EDO & GDO Latest Developments

- Extended LISFLOOD Window (Carolina)
- New Global Soil Moisture Product (Carmelo)
- Database of Drought Events (Marco & Dario & Jonathan)
- Drought Events in GDACS+ (Alfred/Diego)
- Forecasting Drought & Temperature Extremes (Christophe)

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Implementation of the LISFLOOD Extended Window

Carolina ARIAS MUÑOZ

EDO User Meeting 2018

LISFLOOD distributed rainfall-runoff-routing model

- JRC in-house development since 1997
- ***Original aim (1997)***: simulation of impact of measures on floods at large river basin scale
- ***Aims added later*** :
  - Flood forecasting
  - Simulations at continental scale
  - Effects of climate change
  - **Droughts (soil moisture and low-flows)**
  - Flash floods

LISFLOOD user manual

Van Der Knijff, J. M., Younis, J. and De Roo, A. P. J. (2010) LISFLOOD: a GIS-based distributed model for river basin scale water balance and flood simulation, International Journal of Geographical Information Science, Vol. 24, No.2, 189-212.

EDO - LISFLOOD
Extended Window (1/3)

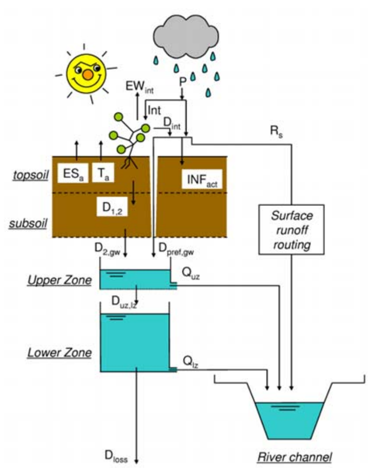


Figure 2.1 *Overview of the LISFLOOD model. P = precipitation; Int = interception; EW_{int} = evaporation of intercepted water; D_{int} = leaf drainage; ES_a = evaporation from soil surface; T_a = transpiration (water uptake by plant roots); INF_{act} = infiltration; R_s = surface runoff; $D_{1,2}$ = drainage from top- to subsoil; $D_{2,gw}$ = drainage from subsoil to upper groundwater zone; $D_{pref,gw}$ = preferential flow to upper groundwater zone; $D_{uz,lz}$ = drainage from upper- to lower groundwater zone; Q_{uz} = outflow from upper groundwater zone; Q_l = outflow from lower groundwater zone; D_{loss} = loss from lower groundwater zone. Note that snowmelt is not included in the Figure (even though it is simulated by the model).*

Spatially distributed hydrological model with routines for:

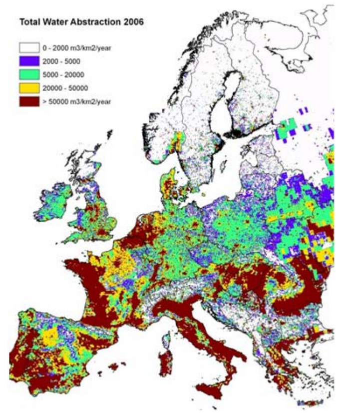
- Snowmelt
- Interception
- Evapotranspiration
- Infiltration
- Overland flow
- **Soil moisture re-distribution**
- Groundwater flow
- Preferential flow
- **River discharge**
- Lakes
- Reservoirs
- Retention polders
- Water abstraction & consumption

EDO - LISFLOOD
Extended Window (1/3)

Changes in LISFLOOD :

- **Water abstraction and consumption included** (irrigation, manufacturing industry, water use for energy production, water use by livestock, public water abstraction & use)

https://publications.europa.eu/en/publication-detail/-/publication/0e2061e9-9ab5-11e6-868c-01aa75ed71a1/language-en



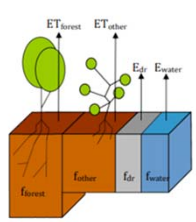
EDO - LISFLOOD
Extended Window (1/3)

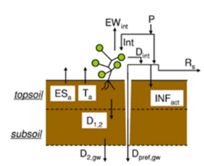
Changes in LISFLOOD :

- **Sub-grid variability included** for landuse & elevation, based on 100x100 m land use (CORINE) and elevation (SRTM) data, for every grid :
  - Fraction of forested areas (increased evapotranspiration, infiltration)

Fraction of forest map

Soil water redistribution between 2 soil layers:





Soil moisture upper layer, forest fraction.
Soil moisture lower layer, forest fraction.
Soil moisture upper, other fraction.
Soil moisture lower layer, other fraction.

EDO - LISFLOOD
Extended Window (1/3)

Other technical changes of LISFLOOD outputs:

- Bigger spatial domain: inclusion of more reservoirs (countries as Turkey, Armenia, Syria, part of Irak and a small portion in the north of Africa).
- Different data files format (from PCRaster to NetCDF).
- Spatial Reference system changed (from GISCO to EPSG 3857).

Current LISFLOOD window

Previous LISFLOOD window

EDO - LISFLOOD
Extended Window (2/3)

Implications of the Changes :

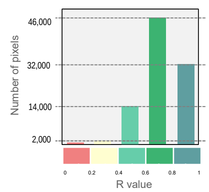
- Verification of inconsistencies and agreements between previous and current LISFLOOD model versions.
- Adaption the storage and publication **procedures** of :
  - ✓ Soil Moisture Anomalies Indicator.
  - Low-Flow Index.
- Recalculation the historical data.
- Change the software from Commercial (Arc info) to Open Source (Python and related Geo Libraries).

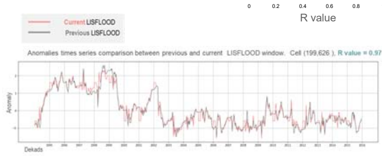
EDO - LISFLOOD
Extended Window (3/3)

European Commission

Comparing Soil Moisture Anomalies between previous and current versions of LISFLOOD hydrological model

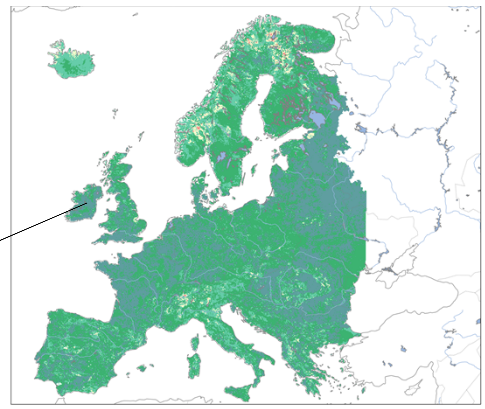
Histogram and legend of the linear regression analysis map





Comparison maps

Spatial distribution of the Pearson correlation coefficient between Soil Moisture Anomalies of the previous and current versions of LISFLOOD



Joint Research Centre

European Commission

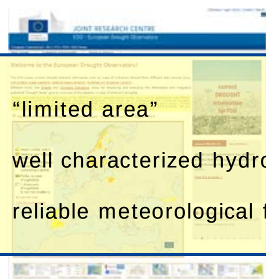
Soil Moisture Anomalies (SMA) from EDO to GDO

Carmelo CAMMALLERI

EDO User Meeting 2018

Joint Research Centre

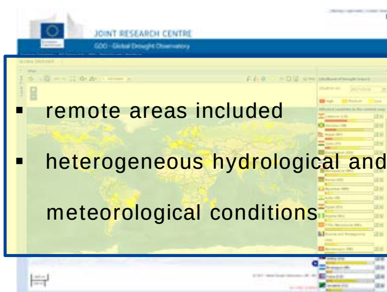
OVER EUROPE



- "limited area"
- well characterized hydrologically
- reliable meteorological forcing

http://edo.jrc.ec.europa.eu

GLOBALLY



- remote areas included
- heterogeneous hydrological and meteorological conditions

http://edo.jrc.ec.europa.eu/gdo/

Rationale

- A **single** model/dataset is **not capable** to reliably capture soil moisture anomalies at **global** scale.
- Ensemble products have provided added value in **monitoring drought** events in case of uncertain accuracy.

Research Goals

- Evaluation of the **similarities** among **three datasets** to be used as proxy of **soil moisture anomalies** for drought monitoring.
- Application of the **Triple Collocation** (TC) procedure to evaluate the **errors** associated to each dataset in comparison with the "true" status.
- Development of an **ensemble product** to be used within the Global Drought Observatory (**GDO**).

Proxy of SM anomalies

LISFLOOD de Roo et al. (2000) [Hydrol. Process. 14]

- precipitation-Runoff model.
- 0.1 degree spatial resolution.

The three datasets are:

- averaged on a 30-day moving window updated every **dekad**.
- Spatially aggregated at **0.1 degree** resolution.
- **Masked** over the areas with low quality or snow coverage.
- Converted into **anomalies** by using the same 2001-2015 baseline.

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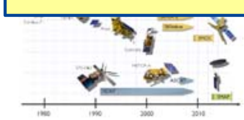


- merged passive/active microwave
- 25-km spatial resolution.
- Covered period: 1979-2015

Triple Collocation (TC) method

Hypothesis

Stoffelen (1998) [J. Geophys. Res. 103: 7755-7766]

- Linearity between the true signal of soil moisture anomalies and the 3 datasets.
- Signal and error stationarity.
- Independency between the errors and the signal (error orthogonality).
- Independency between the errors in the 3 datasets (zero error cross-correlation).

Error estimation

Gruber et al. (2016) [Int. J. Appl. Earth. Obs. Geoinf. 45: 200-211]

$$\sigma_{\varepsilon_1}^2 = \sigma_1^2 - \frac{\sigma_{12}\sigma_{13}}{\sigma_{23}}$$
$$\sigma_{\varepsilon_2}^2 = \sigma_2^2 - \frac{\sigma_{21}\sigma_{23}}{\sigma_{13}}$$
$$\sigma_{\varepsilon_3}^2 = \sigma_3^2 - \frac{\sigma_{31}\sigma_{32}}{\sigma_{12}}$$

Model data variance

Model error variance

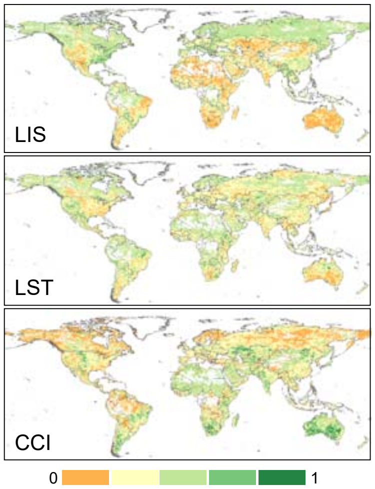
Sensitivity of the model to variation in the true status

1 = Lisflood (LIS)

2 = MODIS LST (LST)

3 = ESA microwave (CCI)

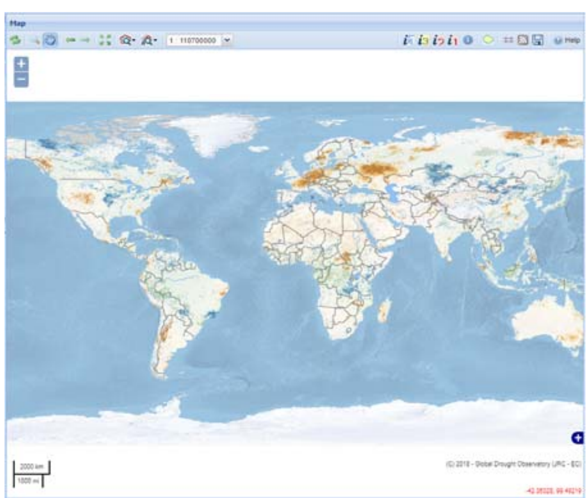
Results of the TC analysis



Spatial distribution of the weighting factors for each product (inverse of the model error variance).

- LIS is more reliable over the northern latitudes.
- LST is more reliable over some dry areas.
- CCI is more reliable over the southern hemisphere.

Results – Implementation in GDO



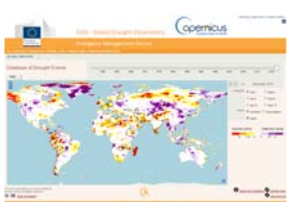
Global Database of Drought Events

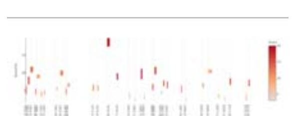
Diego MAGNI, Marco MAZZESCHI , Jonathan SPINONI

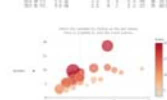
EDO User Meeting 2018

Database of Drought Events

A web tool (dashboard-like) to interactively examine a global database of meteorological drought events







AUTHOR:

Jonathan SPINONI

CONTRIBUTORS:

Dario MASANTE,

Diego MAGNI,

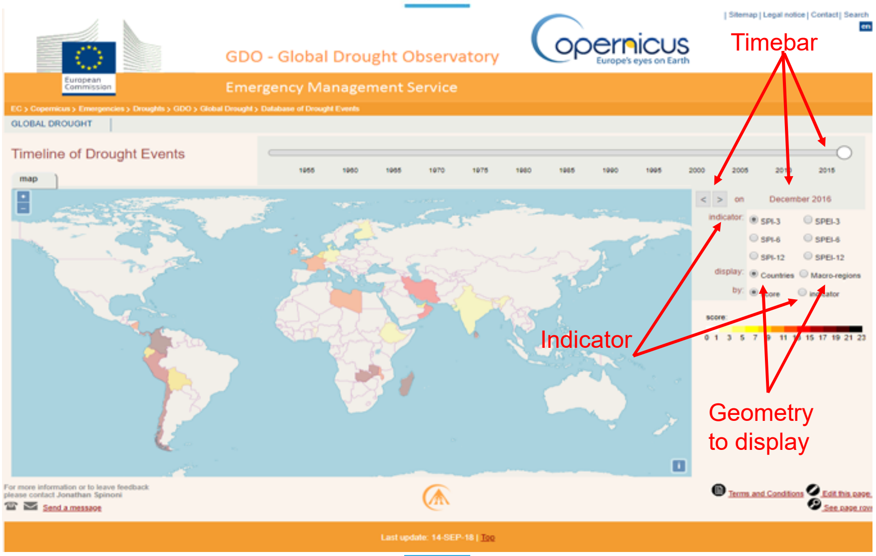
Carolina ARIAS MUNOZ,

Alfred DE JAGER,

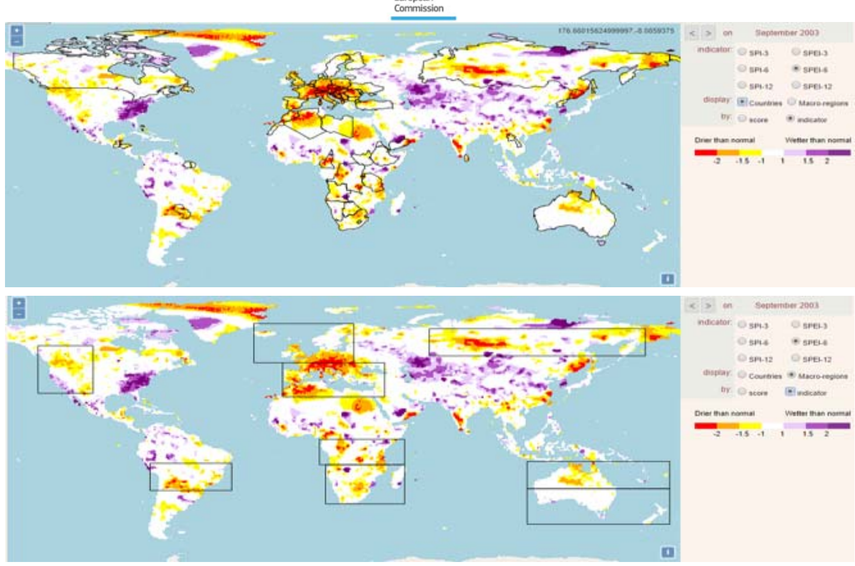
Marco MAZZESCHI

Alive at: http://edo.jrc.ec.europa.eu/gdo/php/index.php?id=2020

Database of Drought Events

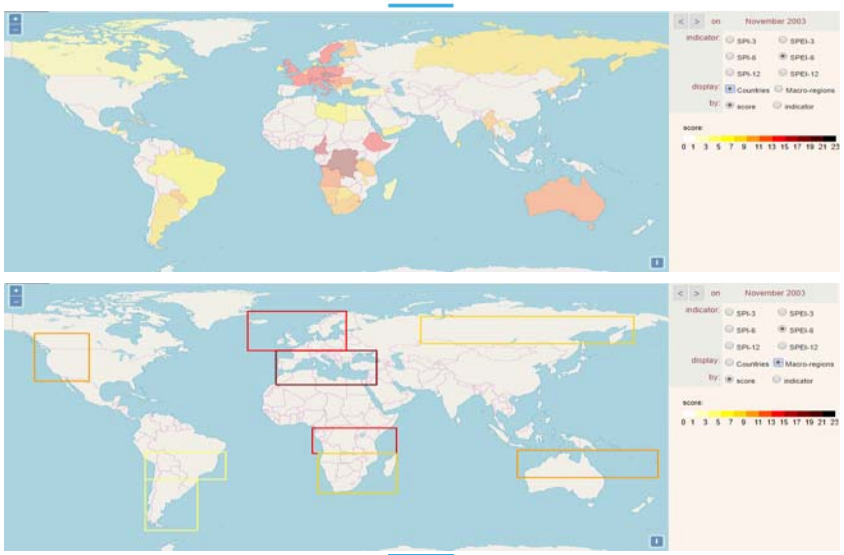


Database of Drought Events



Database of Drought Events

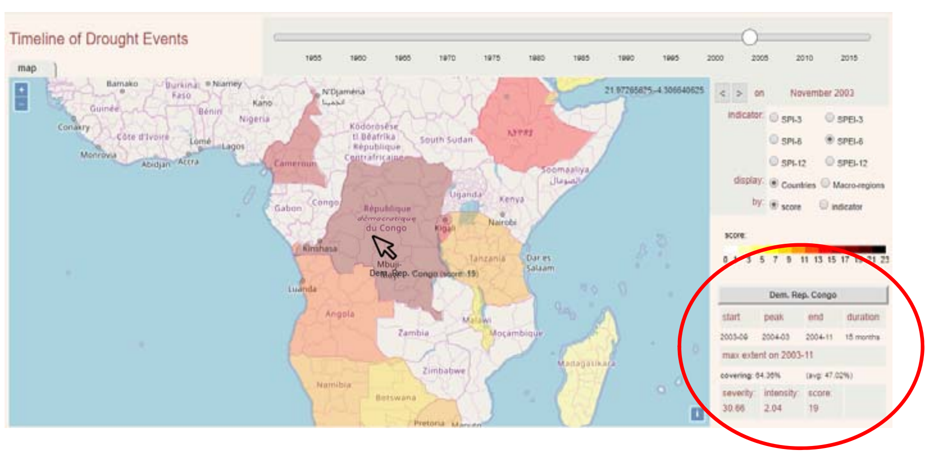
European Commission



Joint Research Centre

Database of Drought Events

European Commission



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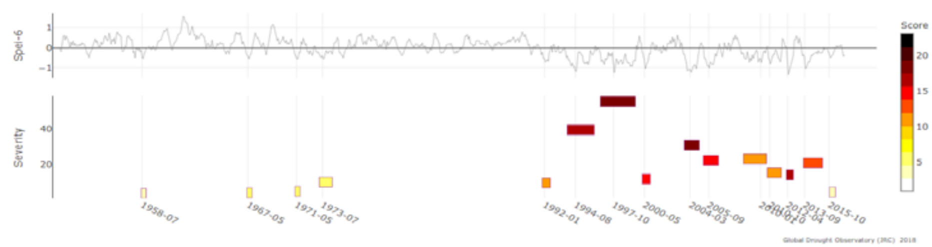
Database of Drought Events

Drought events in Dem. Rep. Congo, detected by Spei-6

start month	peak month	end month	max ext month	duration [months]	severity	intensity	average area [km^2]	score	widest area [%]
1993-12	1994-08	1996-02	1994-07	27	39.34	1.46	39.21	17	62.27
1996-09	1997-10	1999-07	1997-10	35	55.34	1.58	39.71	19	70.37
2000-03	2000-05	2000-10	2000-05	8	11.73	1.47	33.44	15	61.23
2003-09	2004-03	2004-11	2003-11	15	30.66	2.04	47.02	19	64.36
2005-04	2005-09	2006-06	2005-09	15	22.29	1.49	32.65	16	52.74

The bars are the drought events following the timeline from 1950 to 2016 (left to right).
The bar length is proportional to the duration of the event; the thicker purple border highlights the selected event.



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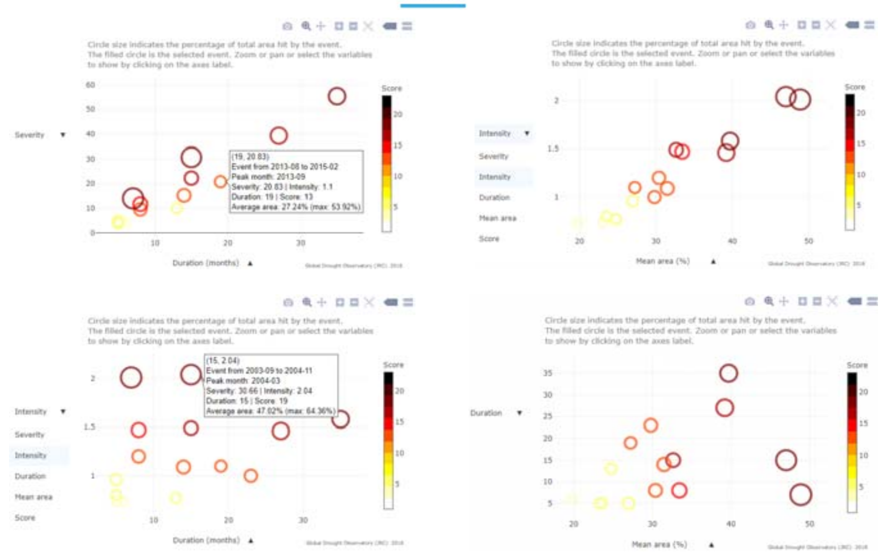
Database of Drought Events



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Injection of Information on Drought Events into GDACS+

Diego MAGNI, Marco MAZZESCHI

Drought events in GDACS+

GDACS - Global Disaster Alert and Coordination System

GDACS is a cooperation framework between the United Nations, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters.

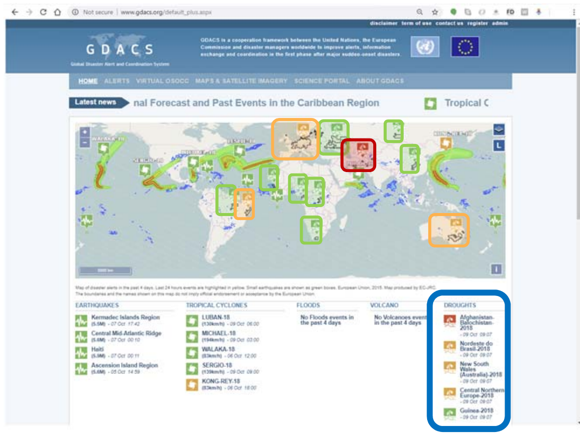
Considered Natural Disasters:

- Earthquakes
- Tsunamis
- Volcanoes
- Tropical Cyclones
- Storm Surges
- Floods

Drought events in GDACS+

GOAL:

Display drought events on **GDACS+** (the development version of GDACS)



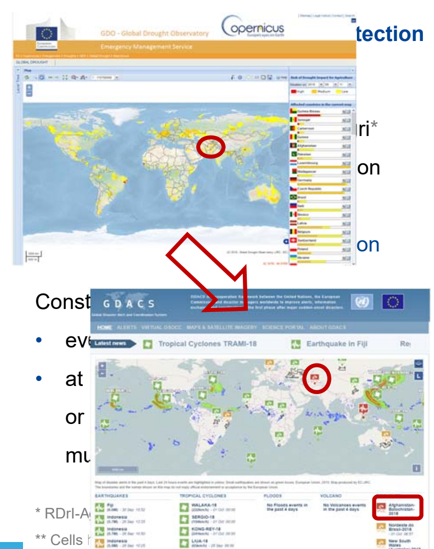
Drought events in GDACS+

STEPS:

1) Automatic detection of agricultural (and other type in perspective) drought events

2) Evaluation and classification of detected drought events

3) Publication in GeoJSON format of confirmed and classified events and display on GDACS+



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Drought events in GDACS+

Each event has the following attributes:

With values set by the algorithm
- ID (unique, primary key)
- Geometry (multi-polygon)
- Name (affected country by default)
- Alert level / alert value (RDrI-Agri)
- Begin date → reference (last) date
- Affected countries and administrative reporting units

With values set during evaluation / classification
- Name (changing the automatic one)
- Alert level (changing the automatic one)
- Status (confirmed, discarded, deferred to next period)
- URL of Analytical Report (if available)
- Event summary and impact type texts
- Event membership to aggregate different events in a unique one
- GDACS Score : quarters of unit from 0 to 3

GDACS Score ≠ RDrI !

2) Drought Events Evaluation and Classification

3) Drought Events Publishing → GDACS+

http://www.gdacs.org/default_plus.aspx

	A confirmed drought (mild to severe), but no evidence of impacts. No action envisaged by humanitarian aid providers.
	A severe/extreme drought with relevant impacts to services or economic sectors, but not severe or life threatening risks to people. No international aid provided yet, but possibly alerted.
	Like before, plus very serious or life-threatening impacts to people: widespread migrations/displacements, famine or starvation, widespread violence related to water resources. International aid is needed or has been requested/dispatched.

Forecasting Droughts and Temperature Extremes

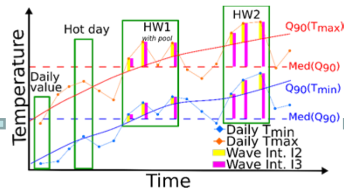
Christophe LAVAYSSE

EDO – GDO
HW/CWs

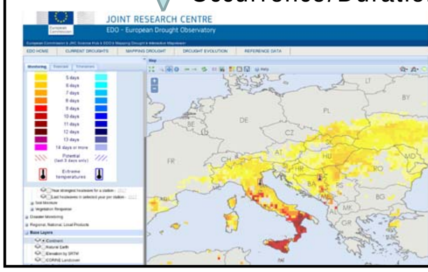
Monitoring of the HW/CWs :

- Operational daily product derived from gridded observations (2-d lag)

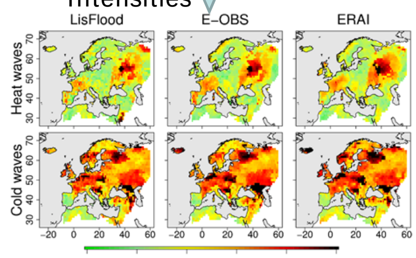
Adaptation of the HW/CW detection
Lavaysse et al. 2017



Occurrence/Duration

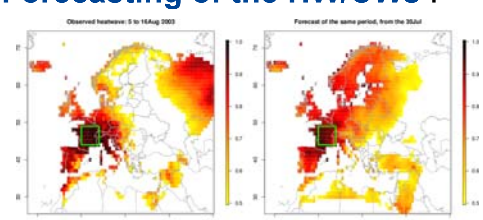


Intensities



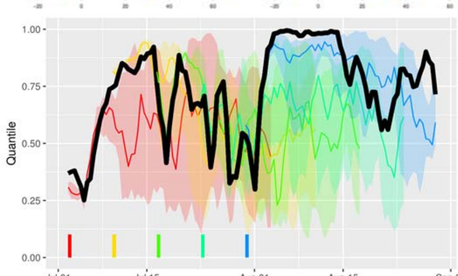
EDO – GDO
HW/CWs

Forecasting of the HW/CWs :



Predictability the HW in France in 2003:

- Slightly underestimation of the intensities
- Good forecast 7 days before with the correct duration



Using 20 years of reforecasts, predictability of :

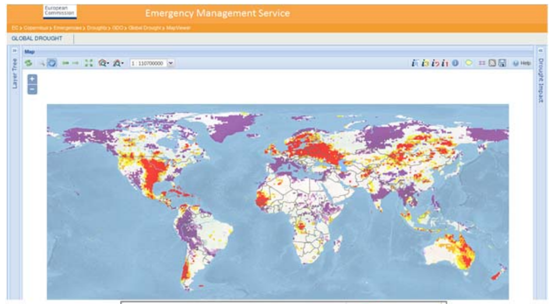
- ➢ HW/CW presence : 2-w lead time
- ➢ HW/CW onset : 1-w lead time
- ➢ intensities : slightly under estimation

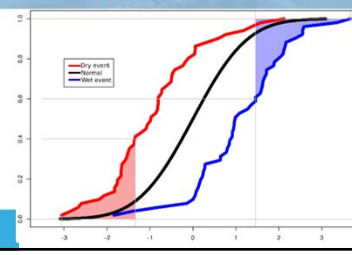
Lavaysse et al. 2018

EDO – GDO
Forecasting ext. SPI

Early warning of extreme wet/dry conditions :

- Operational monthly product derived from the seasonal S5 products (ECMWF)
- Worldwide, from 1-m to 6-m cum. periods (i.e. SPI1, SPI3 and SPI6)
- Computation of the EFI of SPI when extreme precip. detected (Lavaysse et al. 2016)
- Providing comprehensible index of warning (3 levels for dry and for wet conditions) based on hindcast (1981-2010)
- Forecasts available from January 2017

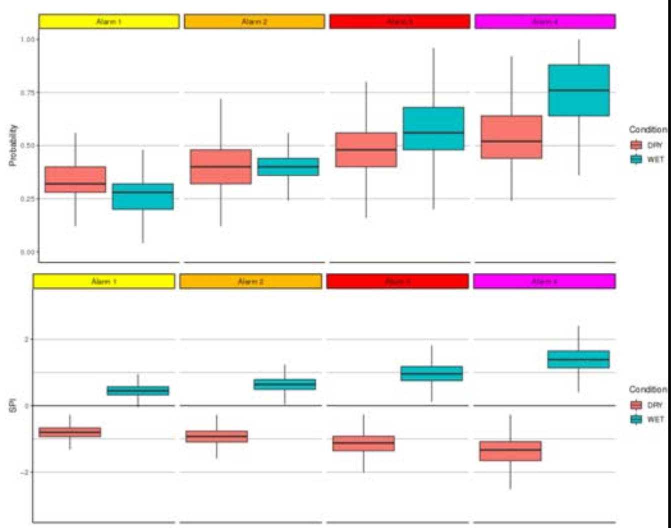




EDO – GDO
Forecasting ext. SPI

Validation

- Understanding the index w.r.t. uncer. / int. in the hindcasts.



EDO – GDO
Forecasting ext. SPI

Validation

- Complete validation of the hindcasts (1981-2010) w.r.t. GPCC depending
  - Durations
  - Wet/Dry
  - Seasons
  - Intensities
- Validation of the forecasts (on going)

Droughts, SPI1, Lev 1+, Year