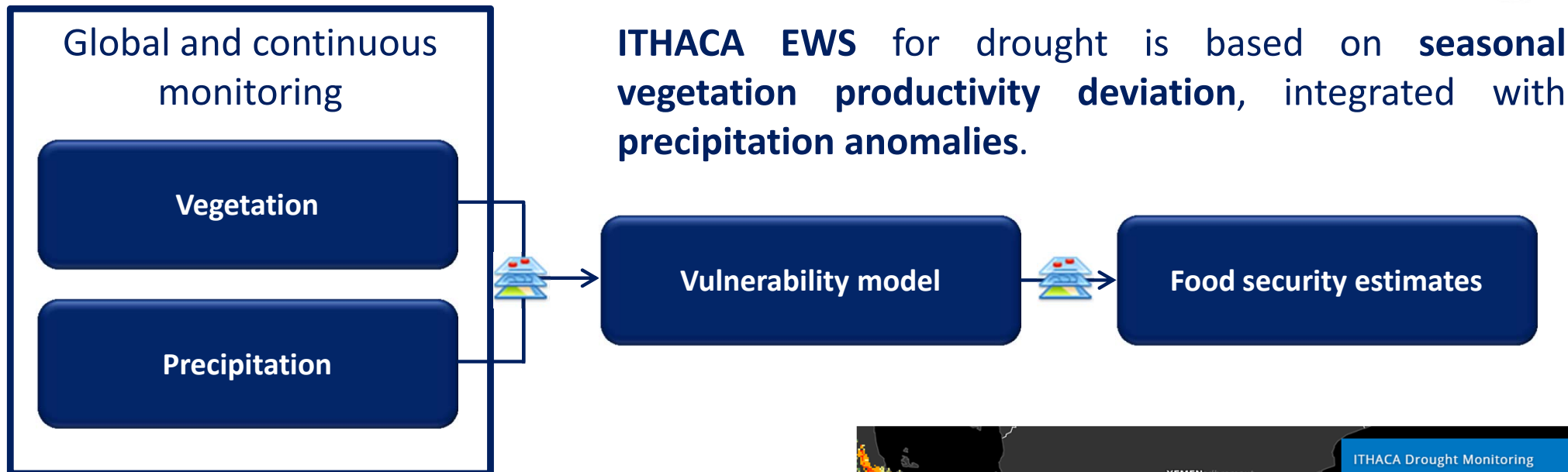
Francesca Perez, Irene Angeluccetti, Walther Cámara, Alessandro Demarchi

In **Less Developed Countries** recurrent **agricultural drought** events engendered famine and consequently **loss of lives**.

Humanitarian agencies need strongly **operational tools** to deliver helps precisely and timely to those in need.

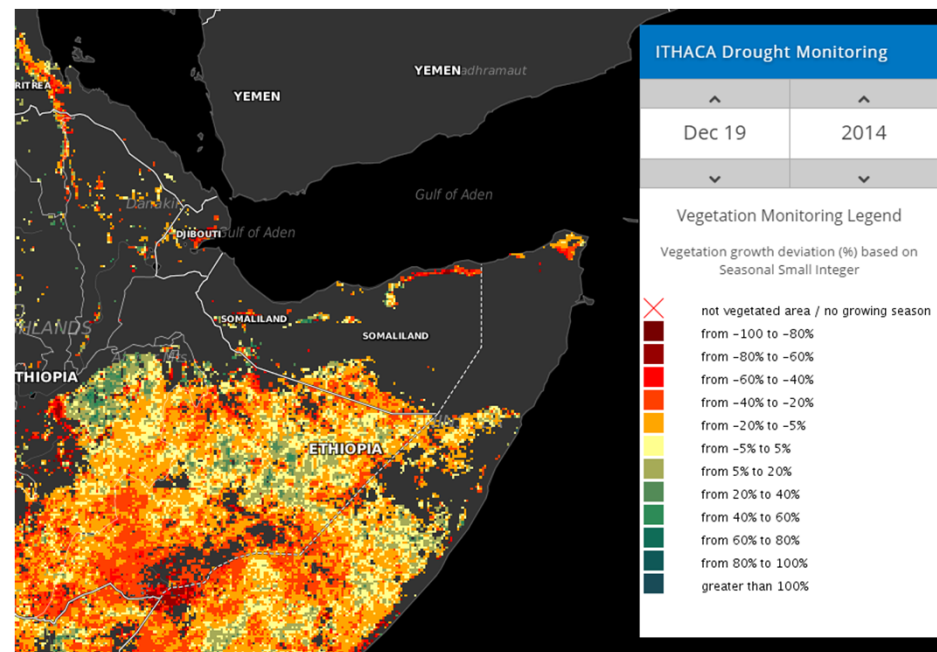


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ITHACA EWS integrates a **simplified vulnerability model** to convert hazard data into likely impacts on population.

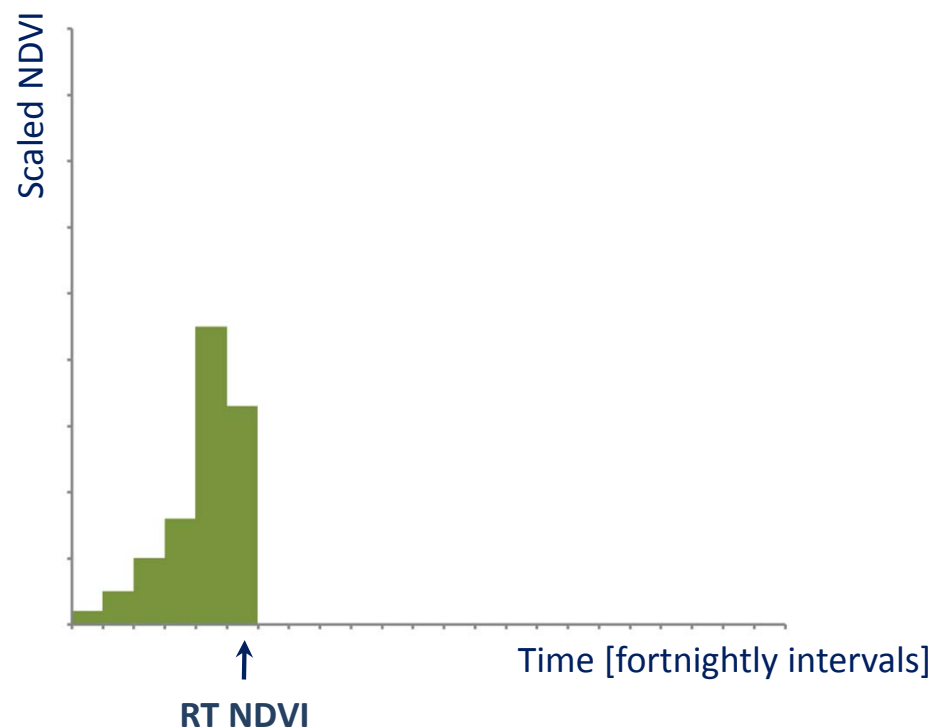
The system currently disseminates on a WebGIS platform **hazard maps** on a pixel basis or aggregated at second administrative level. <http://drought2.ithacaweb.org/>



NASA MODIS

Near RT
fortnightly NDVI

Vegetation monitoring



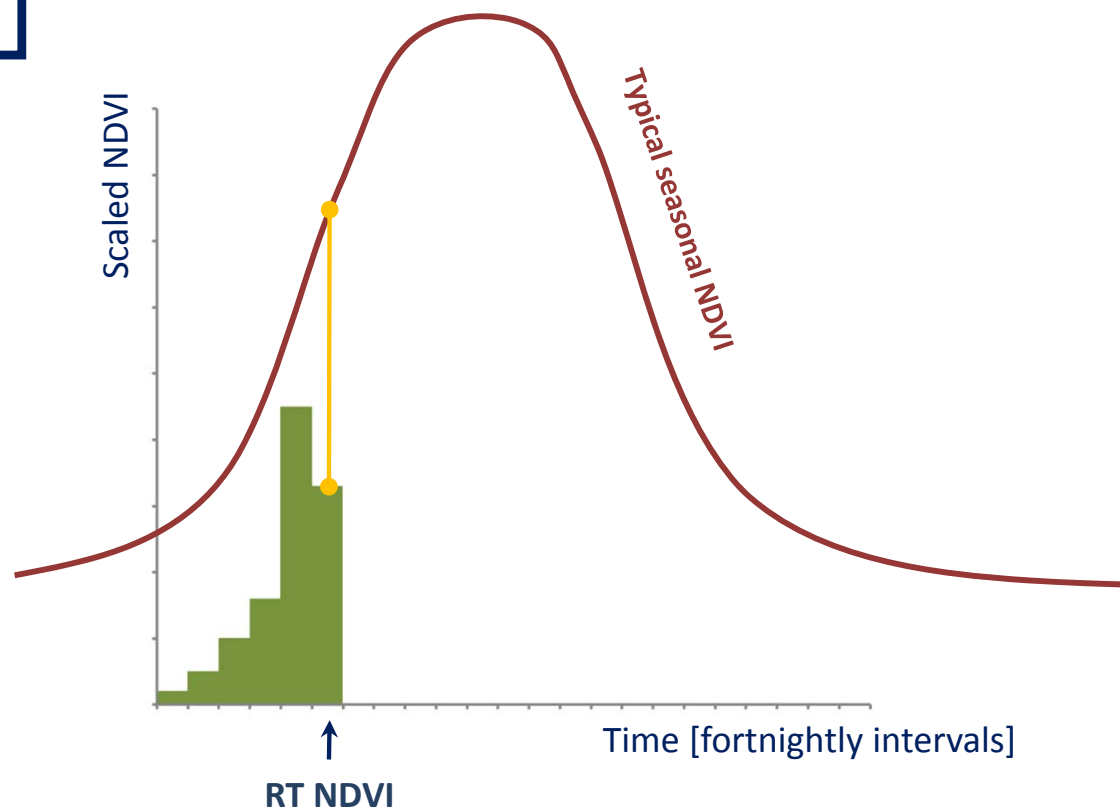
NASA MODIS

Near RT
fortnightly NDVI

NDVI archive
(2001 - today)

Vegetation monitoring

Current NDVI deviation
from the historical
mean



NASA MODIS

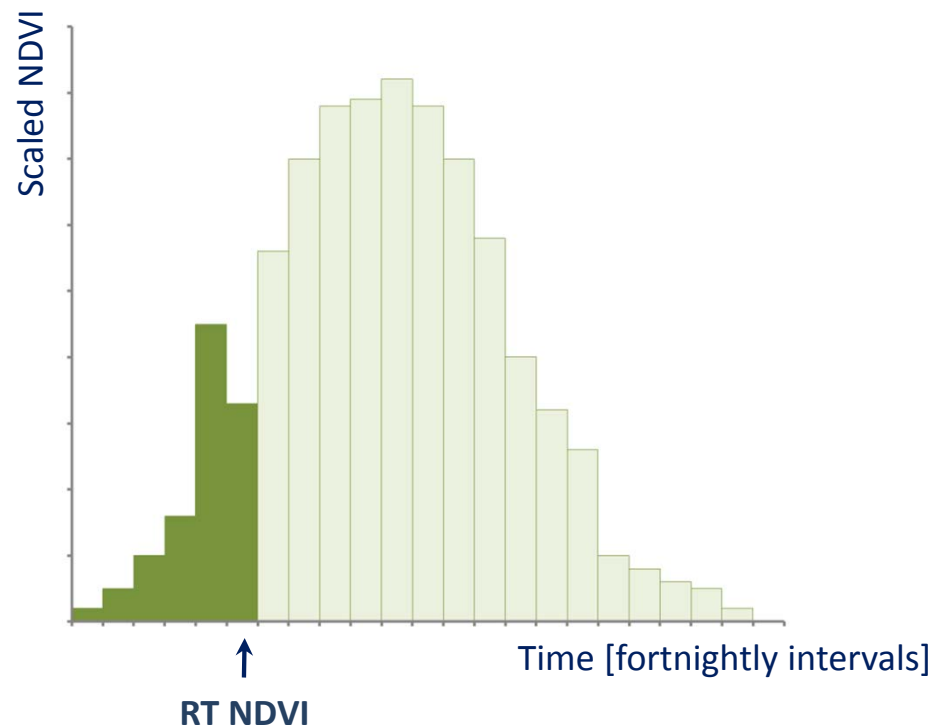
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Definition of NDVI
time-series for the
current growing season



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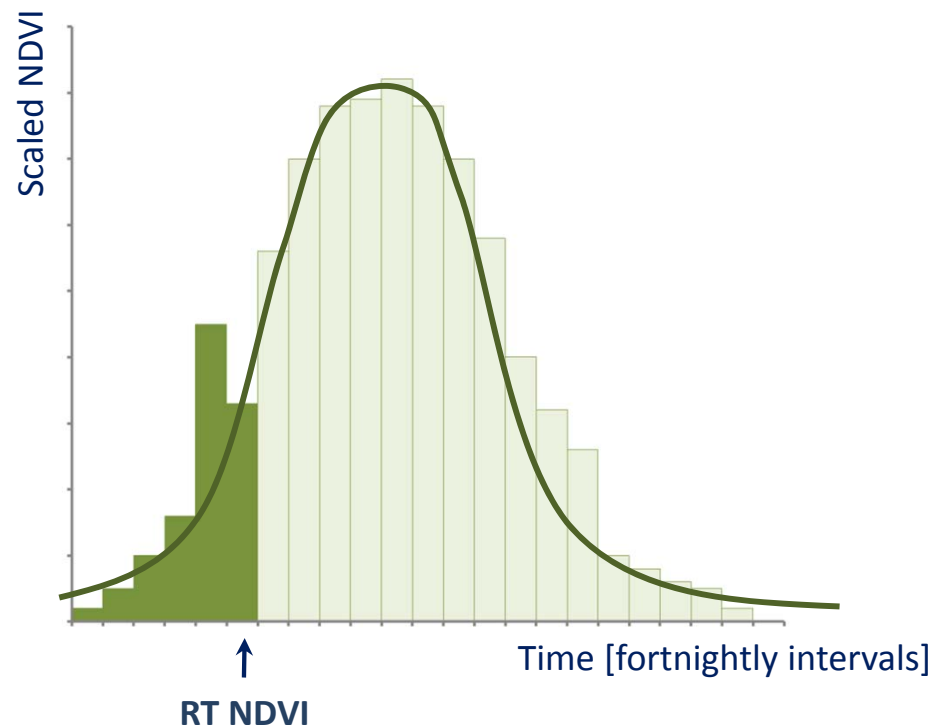
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Definition of NDVI
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Processing of the whole
NDVI time-series
(TIMESAT): residual
outliers removal, local
fitting of NDVI function



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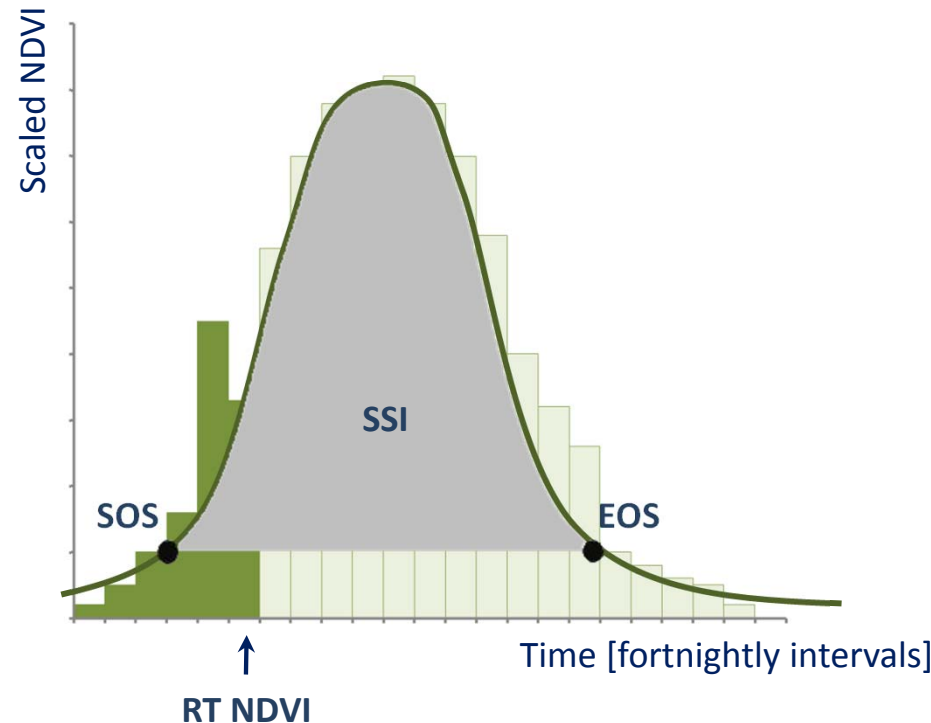
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Phenological
parameters extraction
for all the growing
seasons (TIMESAT)
detected in the NDVI
archive: Start Of the
Season, End Of the
Season, Seasonal Small
Integral



Automatic definition of
typical vegetation
dynamics for different
geographical areas.

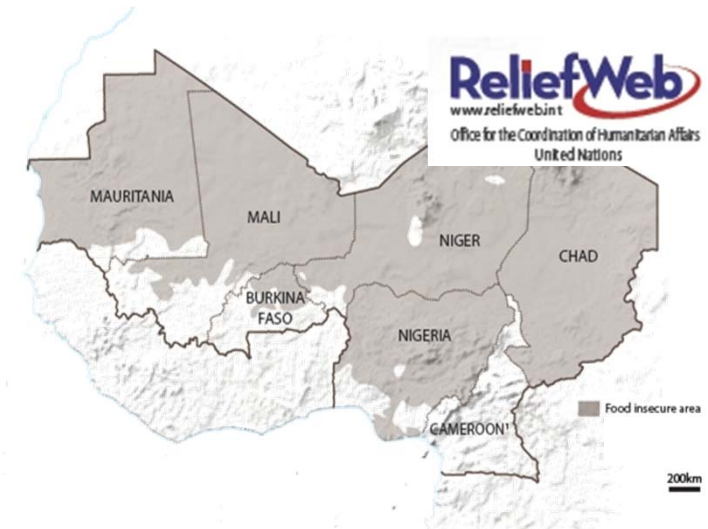
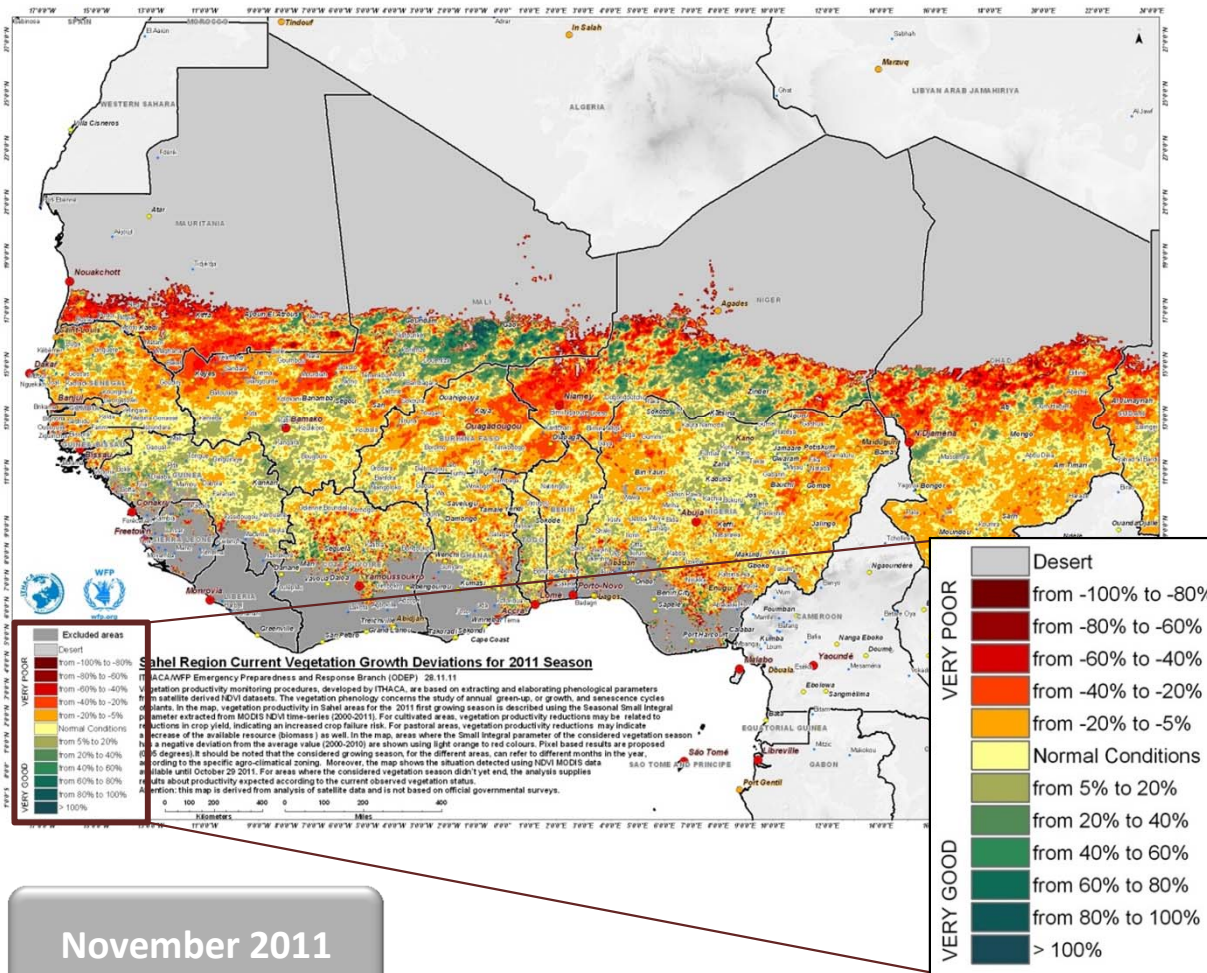
Deviation distribution of
the phenological
parameters for the
current growing season
is calculated with
respect to identified
vegetation dynamics.

Estimate of **vegetation
growing season
performances** expected
at its end.

A global drought monitoring system

Vegetation monitoring

2011 - WEST SAHEL FOOD CRISIS

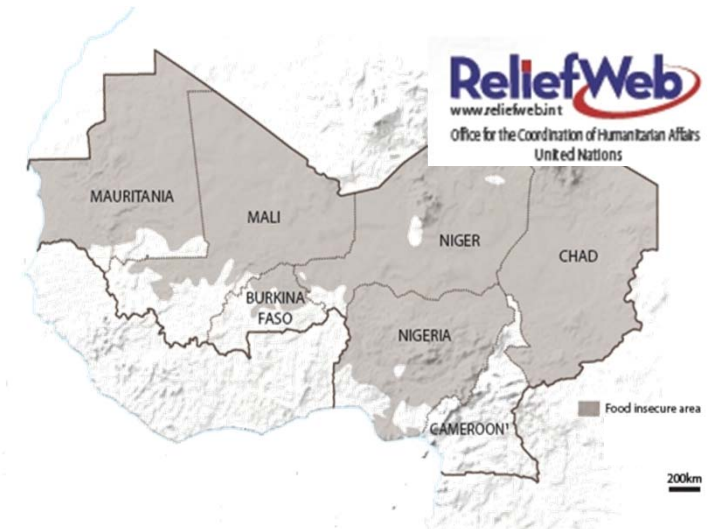
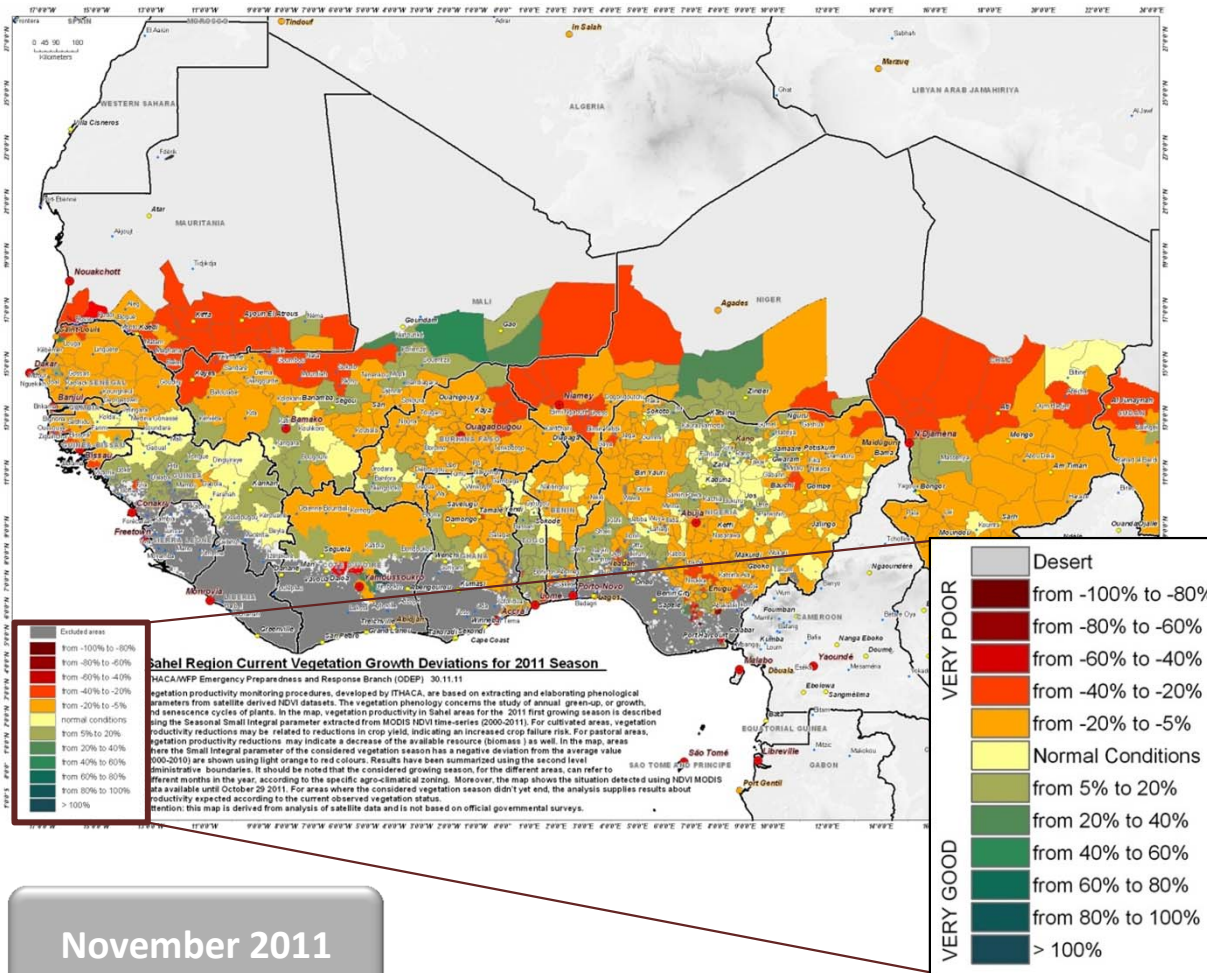


**SEASONAL INTEGRAL
DEVIATIONS FROM HISTORICAL
AVERAGE VALUES (2000-2010)
2011 vegetative season**

Original resolution (5 km)

November 2011

2011 - WEST SAHEL FOOD CRISIS

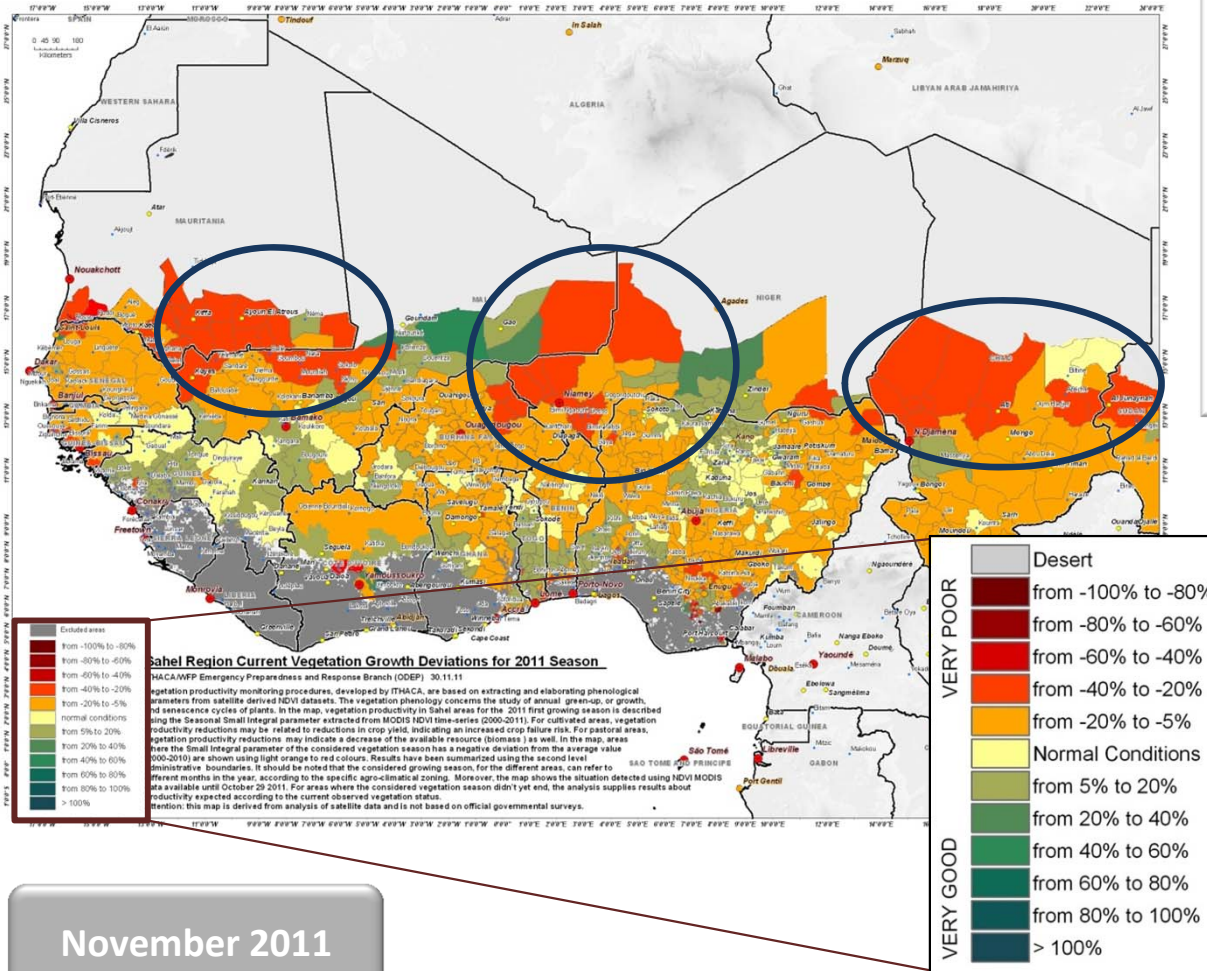


SEASONAL INTEGRAL DEVIATIONS FROM HISTORICAL AVERAGE VALUES (2000-2010) 2011 vegetative season

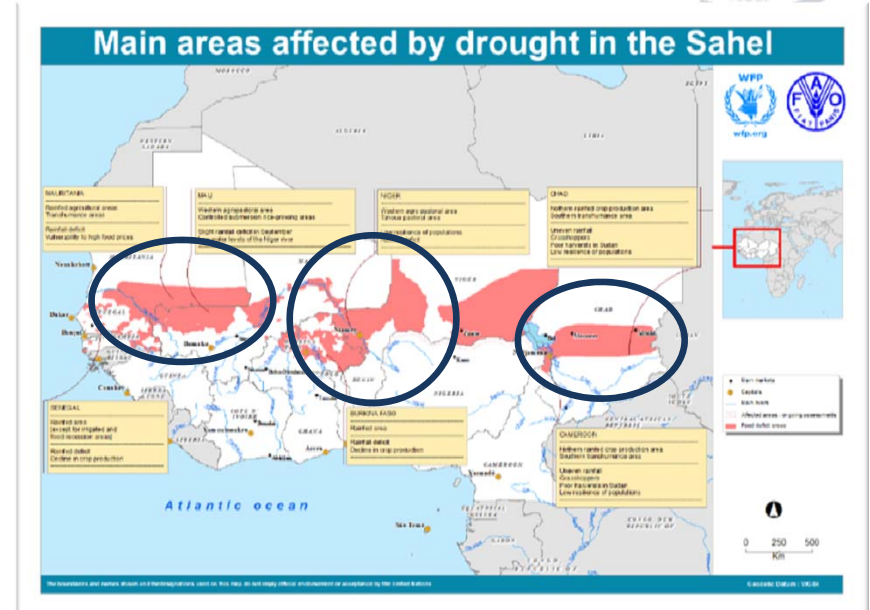
Results aggregated by second
level administrative boundaries

November 2011

2011 - WEST SAHEL FOOD CRISIS



November 2011

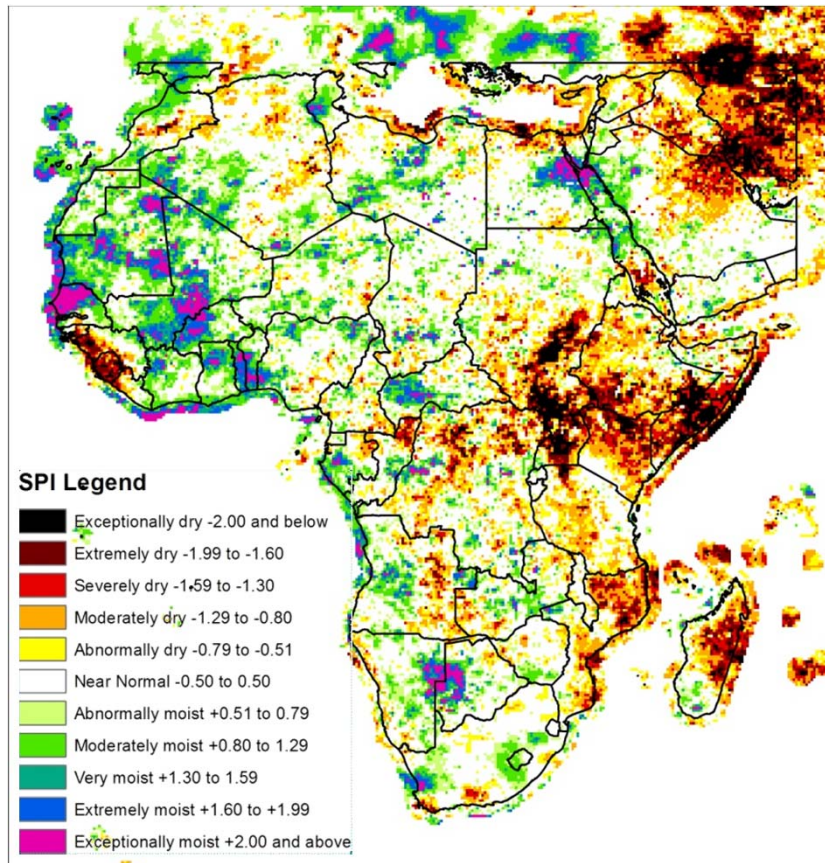


May 2012

**SEASONAL INTEGRAL
DEVIATIONS FROM HISTORICAL
AVERAGE VALUES (2000-2010)
2011 vegetative season**

**Results aggregated by second
level administrative boundaries**

A statistical study was conducted in order to correctly define the operational use of precipitation data for drought detection. Therefore in the ITHACA drought EWS, the monitoring of vegetation conditions is coupled, where it is meaningful, with the near RT evaluation of precipitation deficits explained through the SPI.



Several phenological metrics were considered for each vegetation growing season in the examined time interval (2000-2014)

Pixel basis investigation of the statistical relationship between time-series of phenological metrics and precipitation data with different cumulating intervals

Spatial aggregation and analysis of results based on different vegetation types and climatic areas

Identification of:

- areas where the spatial and temporal variability in vegetation conditions are closely related to the climate
- the rainfall cumulating interval to be used for SPI monitoring purposes

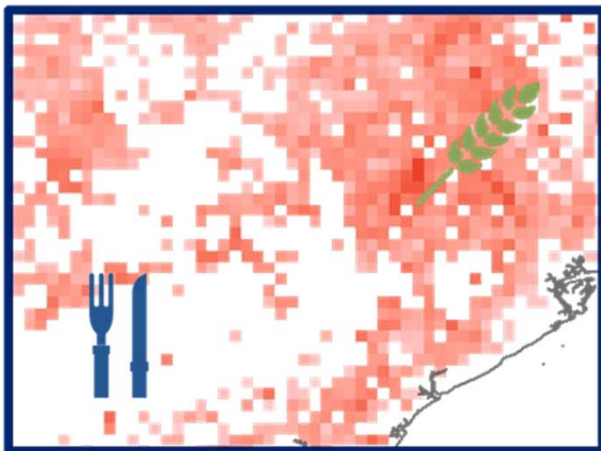
Attach further meaning to the hazard map.

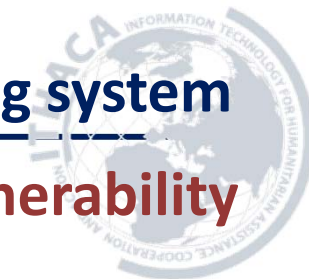
Provide a cause-effect spatial link between hazard hit zones and impacted ones.

Creation of a **vulnerability model** to embed into the ITHACA drought monitoring system.

Agricultural vulnerability

Risk surfaces





AGRICULTURAL VULNERABILITY

Classify crop areas in function of the **agriculture suitability**, the percentage of **irrigation** and the **variety of crops** produced.

Soil suitability for crop production

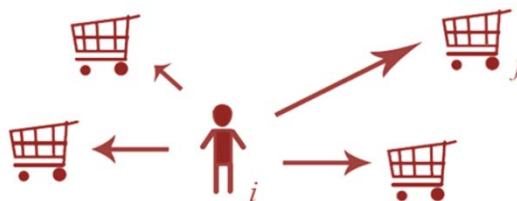
Presence of irrigation systems

Crop Diversity Index

RISK SURFACES

Define surfaces that explain the link between the **population density**, **settlements** and **markets** by considering land cover and major **infrastructures**.

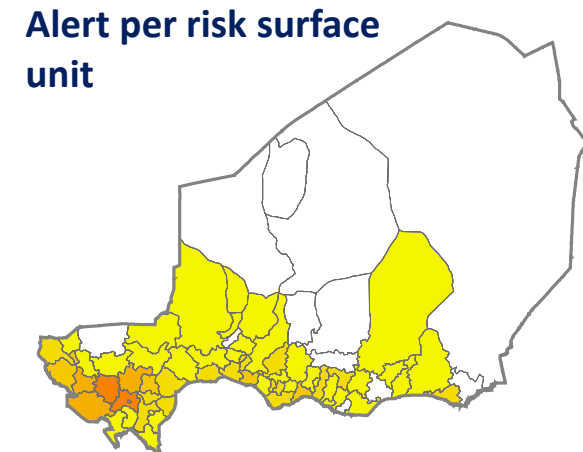
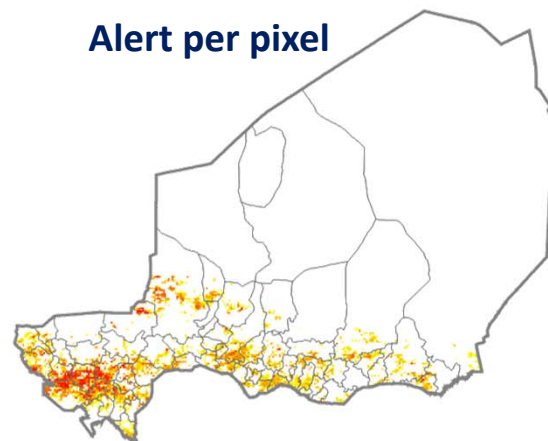
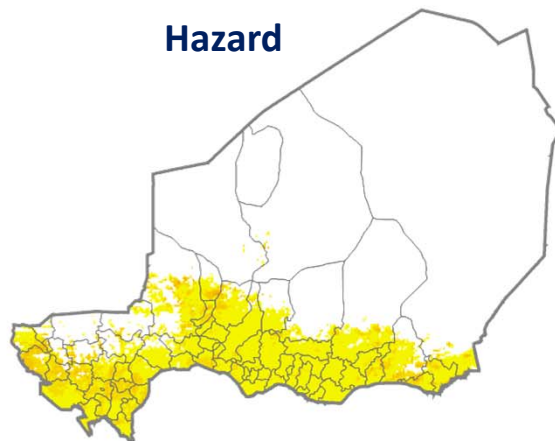
Spatial choice gravity model



Accessibility

Markets location

Market analysis



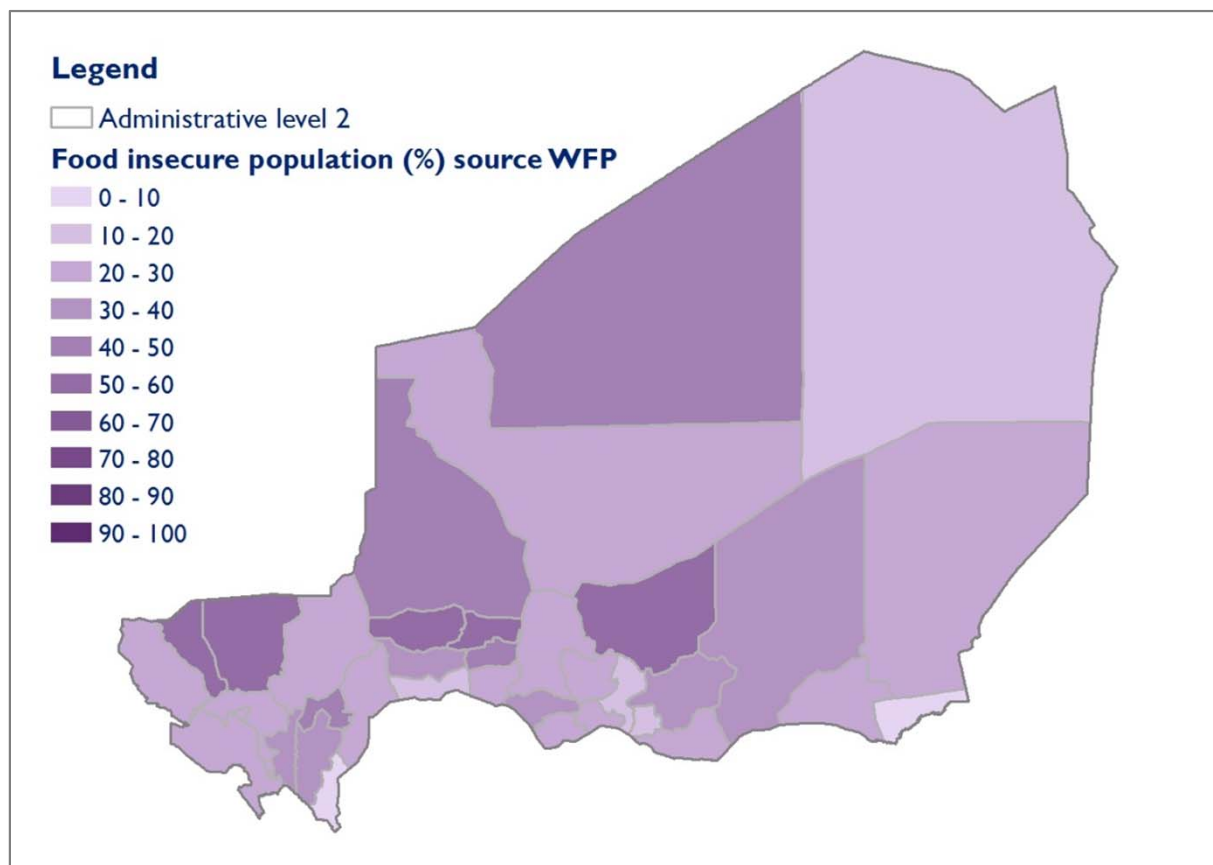
Final alerts are given per **Risk surface unit**: by introducing market analysis and a modelisation of people principal **strategies to access food**, the hazard alert is transformed in a **food security alert**.

The final alerts were compared with two types of data resuming food insecurity conditions at sub-national level.

WFP Food Security Assessments

Based on field surveys. Target households are monitored in order to establish the percentage of population in food insecurity status.

- Food consumption score;
- Coping strategy index ;
- Share of expenditure devoted to food;
- Tropical Livestock Units owned;
- Duration of food stock.

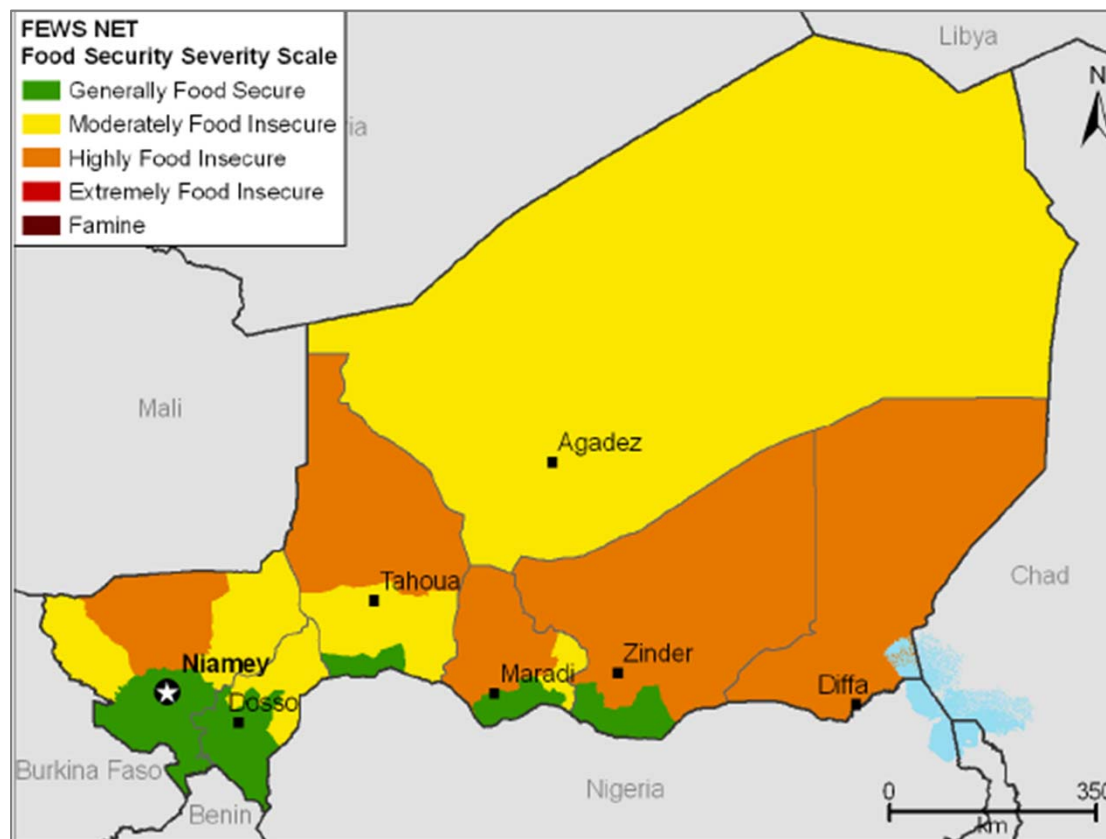




The final alerts were compared with two types of data resuming food insecurity conditions at sub-national level.

FewsNet Food Security Outlooks & Updates

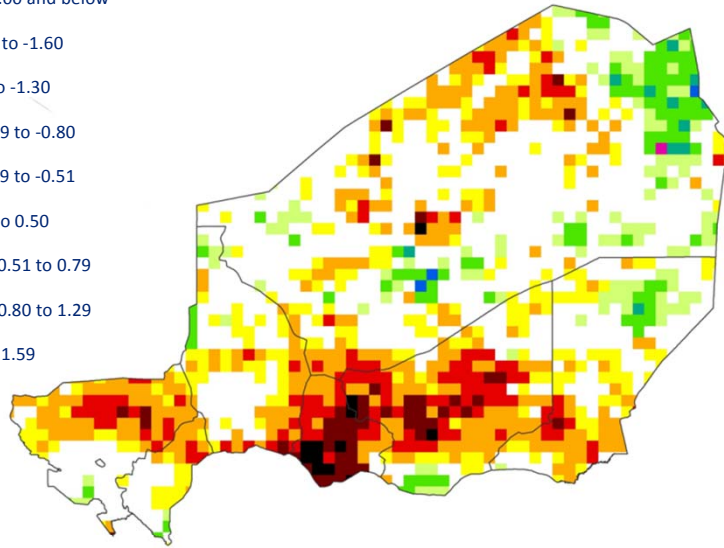
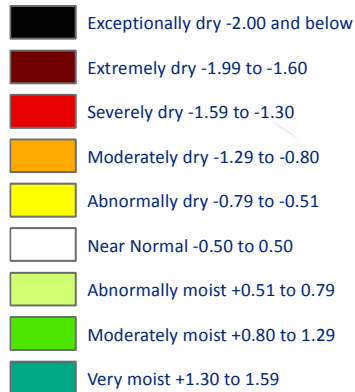
Outlooks and updates supplied on quarterly basis, providing food security conditions for the coming three to six months according to most likely scenario. The targeted group is classified on the basis of food security conditions with the Food Security Classification Protocols.



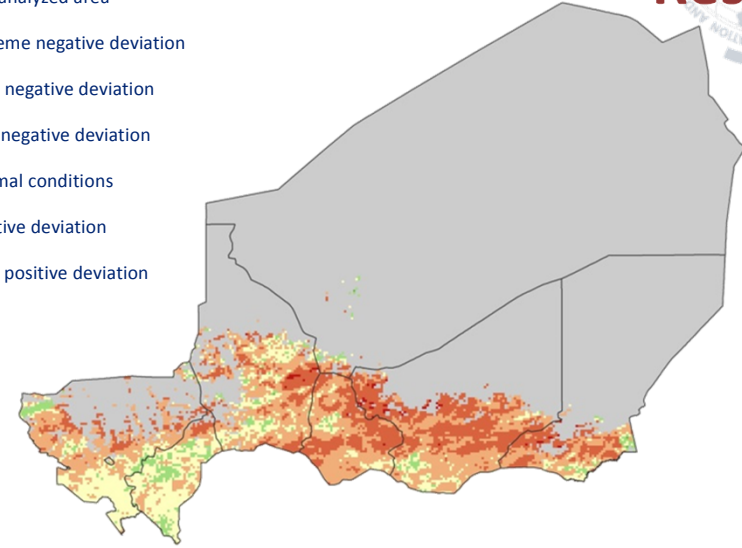
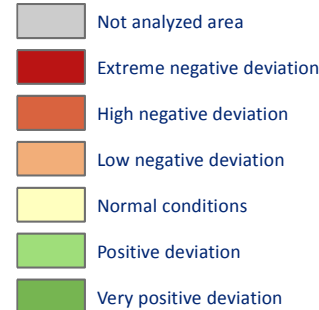
A global drought monitoring system

Results

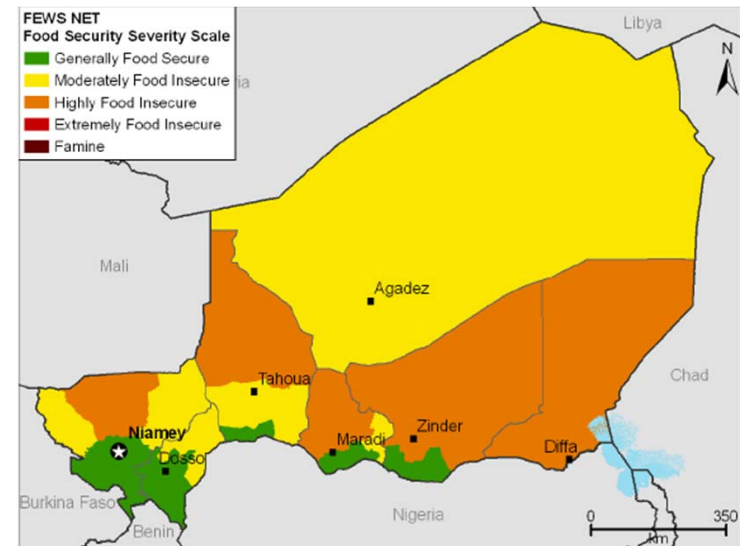
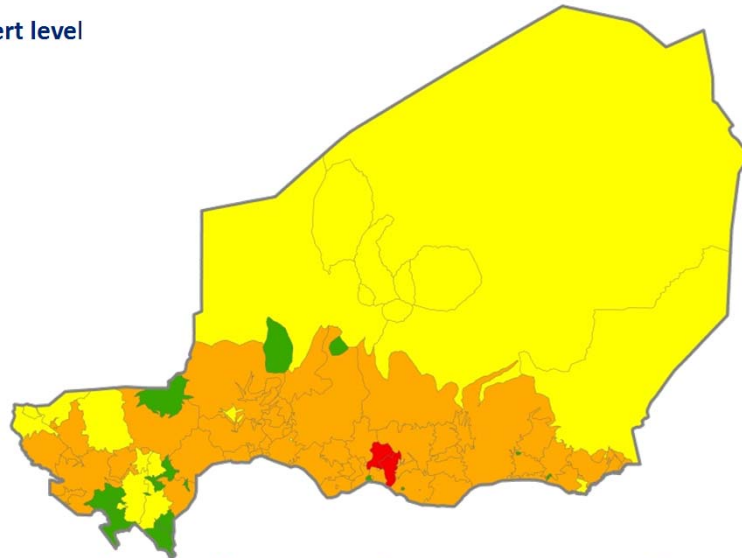
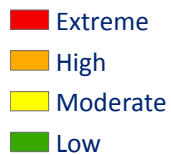
2009 season - 3 months (June-July-August) SPI



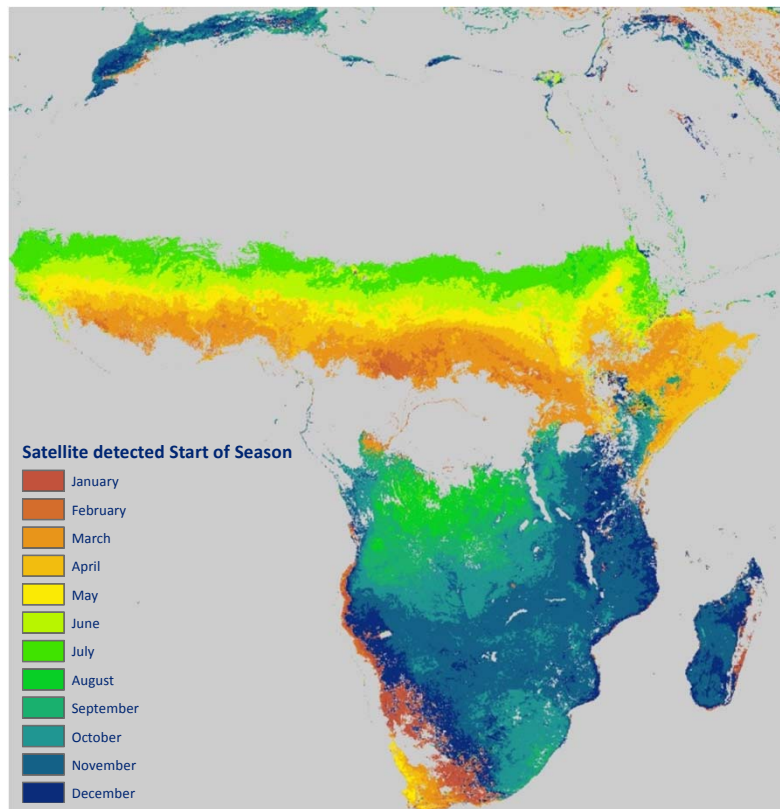
Vegetation growth deviations for 2009 season



2009 season final alert level



The system works well over administrative divisions with cropland prevalence even considering the bias of validation data that are not drought-specific. Worse results are given for grazing areas and for cross-border market areas.

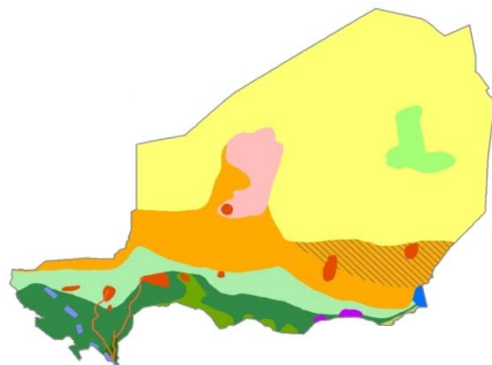


Legend

Administrative level 0

Niger Livelihoods

- Not Zoned (Desert)
- NE Oases - Dates Salt and Trade
- Air Massif Irrigated Gardening
- Transhumant and Nomad Pastoralism
- Agropastoral Belt
- Rainfed Millet and Sorghum Belt
- Cropping and Herding with High Work Outmigration
- S Irrigated Cash Crops
- SW Cereals with Fan-Palm Products
- Niger River Irrigated Rice
- Dallols - Seasonal Water-Course Irrigated Crops
- SE Natron Salt and Small Basin Irrigated Dates
- Komadougou Irrigated Peppers
- Lake Chad Flood-Retreat Cultivation with Fishing
- Transhumant and Nomad Pastoralism-Camels



- Validation of the system against other **case studies** and, where available, with **locally retrieved data**
- Development of a procedure for the integration of the **Start Of the Season** analysis into the operational system
- Selection and integration of **socio-economic data** proven to influence the ability of the population to cope with drought events
- Integration of **livelihood** information
- Completion of the **Web application** in order to include SPI and vulnerability