

Development of a European Drought Observatory and Drought Research at JRC

Jürgen Vogt

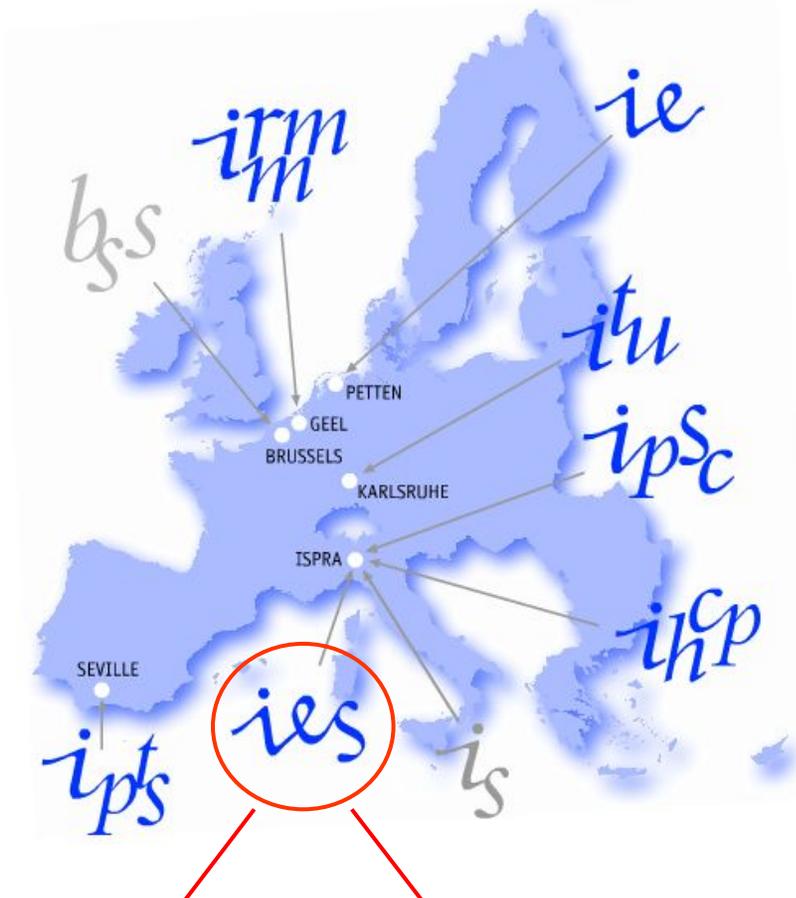
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Olivier Leo, Oscar Rojas (IPSC)**

*European Commission Joint Research Centre (JRC)
Institute for Environment and Sustainability (IES)
Institute for the Protection and Security of the Citizen (IPSC)*

<http://www.jrc.ec.europa.eu/>

- 1. Who are we, how are we organised?**
- 2. Development of a European Drought Observatory**
 - Vision, set-up
 - Products
 - Status and future developments
- 3. Drought activities in Africa**
- 4. Summary & conclusions**

The JRC is a Directorate General of the European Commission



230 core staff **6 scientific units**
220 visiting staff **22 actions**

<http://ies.jrc.ec.europa.eu/>

IRMM - Geel, Belgium

Institute for Reference Materials and Measurements

ITU - Karlsruhe, Germany

Institute for Transuranium Elements

IE - Petten, The Netherlands and Ispra, Italy

Institute for Energy

IPSC - Ispra, Italy

Institute for the Protection and Security of the Citizen

IES - Ispra, Italy

Institute for Environment and Sustainability

IHCP - Ispra, Italy

Institute for Health and Consumer Protection

IPTS - Seville, Spain

Institute for Prospective Technological Studies

IS - Ispra, Italy

Ispra Site Directorate

BSS - Brussels, Belgium

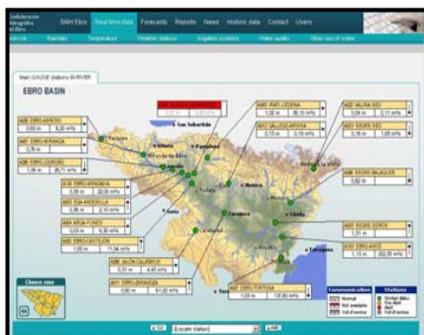
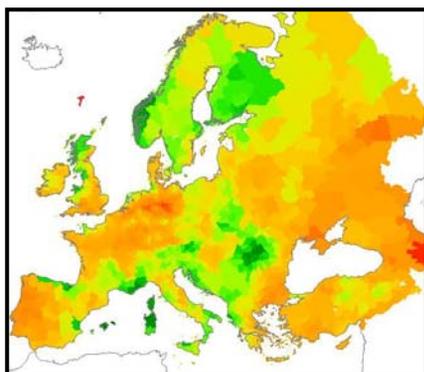
Directorate General, Programmes Directorate and Stakeholder Relations

Institute for Environment and Sustainability (IES):

- **Land Management and Natural Hazards Unit**
 - Action **DESERT** (Desertification Land Degradation and Drought – Assessment, Monitoring and Early Warning)
 - Action **FLOODS** (Prediction, Mitigation, Impact Assessment)
 - Action **SOIL** (Soil Data and Information Systems)
- **Global Environmental Monitoring Unit**
 - Action **MONDE** (Monitoring Natural Resources for Development)
 - Action **SOLO** (Systematic Observations of Land and Ocean)

Institute for the Protection and Security of the Citizen (IPSC):

- **Agriculture and Fisheries Unit**
 - Action **FOODSEC** (Crop Monitoring for Food Security)



- **Web-based Platform for detection, monitoring, forecasting and information exchange**

- commonly agreed products (e.g. drought indices)
- joint comparison and analysis of information
- mutual exchange of knowledge & methodologies
- direct up- and downscaling
- real-time monitoring and forecasting (early warning, preparedness)

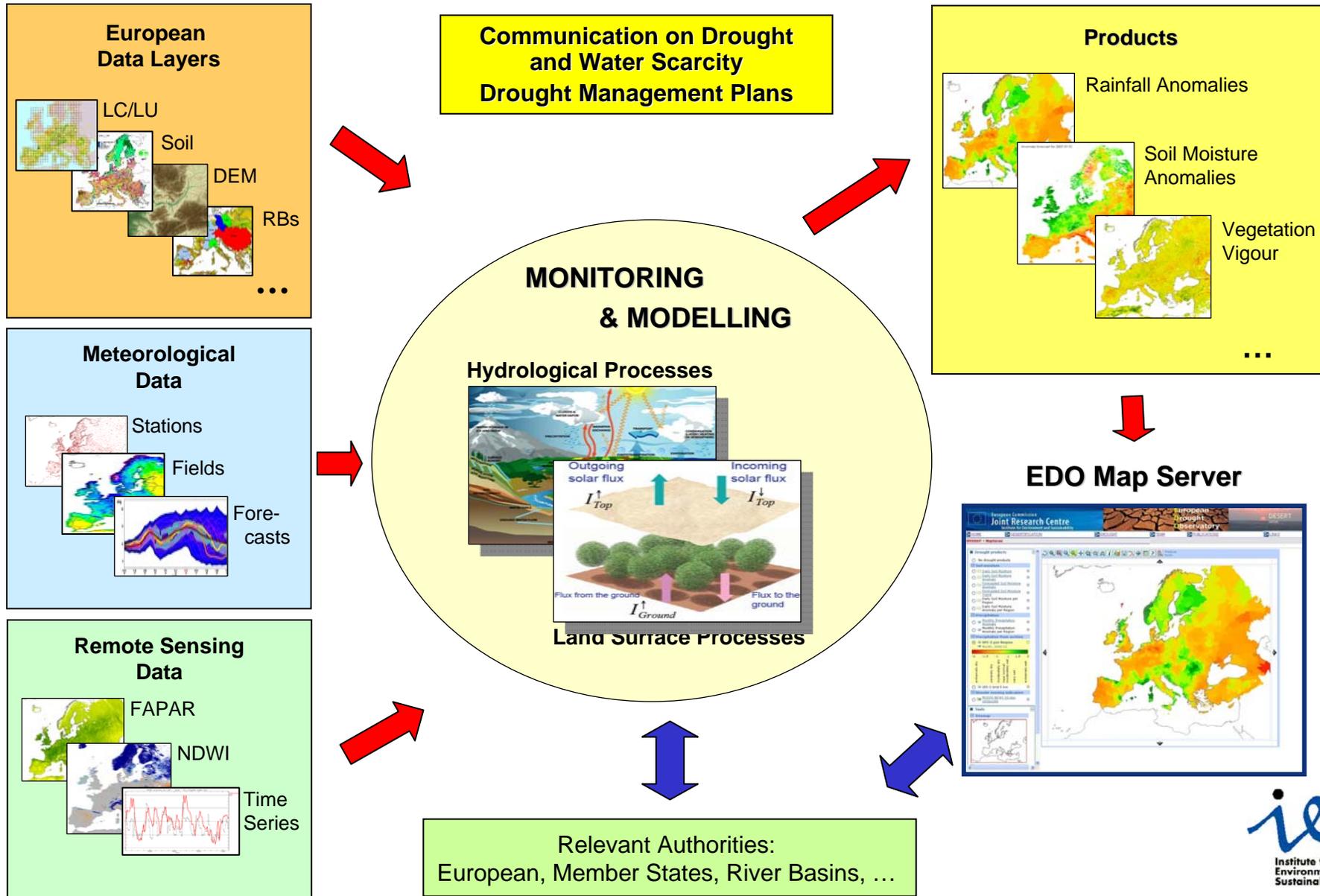
- **Multi-scale approach, integrating**

- EU / continental level
- MS level
- Regional / river basin level

Data
Infrastructure
INSPIRE

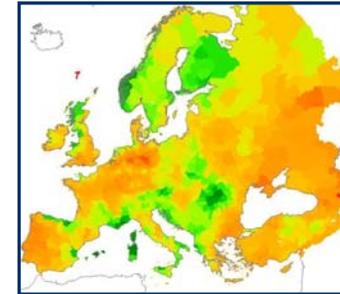
- **Subsidiarity principle**

- European level information + platform (JRC)
- National datasets managed at MS level
- Regional information processed by river basin / regional environmental authorities
- De-central data holding



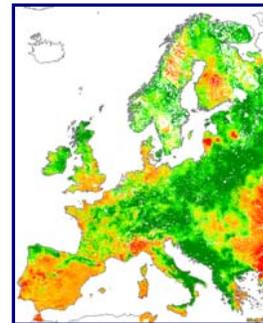
- **Precipitation**

- ✓ Monthly SPI (for different aggregation periods)



- **Soil Moisture**

- ✓ Daily soil moisture
- ✓ Daily soil moisture anomaly
- ✓ Forecasted soil moisture anomaly
- ✓ Forecasted soil moisture trend



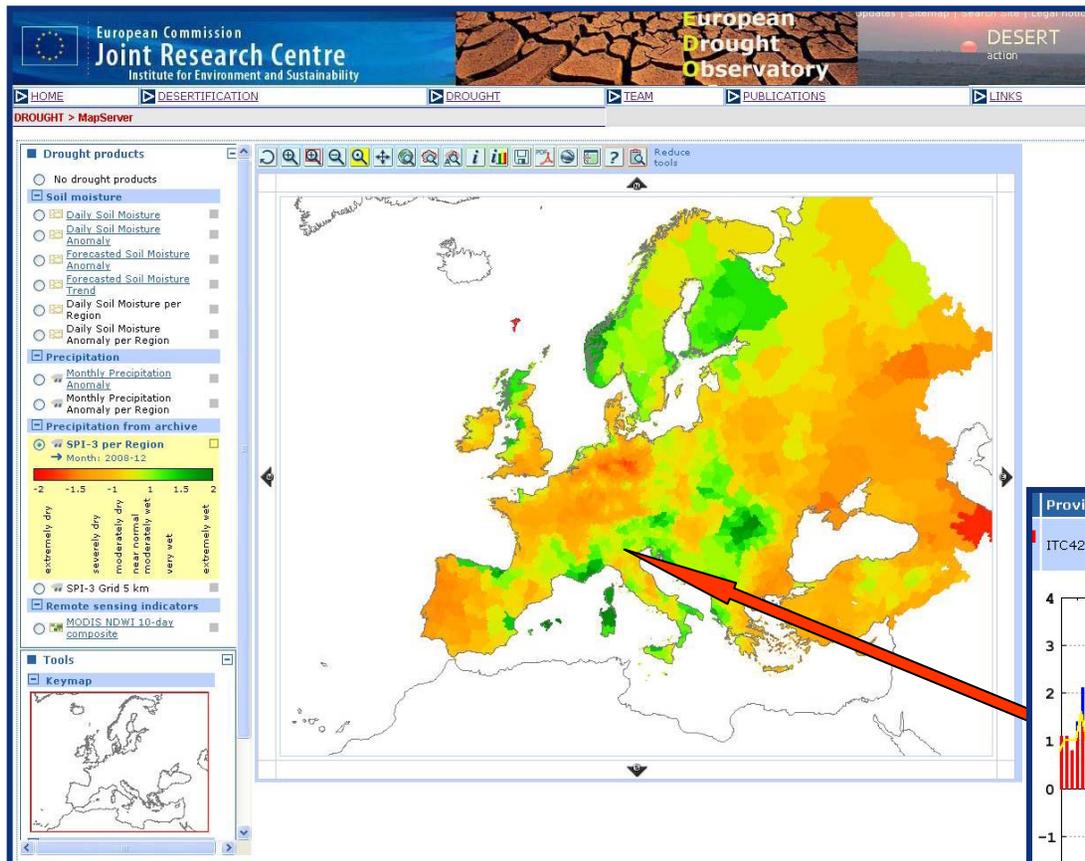
- **Vegetation status**

- ✓ NDWI 10-day daily composites
- ✓ fAPAR 10-day composites.
- ✓ fAPAR anomalies 10-day composites.

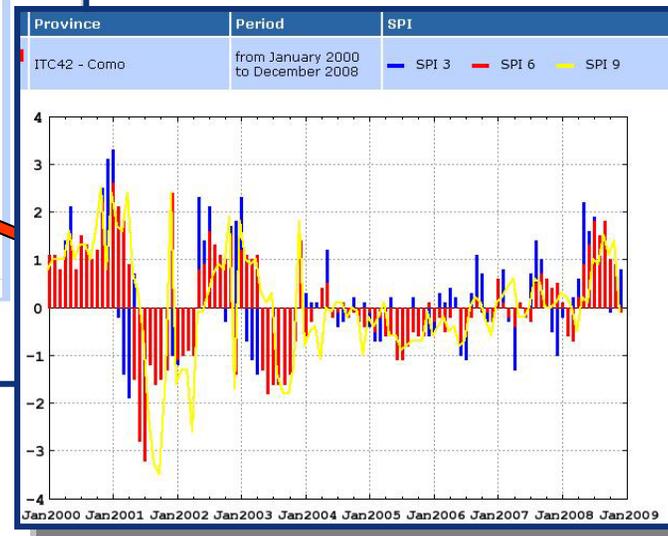


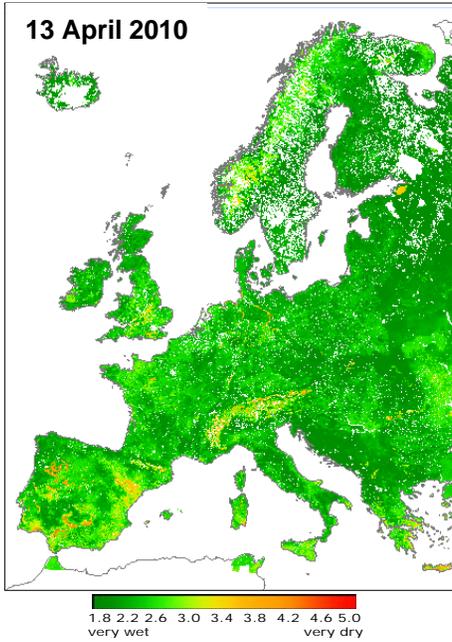
SPI

Como, IT

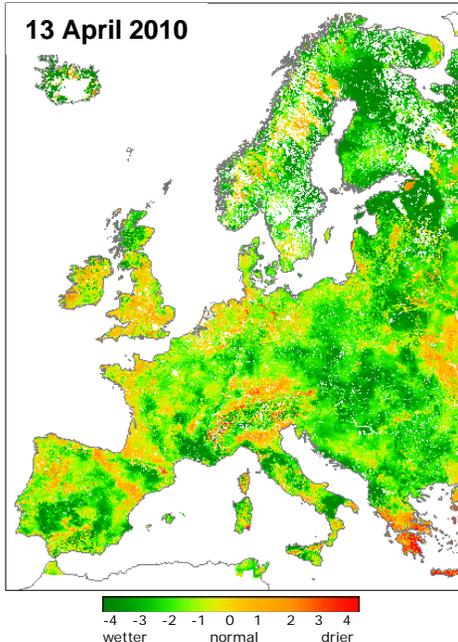


3-month Standardized Precipitation Index (SPI) for 10-12/2008 aggregated to regional level

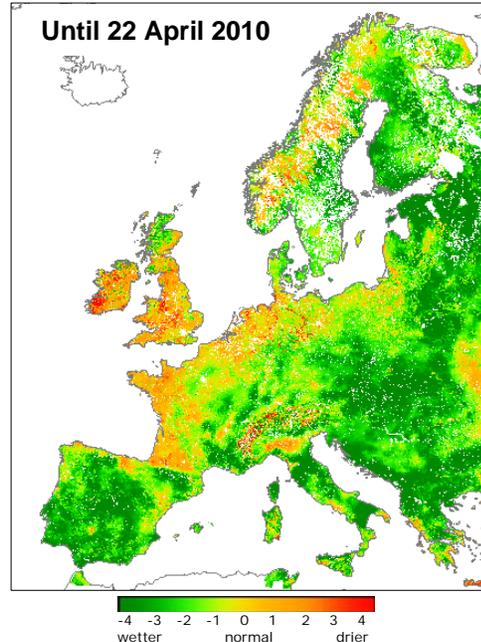




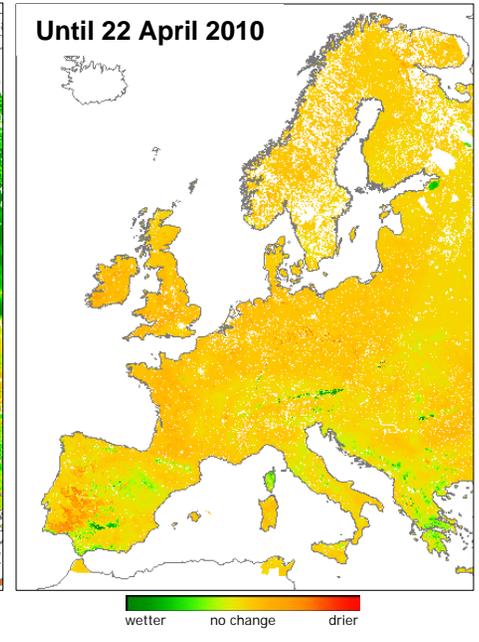
Soil Moisture



Soil Moisture Anomaly

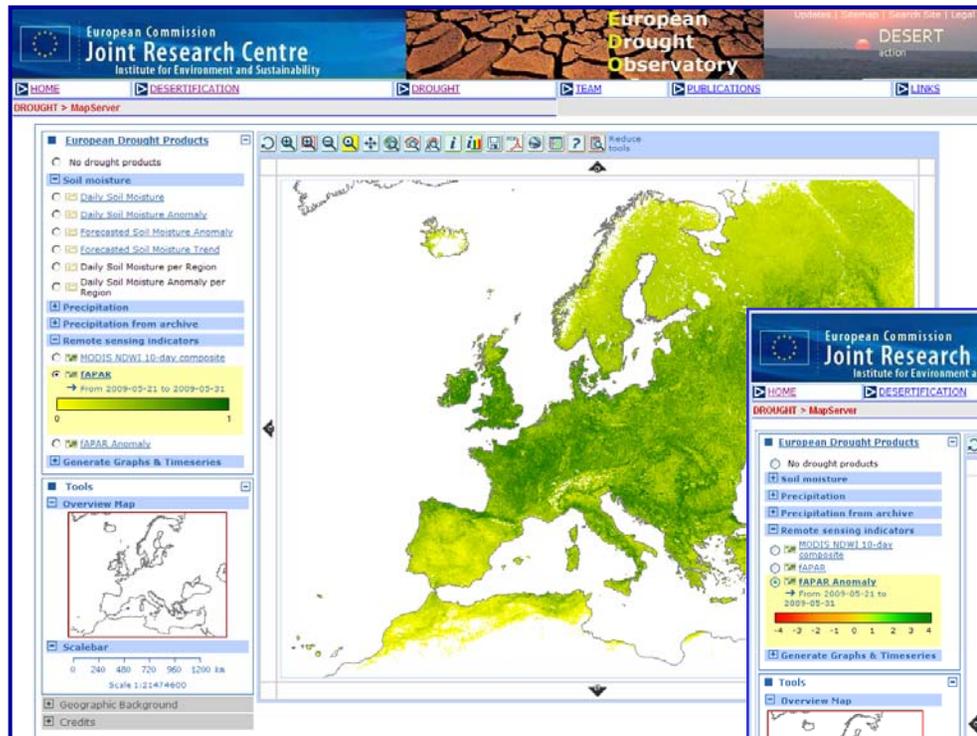


Soil Moisture Anomaly Forecast (7 days)

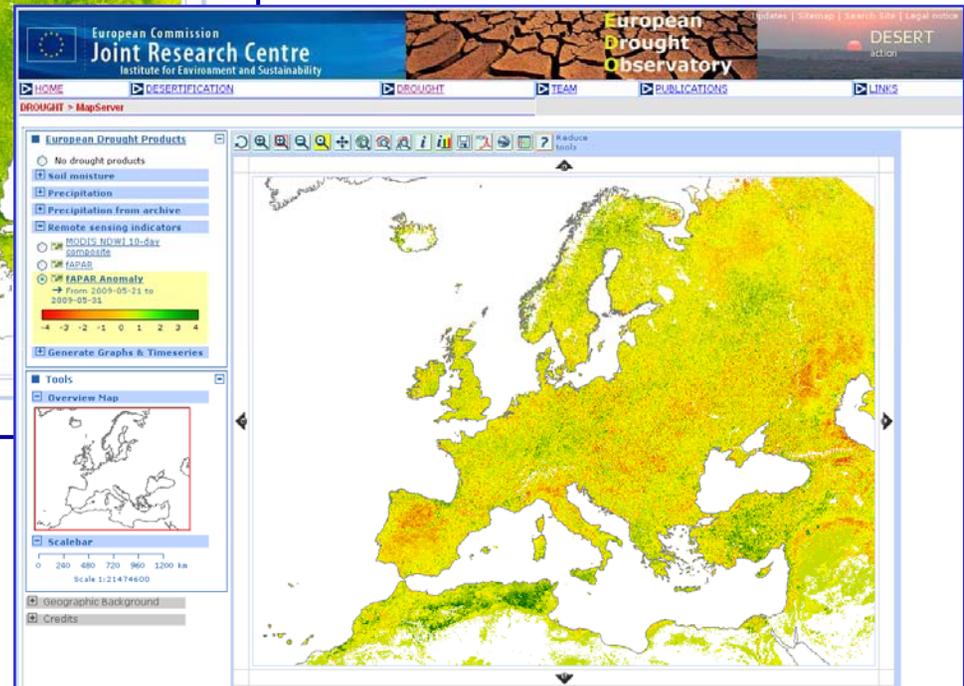


Soil Moisture Trend (7 days)

Based on a modified Version of LISFLOOD
5km spatial resolution



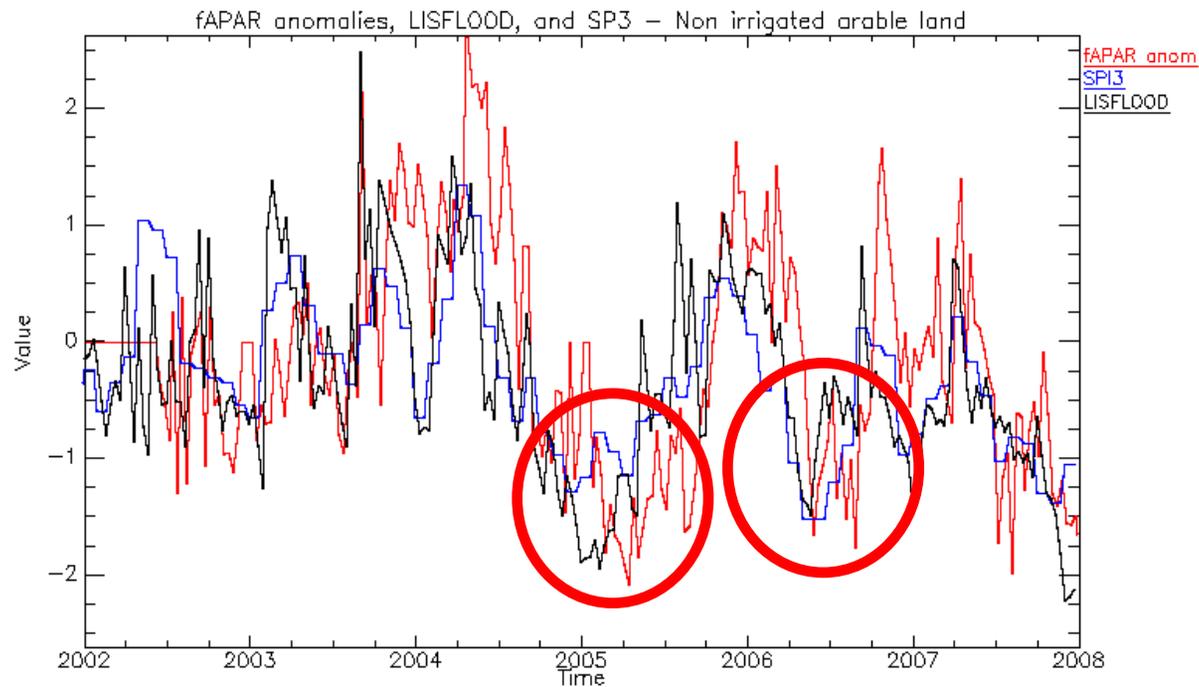
**fAPAR, 21-31 May 2009
1km resolution**



fAPAR Anomaly, 21-31 May 2009

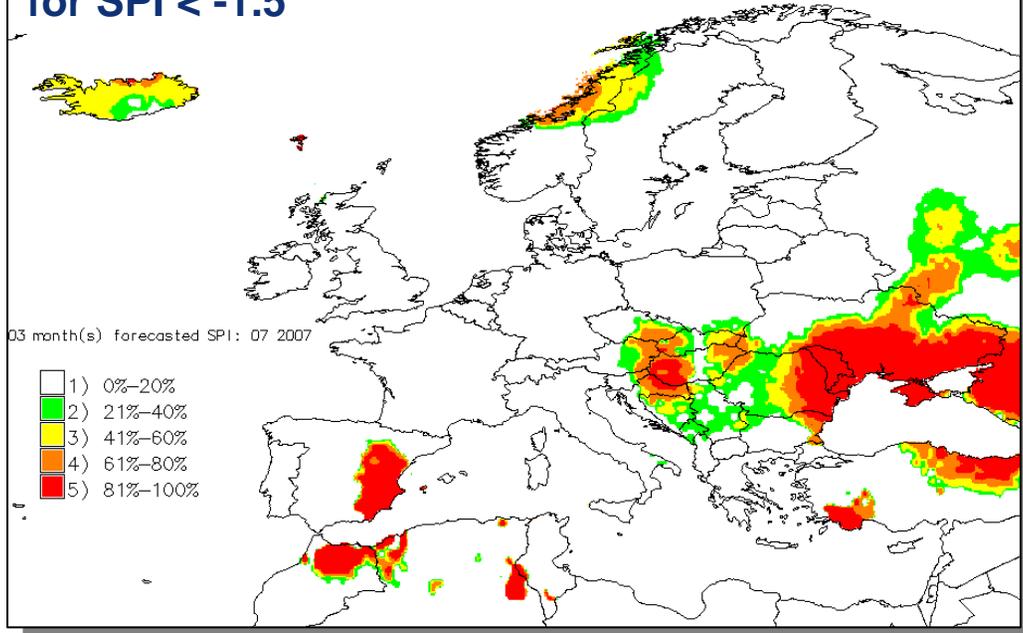
- Calculated from MERIS and SeaWiFS data (1997 →)
- <http://fapar.jrc.ec.europa.eu>

fAPAR anomalies, soil moisture anomalies, and SPI3 Non-irrigated arable land



SE Spain
Drought events in 2005 and 2006.

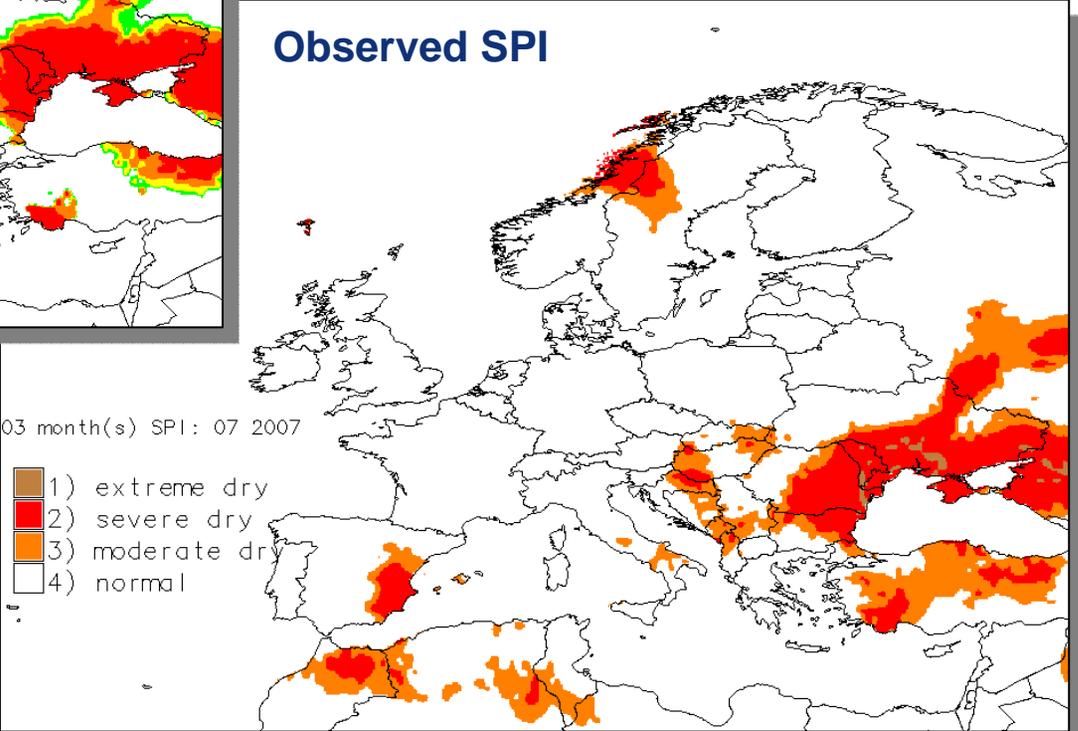
**Forecasted Probability
for SPI < -1.5**



**1-month Probabilistic
Forecast of SPI-3**

July 2007

Observed SPI



Probability that SPI-3 for the next month is "severe dry" or worse

(SPI < 1.5)

Status:

- Prototype map server established
- Regular processing of precipitation, soil moisture and RS indicators
- Networked with EU scientific community (e.g., XEROCHORE, EUROGEOSS, ...)
- Regular consultation with EU, national and regional stakeholders
- First collaboration agreements signed (DMCSEE)
- Carpathian Climate Project

Further System Development

- Further development of the prototype EDO Map Server
- Stepwise integration of drought information from pilot MS (Spain, Slovenia, ...)
- Bottom-up approach, increasing level of complexity

Research and Development

- Drought indices (development, testing, validation)
- Drought forecasting (development & testing of monthly forecast products)
- Data exchange, standards and protocols (EUROGEOSS project)

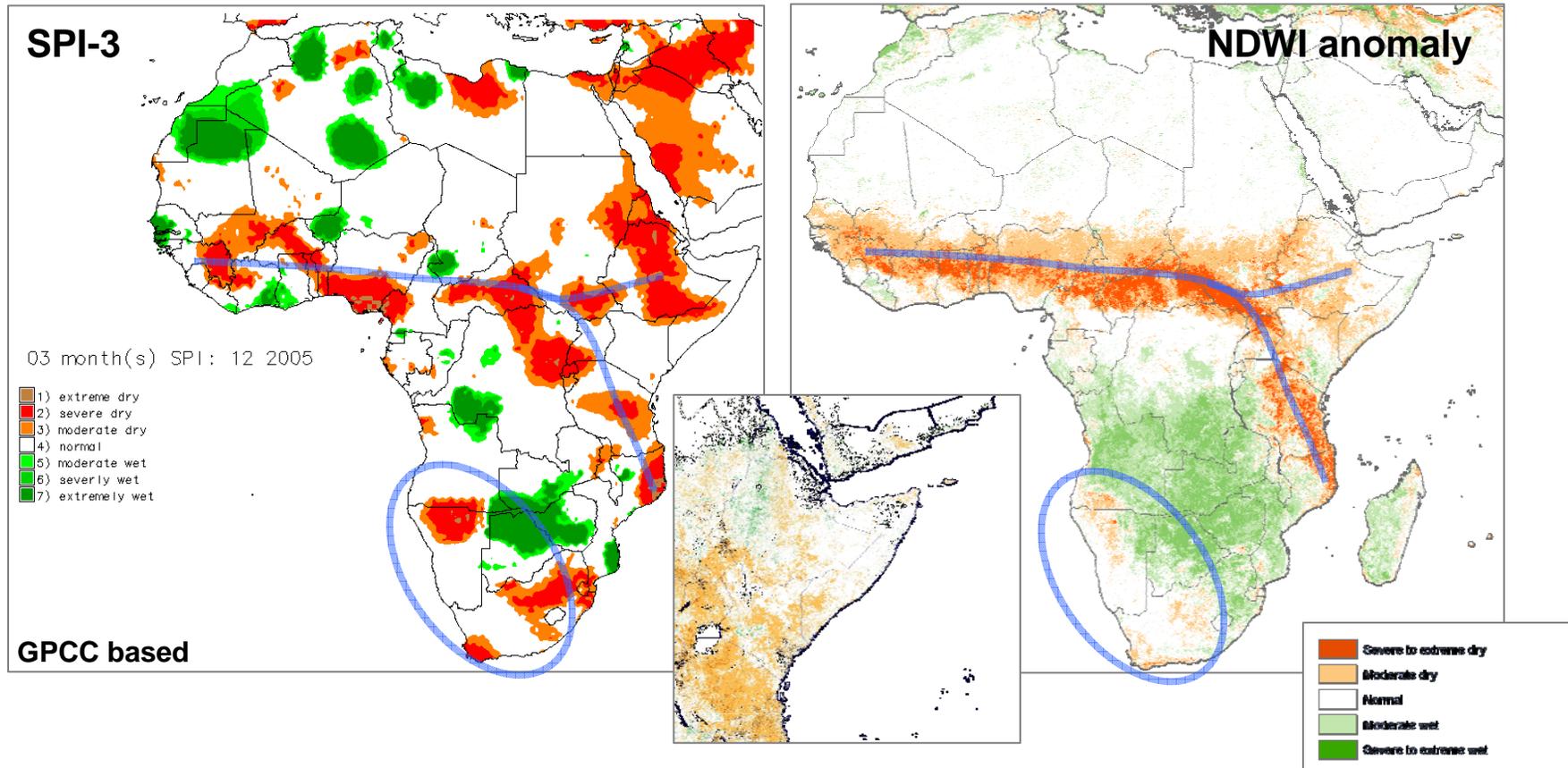
Networking

- Foster global exchange and networking (e.g., NDMC, GEO, UNCCD, ...)

	Indicator	Sensitive to...	Technical characteristics
Meteorological	<i>Standardized Precipitation Index (SPI-3/6/12)</i>	Lack or surplus of precipitation of the last 3/6/12 months	<ul style="list-style-type: none"> Window: Africa Monthly value Spatial resolution: ca. 0.5 deg >30y. of archives Derived from GPCC - gridded GTS data (DWD+WMO)
	Remote sensing	<i>Anomalies of Normalized Difference Water Index (NDWIa)</i>	Change in leaf water content of vegetation canopies
		<i>Anomalies of MERIS Global Vegetation Index (MVG1a)</i>	Change in the amount and vigor of vegetation

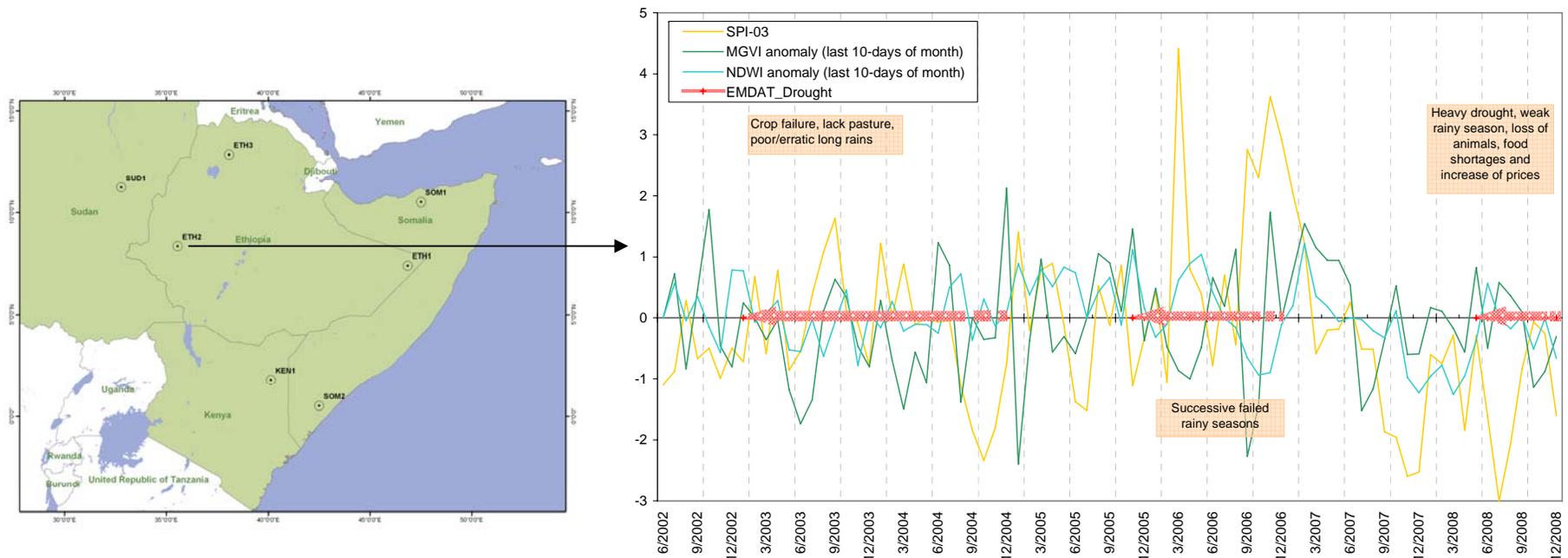
Note: After tests, MODIS FAPAR data were not considered as a suitable indicator for drought monitoring in Africa (due to numerous aberrant and missing values).

Situation for December 2005



Drought emergency state for GHA reported by EM-DAT at the end of 2005

- Analysis of major historical droughts reported in the **Emergency Database (EM-DAT)** of the Centre for Research on the Epidemiology of Disasters (CRED, Leuven Belgium)

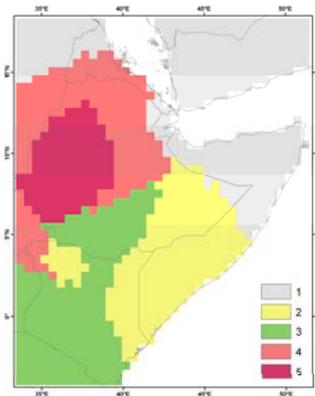


- ➔ No direct, simple or systematic link between the temporal profiles of SPI-3, NDWI anomaly and MGVI anomaly
- ➔ But similar spatial patterns between indicators during drought events (ex. 2005)

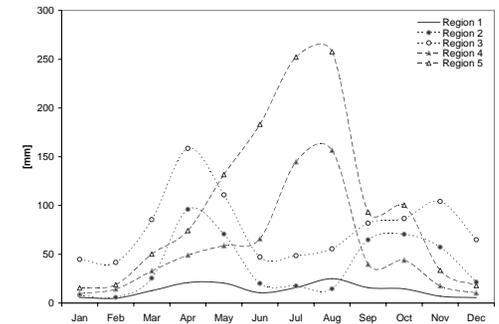
Cross-correlation analysis with R_{pearson} calculated between monthly SPI-3 and the last 10-daily NDWI/MGVI anomaly of the same month

Method:

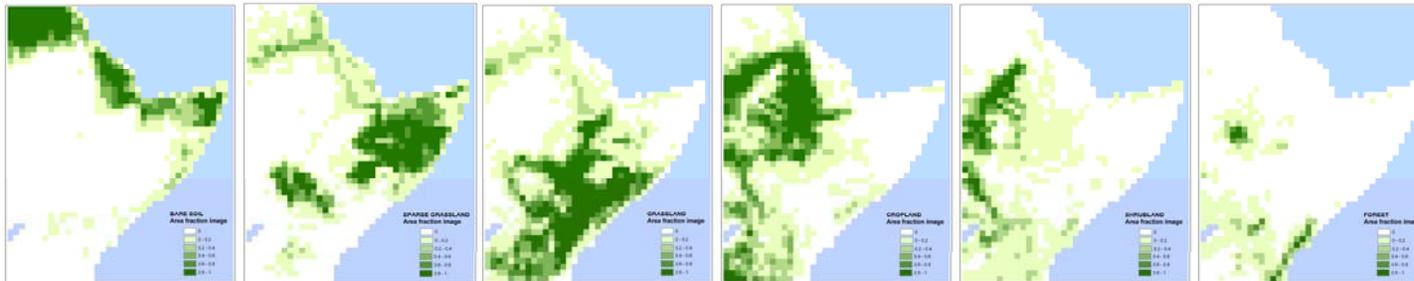
Implemented for different regions in GHA (rainfall-based clustering)



Only considering the rainy season specific to each region



Resampling of RS products to 0.5 degree specific for 6 land cover types

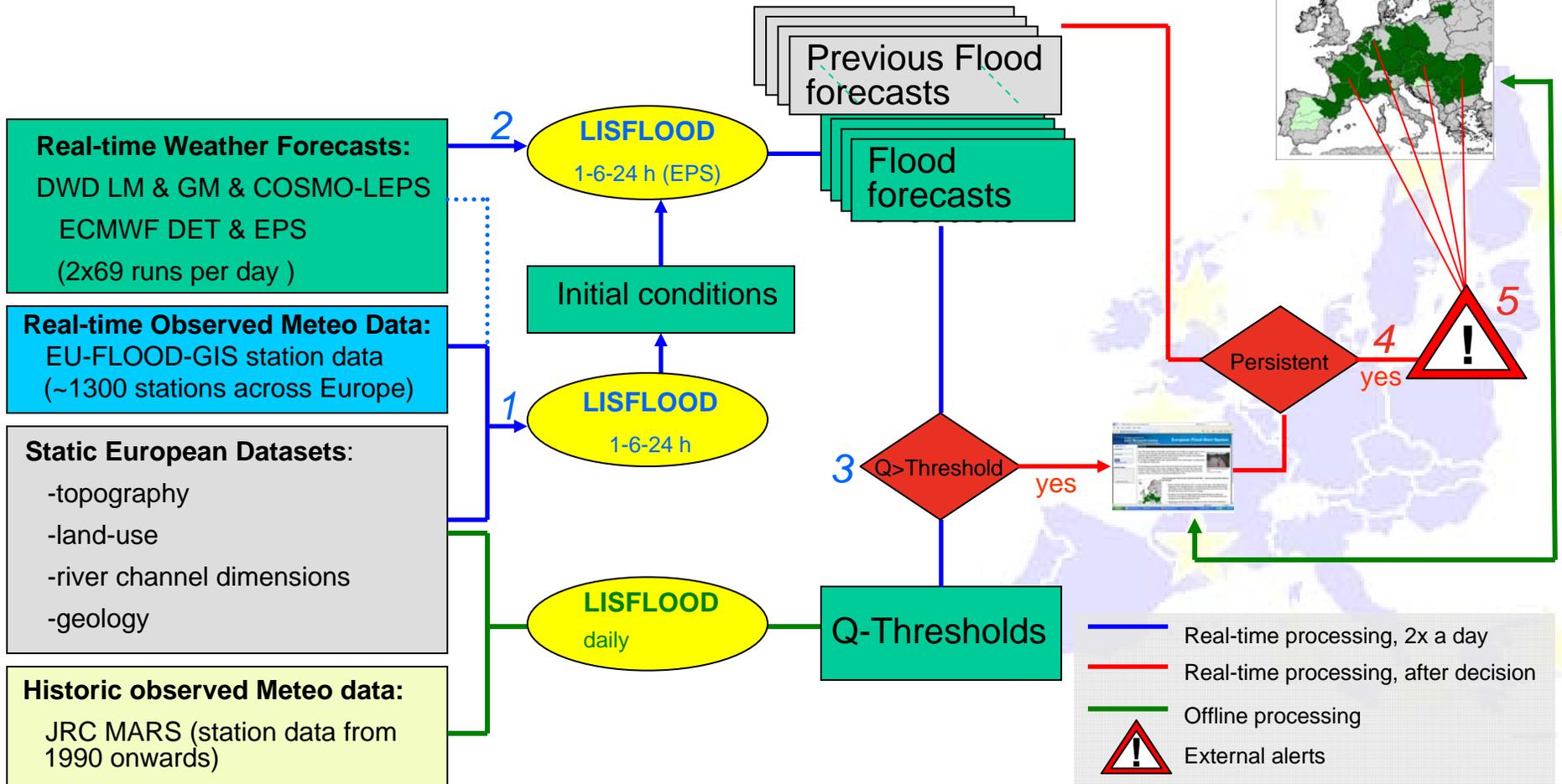


% LC cover
(bare soil, sparse grass, grass, crop, shrub, and forest)

- ✓ No (very weak) correlation between SPI-3 and RS-indicator for region with bare soil → importance of the LC un-mixing
- ✓ Correlation increases when only considering the rainy season specific to the region → importance of the regionalization
- ✓ Significant correlations exists for other LC but are still very low (between 0.3 and 0.5) at regional level
 - different information given by each drought indicator
 - they should be considered as complementary when building the integrated drought indicator
- ✓ GPCC data better related to local precipitation measurements than ERA-40 reanalysis data

European Flood Alert System (EFAS)

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Pilot in East Africa: Juba & Shabelle

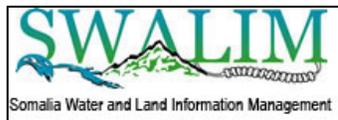
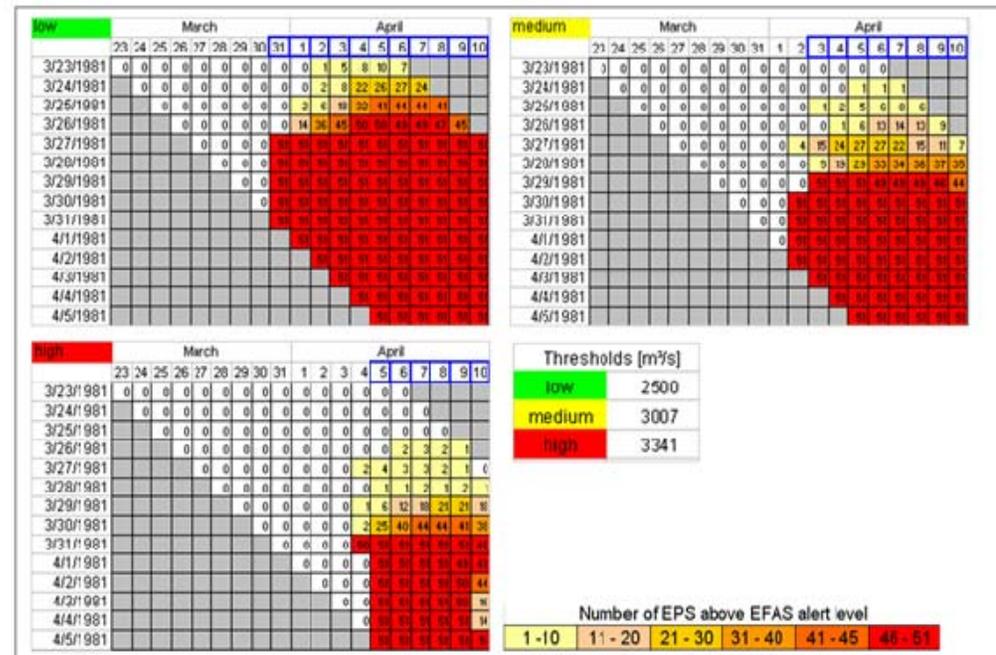
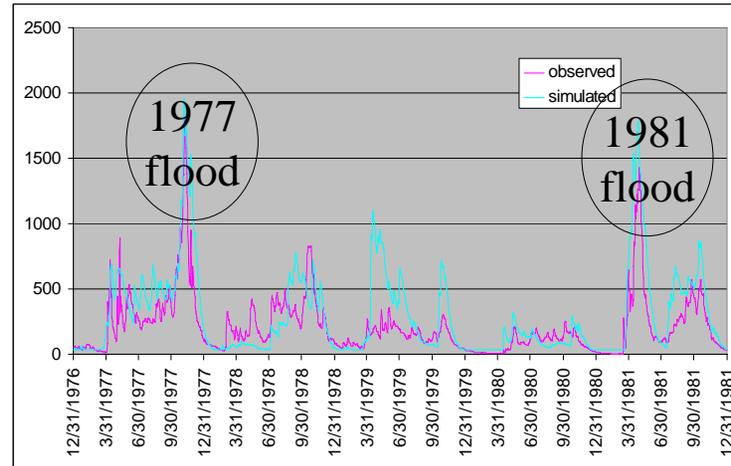
Global Drought Assessment Workshop, 21-22 April 2010, Asheville, NC, USA

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Two pilot studies:

Juba/Shabelle river basins (Somalia - Ethiopia)

Zambesi river basin (Southern Africa)



- **Aim:**

- Twice-daily 15 day hydrological ensemble forecast for floods & droughts
 - Early warning of extreme floods, extreme low flows
 - ‘Warning’ as much as possible through national competent authorities
- At least once a week a monthly forecast for droughts
 - Hydrological drought indicators

- **How:**

- Pilot studies in parallel with a pan-African set-up
 - Juba/Shabelle, Zambezi/Limpopo, Niger
- Work and establish this together with African basin authorities
 - Include local needs, knowledge, data, and feedback

- **Already contacted envisaged partners:**

- ACMAD (African Centre for Meteorological Application to Development)
- INBO & ANBO (African Network of Basin Organisations)
- African Hydrological - National and Basin - Authorities
- EC (JRC, ECHO/MIC and RELEX/DEV)
- ECMWF
- WMO
- WFP

- System should eventually run in Africa (e.g. ACMAD)

- **Problem:**

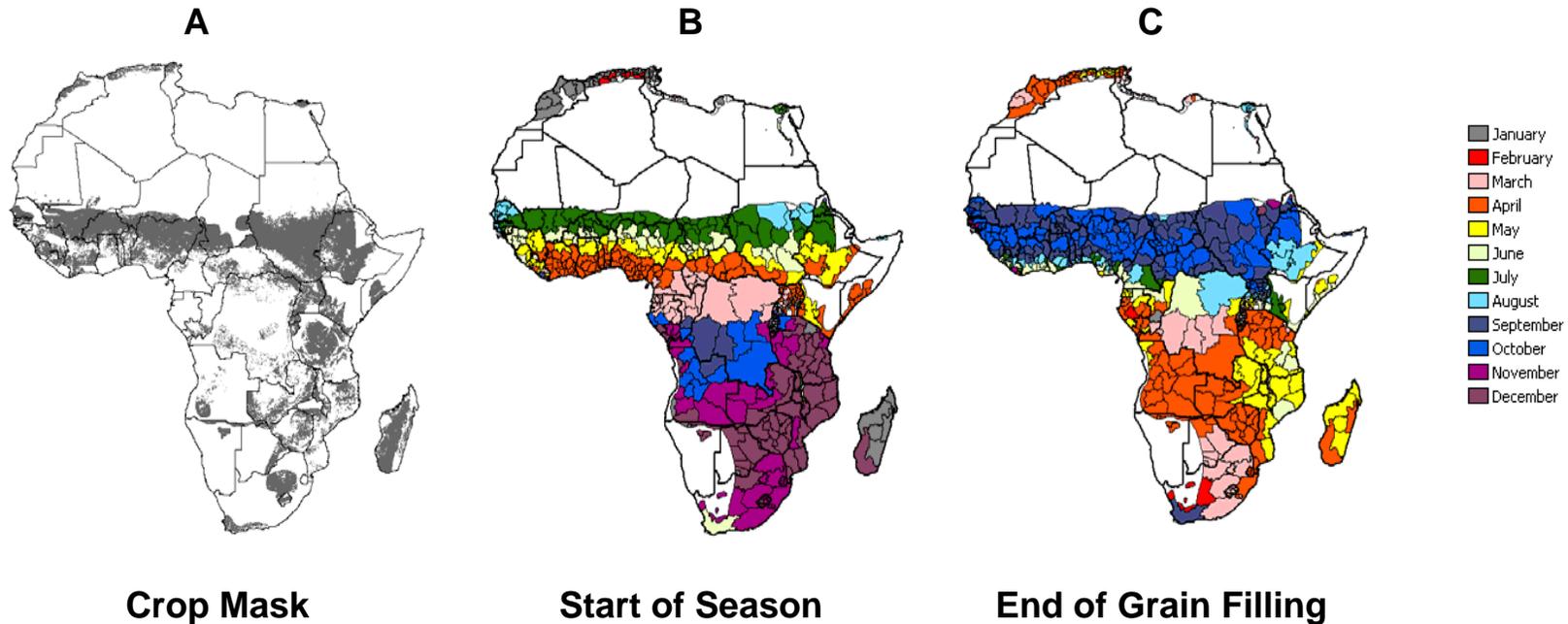
- Currently weather stations are sparse and provide discontinuous data
- Rainfall estimates have a bias and show deviations in different regions of Africa (Dinku *et al.* 2007, Lim and Ho 2000)

- **Objective:**

- The objective of the present study is to use the NDVI derived from NOAA-AVHRR to calculate the probability of agricultural drought occurrence

- **Data:**

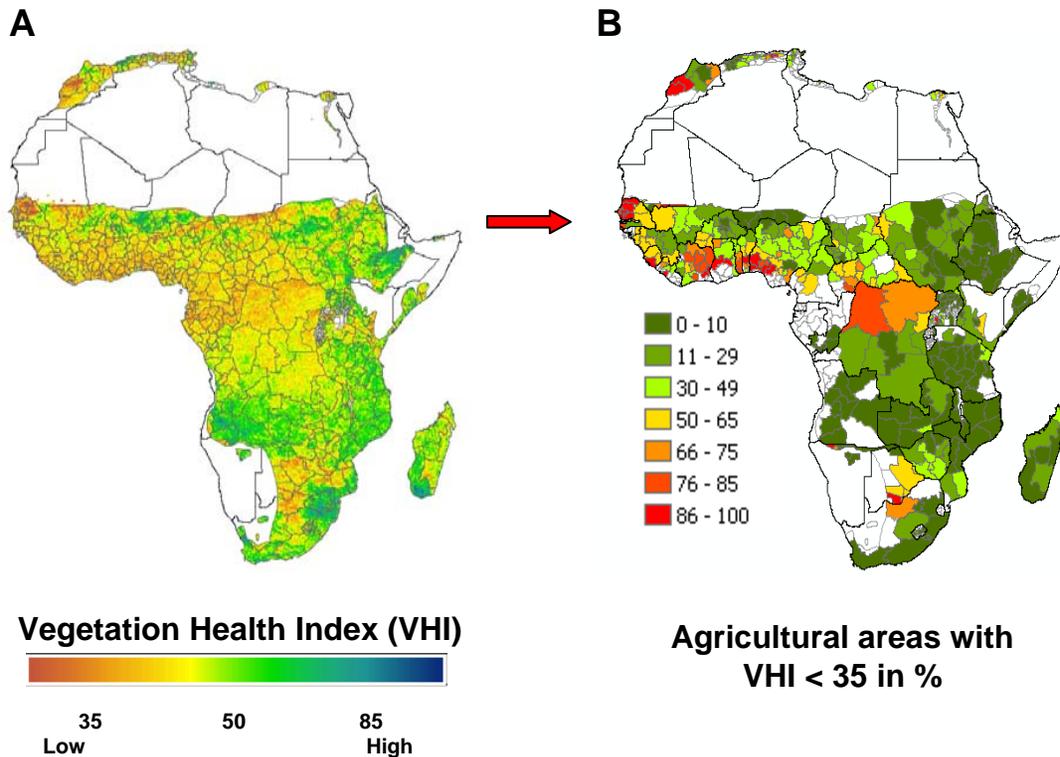
- Vegetation Health Index (VHI) produced by the Center for Satellite Applications and Research (STAR) of the National Environmental Satellite, Data and Information Service (NESDIS) (1981-2009). Weekly product, 16 km resolution.
- Normalized Difference Vegetation Index (NDVI) dataset from the NASA Global Inventory Monitoring and Modeling Systems (GIMMS) group. 15-day MVC, 8 km resolution. (1981-2006)
- A crop mask. The crop mask was constructed using FAO crop zones for 10 crops, and the Global Land Cover (GLC2000)
- The first sub-national administrative units from the Global Administrative Unit Layers (GAUL) database



- (A) **Agricultural crop mask** considering the main FAO crop zones and masking out the forest using GLC2000 for the following annual crops: pulses, sorghum, wheat, millet, maize, niebe, teff, yams, rice and barley.
- (B) **The start of crop development stage** by administrative unit
- (C) **End of the grain filling stage** by administrative unit. In maps B and C a monthly color scale was used only for graphic representation, operationally a weekly time step is used.

Source: Rojas, O., Vrieling, A. and Rembold, F., 2010. Assessing drought probability for agricultural areas in Africa with remote sensing. *Remote Sensing of Environment* (submitted)

Cropping Season 83-84



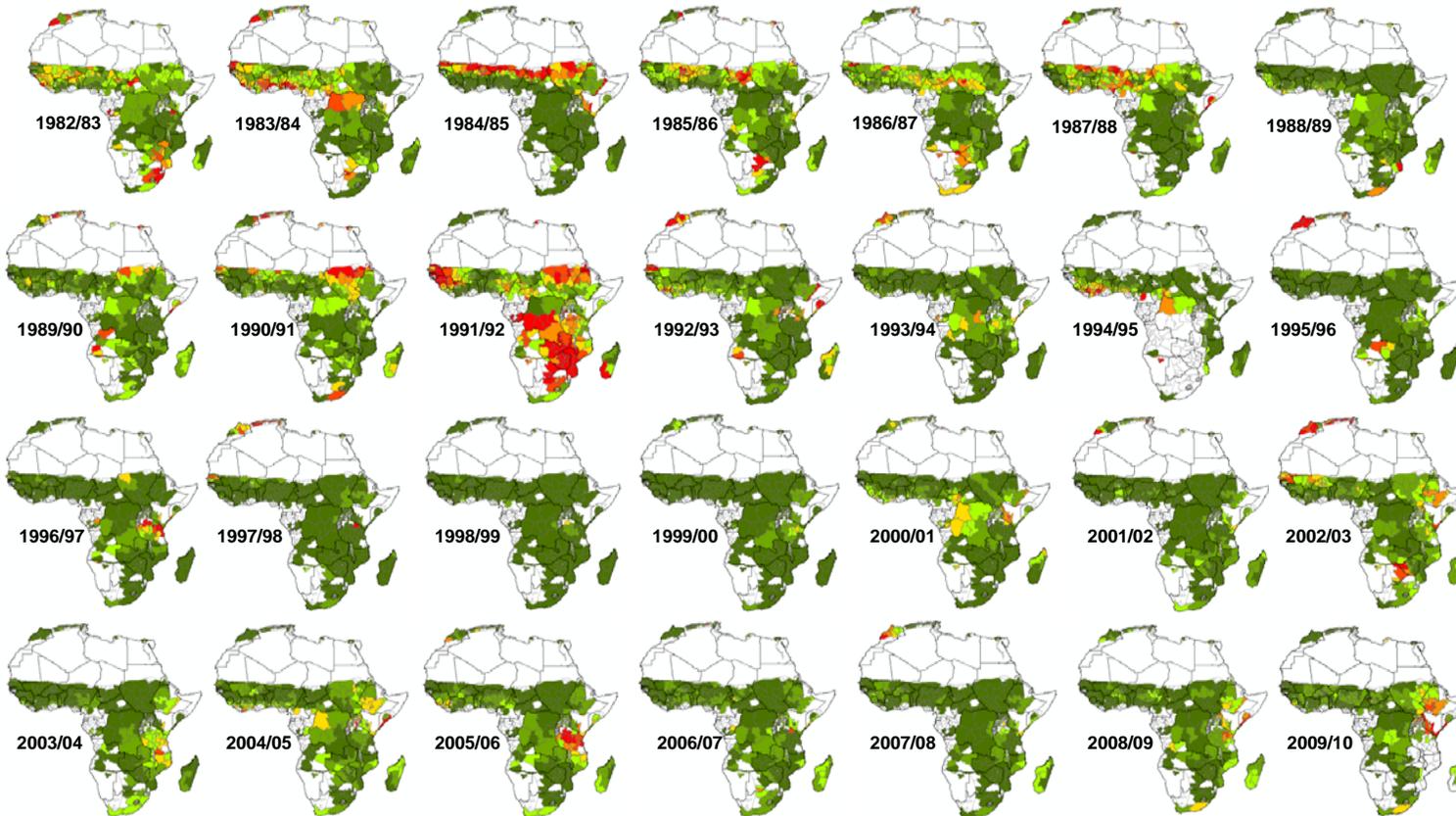
- Agricultural area affected by drought (VHI < 35)
- Transformed into % total agriculture area at sub-national unit (Gaul 1)

(A) Average VHI image for the crop season 1983/84

(B) Percentage of agricultural area affected by drought (VHI < 35) based on (A).

The average crop season VHI shows the temporal impact of drought while the percentage of affected agricultural area explains the spatial dimension of the drought.

1982

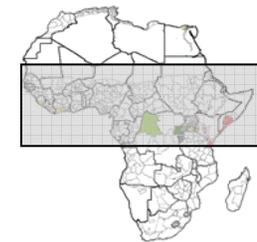
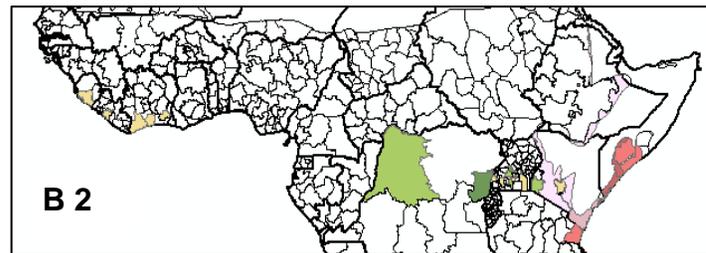
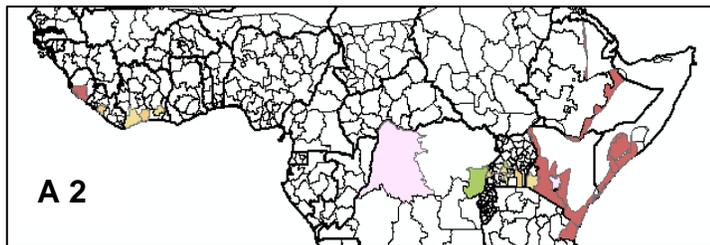
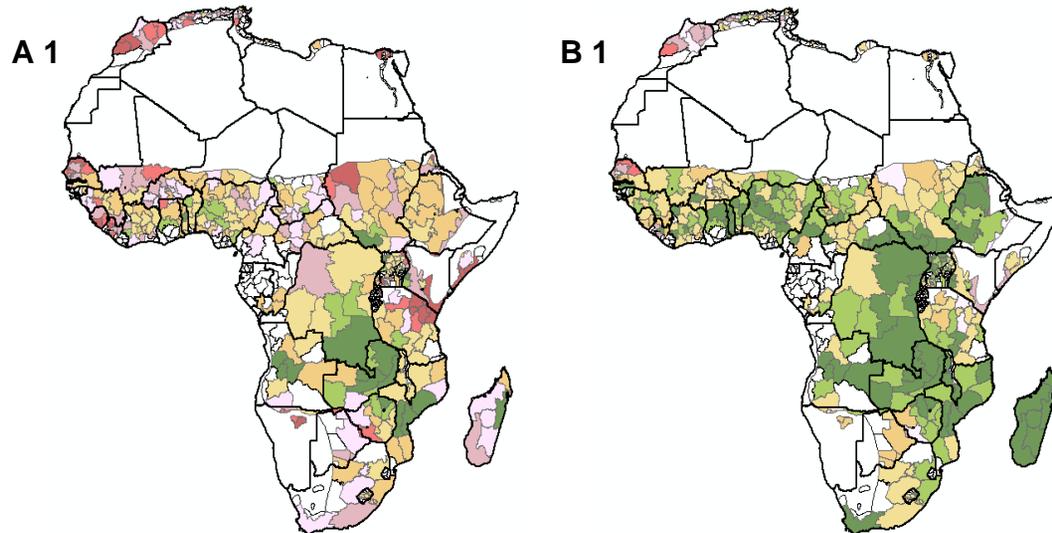


2009

Agricultural areas with VHI < 35 in %

Percentage of agricultural area affected by drought during the first crop season (VHI < 35) from 1982 to 2010 (seasons 1994/95 and 2009/10 are incomplete).

Probability in % of having 30% (A) or 50% (B) of the agricultural areas with VHI<35



Probability of having (A) more than 30% or (B) more than 50 % of the agricultural area affected by drought (by administrative unit)

(1) during the first crop season (2) during the second crop season.

- ✓ JRC develops a multi-level European Drought Observatory (EDO) together with the relevant authorities and stakeholders at the different scales (European, regional, national, sub-national, river basin)
 - ✓ First EDO map server available
 - ✓ Regular contacts with stakeholders at different levels
 - ✓ First collaboration agreements established
- ✓ Based on the European experiences (droughts, floods, yield prediction), regional to continental applications are under development and testing for Africa
- ✓ African applications to be developed in close collaboration with local stakeholders under the EU- African partnership

Action **DESERT**

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Action **FOODSEC**

- Contacts: Olivier Leo (olivier.leo@jrc.ec.europa.eu), Oscar Rojas, Felix Rembold
- Web: <http://www.marsop.info/>, <http://mars.jrc.it/mars/about-us/FOODSEC>