



Drought Monitoring and Forecasting: Needs and Experiences of the EC

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Disaster Risk Management Unit*

Joint
Research
Centre



1. Introduction

2. What are the needs?

- Who needs drought information?
- Why do they need drought information?
- What type of information is required?

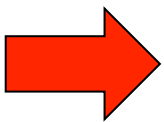
3. What is the current situation?

- The case of Europe: EDO
- The global case: GDO & GDIS

4. What are the gaps?



- Slow onset, “creeping” phenomenon
- Sector specific definitions
- Propagates slowly through the hydrological cycle (rainfall, soil moisture, groundwater, reservoirs, river flows)
- Impacts are non-structural, spread over large areas and long time periods (direct and indirect), and affect many people



About 15% of the EU territory and 17% of the EU population affected annually

Average Economic impacts in the EU are estimated to about 3 billion Euros/year

Environmental impacts are difficult to quantify and not included!

Flood and Drought Damage in the EU



Today

2050

2080



Floods

5
B€/yr

13
B€/yr
(10 to 20)

17
B€/yr
(10 to 42)



Droughts

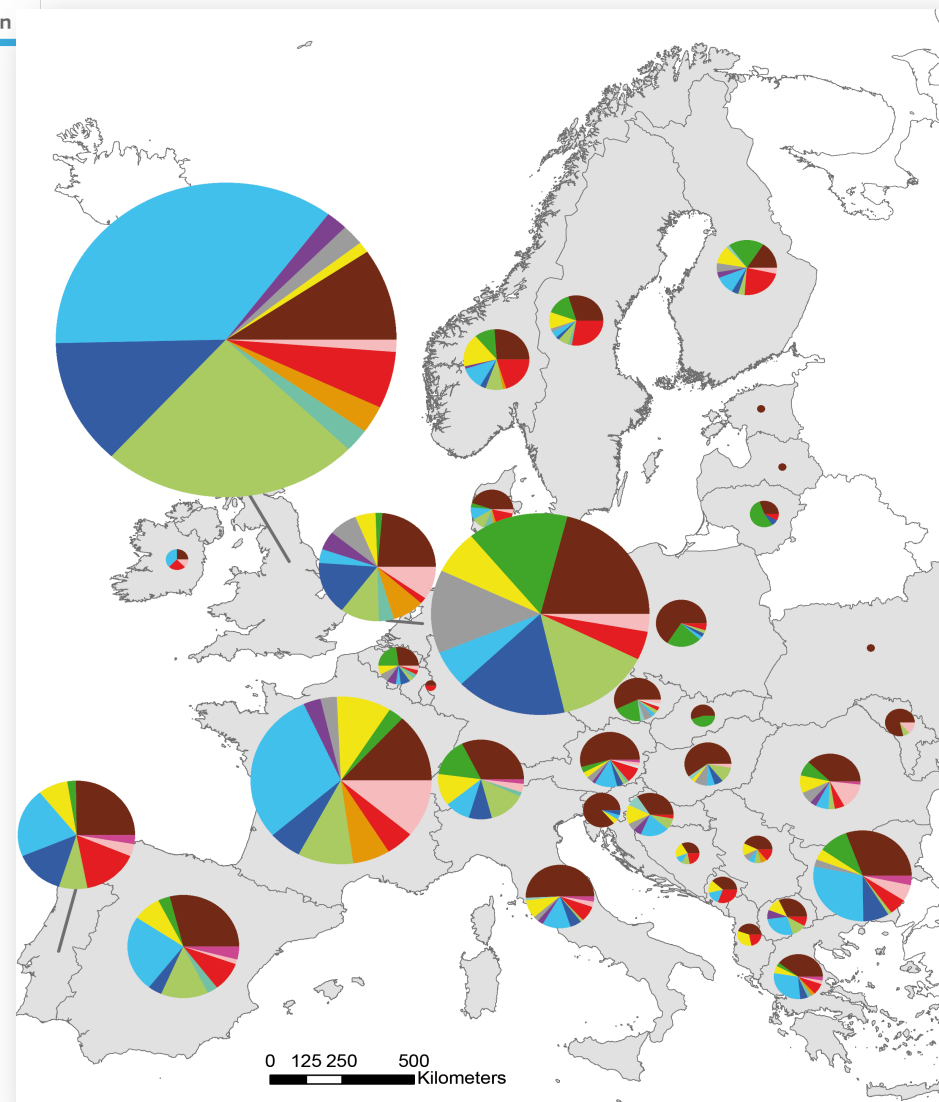
3
B€/yr

13
B€/yr
(5 to 25)

27
B€/yr
(15 to 36)

- RCP 8.5, 30-year averages, 7 independent climate models for floods and 6 for droughts

	Agriculture & Livestock farming
	Forestry
	Aquacultures & Fisheries
	Energy & Industry
	Waterborne Transportation
	Tourism & Recreation
	Public Water Supply
	Water quality
	Freshwater Ecosystems
	Terrestrial Ecosystems
	Soil System
	Wildfires
	Air Quality
	Human Health & Public Safety
	Conflicts





EU Policy Makers:

- **DG Civil Protection and Humanitarian Aid (ECHO):**
 - Drought monitoring and forecasting at European and global scales
 - Drought impact and risk assessment at European and global scales
- **DG Regional and Urban Policy (REGIO):**
 - Assessment of the current and future drought hazard and associated risks across the EU and neighbouring countries → priorities for regional development
 - European Solidarity Fund → compensations in case of significant drought impacts
- **DG International Development and Cooperation (DEVCO):**
 - Assessment of the current and future drought hazard and associated risks → priorities for development cooperation
- **DG Agriculture and Rural Development (AGRI):**
 - Crop yield forecasting for EU and major global production zones
- **DG Environment (ENV):**
 - Drought risk assessment → Water Framework Directive requires that RBs at risk of drought develop a Drought Management Plan
- **DG Climate Action (CLIMA):**
 - Changes in drought hazard and risk under climate change in Europe and globally



National Authorities:

- **Civil Protection:**

- Drought Monitoring and forecasting → public water supply, energy production, inland water transport, ...

- **Regional Planning and Rural Development:**

- Drought hazard & risk assessment → regional development priorities

- **Agriculture:**

- Drought forecasting → yield assessments

River Basin Authorities:

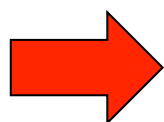
- Water management (forecasting)
- Drought hazard and risk assessment

Local Water Managers:

- Water allocation (forecasting)

Industries:

- Energy production, tourism, food sector, transport, insurances, etc.

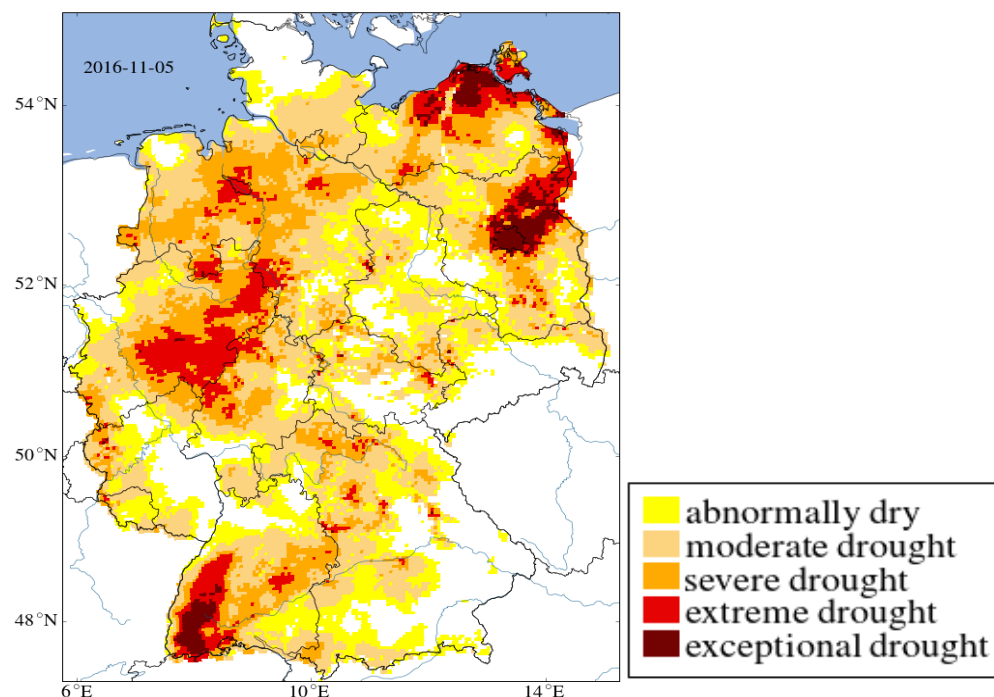


Drought monitoring and assessment requires information that is sector-specific (multiple indicators) and available at different scales!

Examples of Drought Monitors



German Drought Monitor

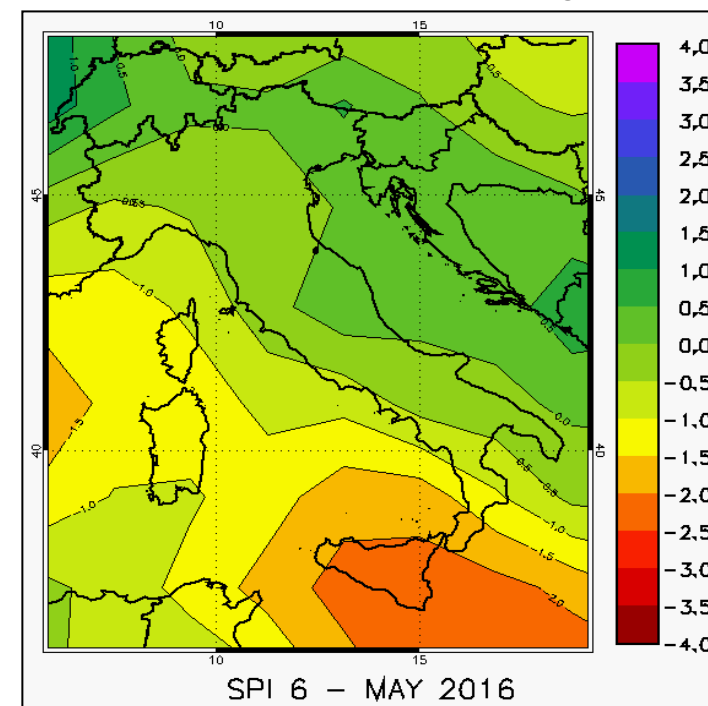


Soil Moisture Index (SMI), 4 km grid,
5 drought classes, updated daily,
4 days lag time.

www.ufz.de/droughtmonitor/

Samaniego et al. 2013

Bollettino Siccità, Italy



SPI for different accumulation periods and
regions (Italy, Mediterranean, Europe),
monthly product, based on NCEP Reanalysis
II data.

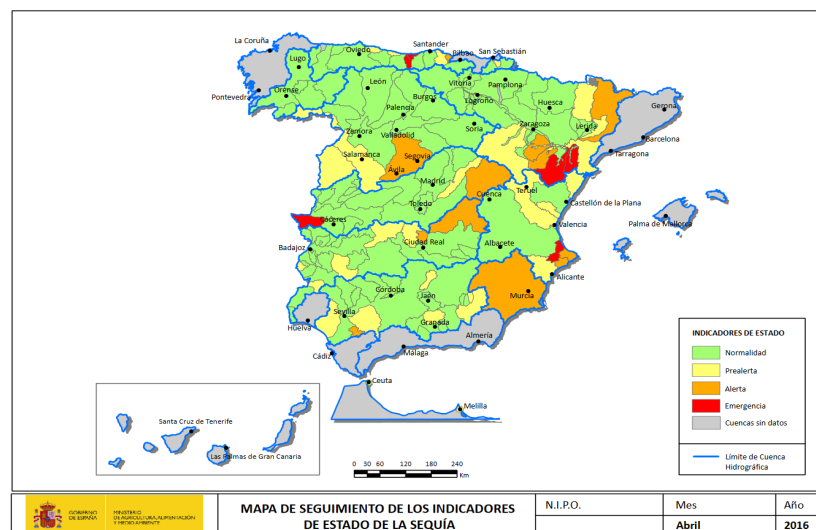
*Istituto Superiore per la Protezione e la Ricerca Ambientale
(ISPRA), Rome*

www.isprambiente.gov.it/pre_meteo/siccitas/

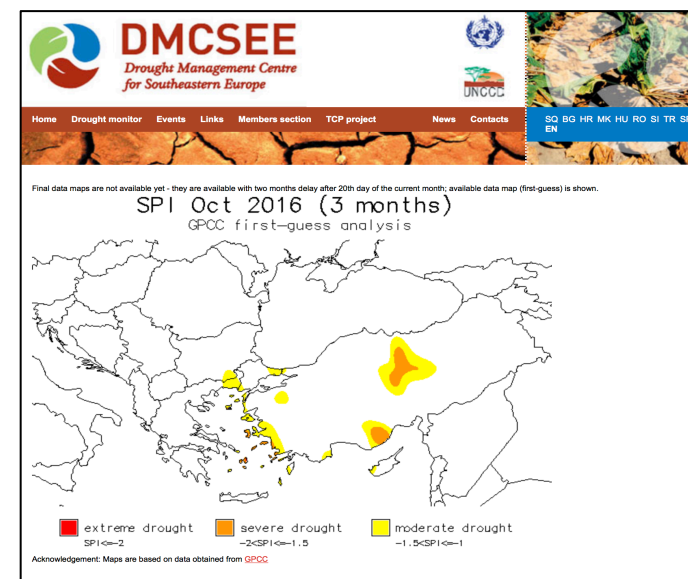


Observatorio Nacional de la Sequía

Mapa de Seguimiento de los Indicadores de Estado de la Sequía



DMCSEE Drought Monitor



Monthly maps on river basin level, aggregated indicator

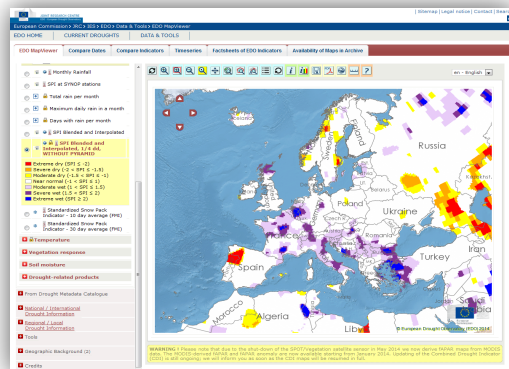
Ministerio de Agricultura, y Pesca, Alimentación y Medio Ambiente
www.mapama.gob.es

Monthly SPIs and Percentiles (Based on GPCC)

Drought Management Centre for South-Eastern Europe
www.dmcsee.org

EC Communication on Water Scarcity and Drought (2007)

Asks for the establishment of a **European Drought Observatory (EDO)** that will integrate relevant data and research results, drought monitoring, detection and forecasting on different spatial scales, from local and regional activities to a continental overview at EU level, and will make it possible to evaluate future events.



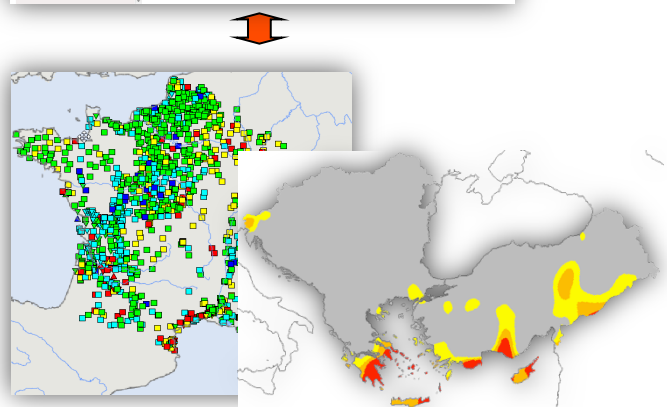
Web-based Platform

- commonly agreed products (e.g. drought indices)
- exchange of knowledge & information
- real-time monitoring and forecasting (early warning, preparedness)

Multi-scale approach, integrating

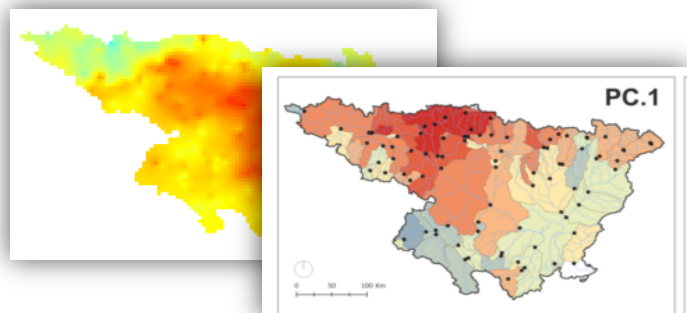
- EU / continental level
- Member State level
- Regional / River Basin level

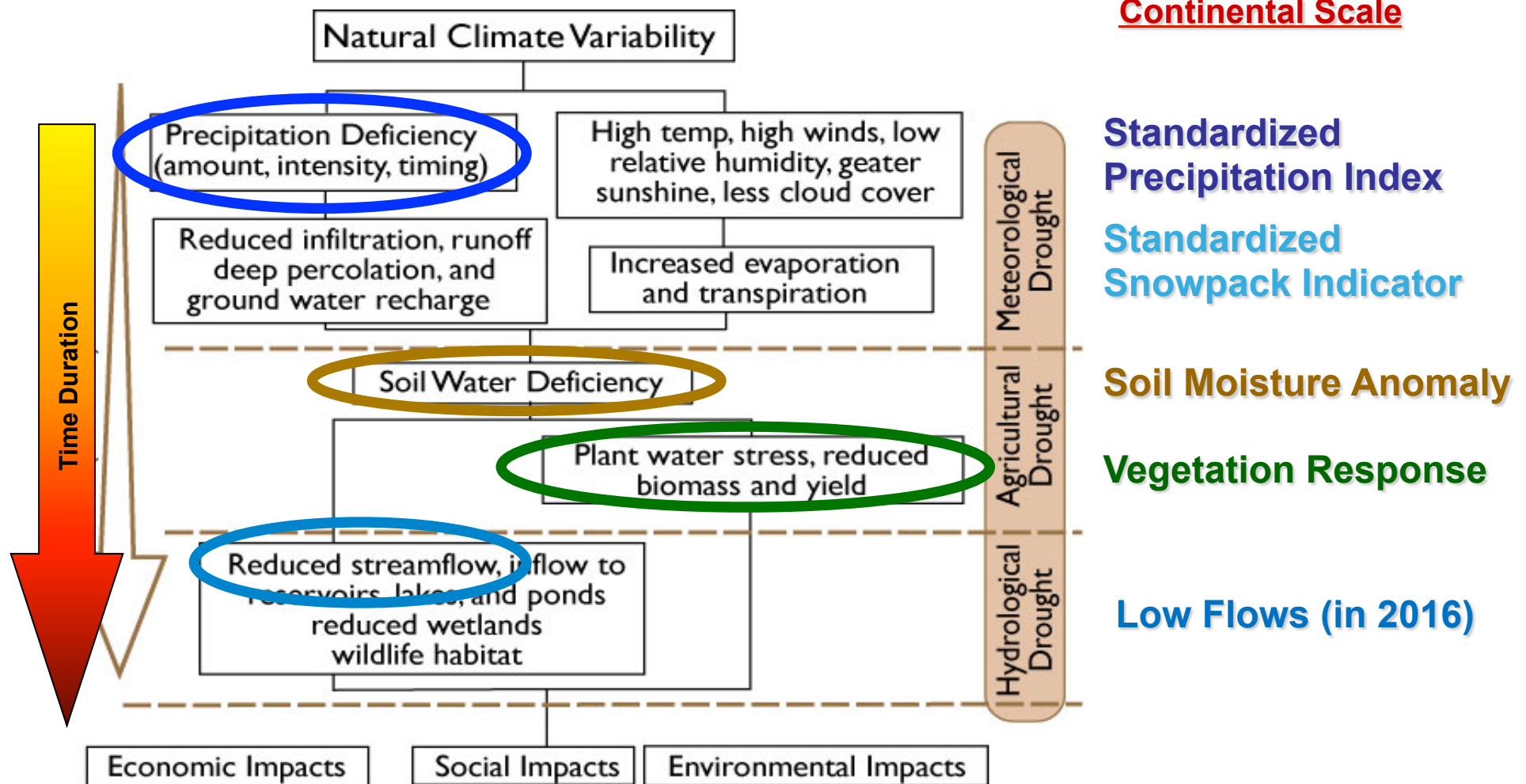
Interoperable
Data
Infrastructure



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

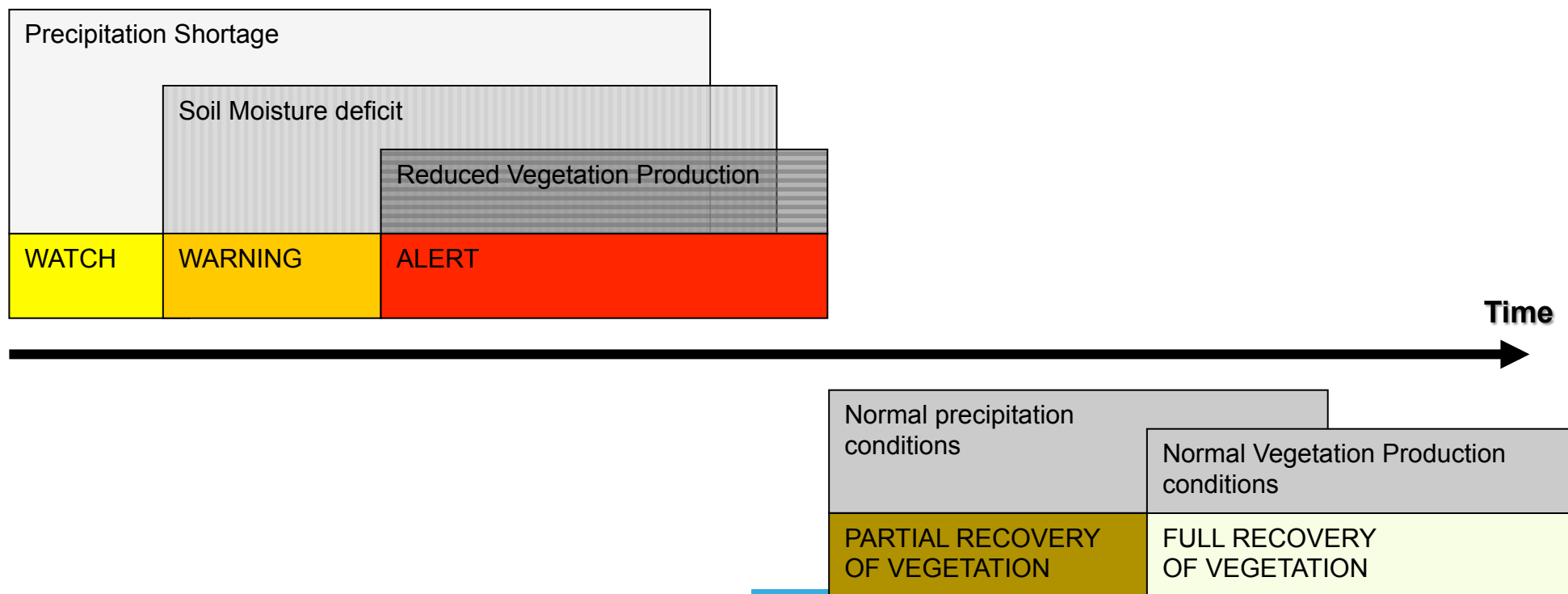




Source: National Drought Mitigation Center, University of Nebraska-Lincoln, USA

Combined Drought Indicator (CDI) for Agricultural Drought

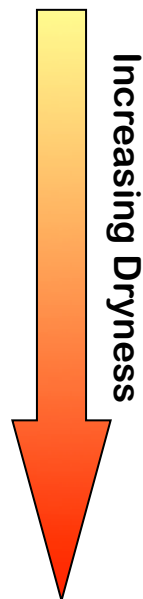
Cause-effect relationships and related warning levels



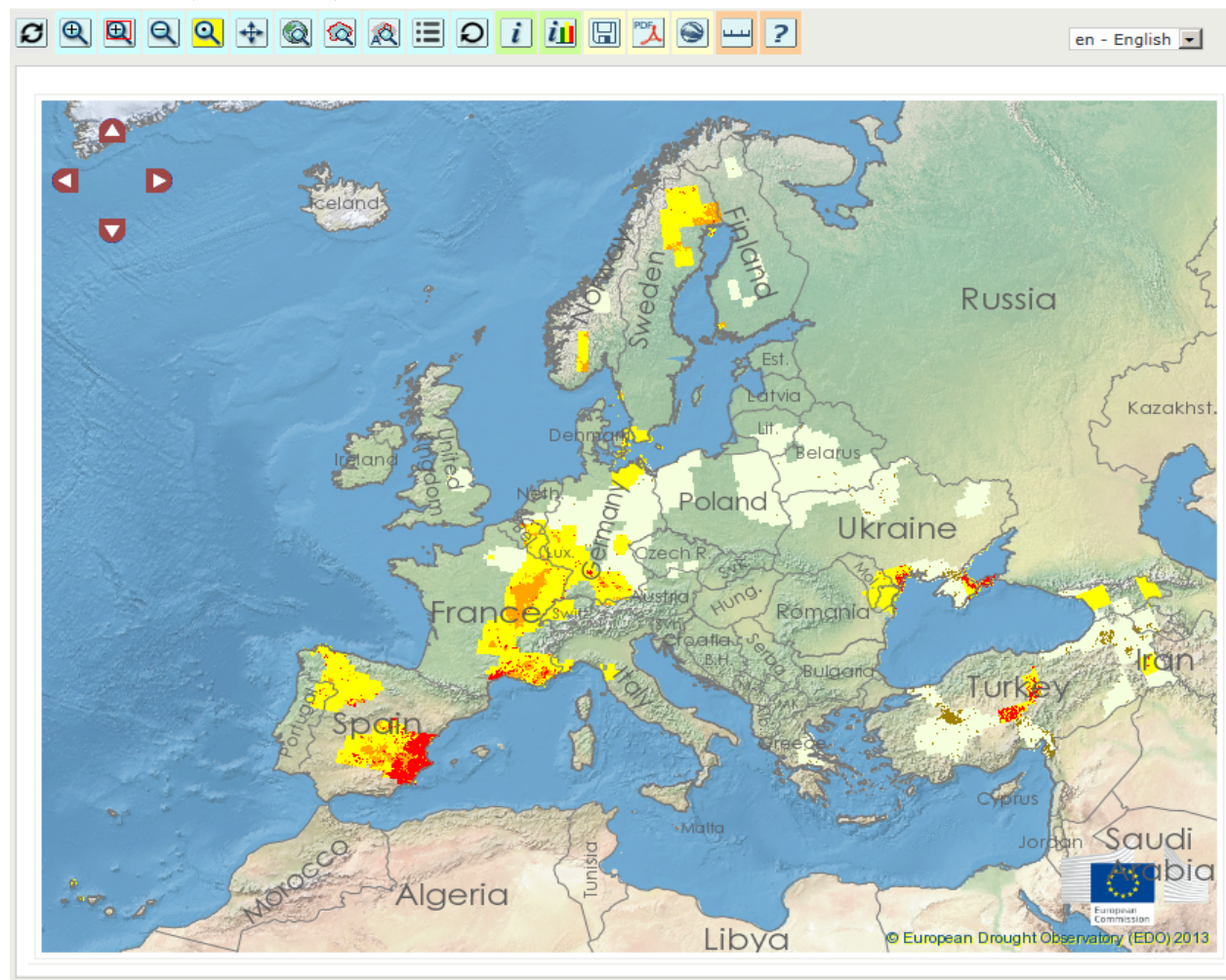
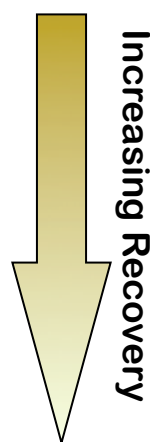


Combined Drought Indicator (CDI)

Impact	Level
Watch: rainfall deficit	1
	2
	3
Warning: soil moisture deficit	4
	5
	6
Alert: vegetation stress following rainfall/soil moisture deficit	7
	8
	9
	10



Impact	Level
Partial Recovery of Vegetation:	11
	12
Full Recovery of Vegetation:	13
	14



CDI, 1-10 June 2014

Every indicator is accompanied by a factsheet:

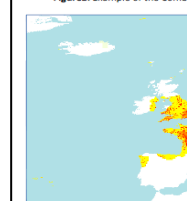


PRODUCT FACT SHEET: Combined Drought Indicator – EUROPE Version 2 (April, 2013)

Combined Drought Indicator

Type	Temporal scale	Spatial scale	Geo. coverage
Vegetation response	10-day product	(1/24) °	Europe

Figure1: Example of the Comb



Key message

A precipitation reduction respecting precipitation reduction produces a demand of the plants and therefore agricultural drought.

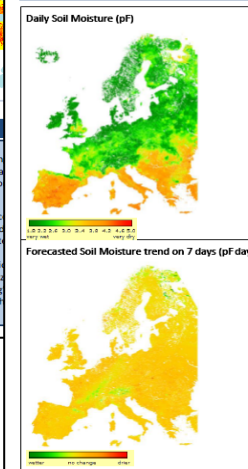
Following this idea, a method that combines precipitation reduction and FAPAR anomalies is proposed drought but also areas with the potential for agricultural drought.

The method consists in a classification to the different stages of the idealized drought, named as "Watch", "Warning", "Recovery", identify the stages of the

PRODUCT FACT SHEET: ACROTIME – EUROPE Version 1 (Sept. 2011)

SOIL MOISTURE:
Daily, Anomaly and Forecasted values

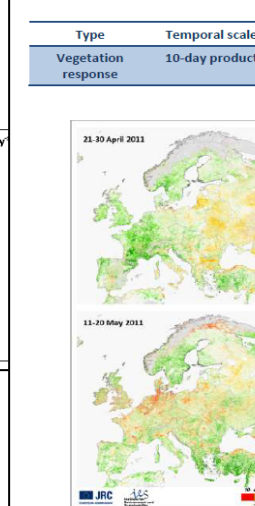
Type	Temporal scale	Spatial scale	Geo. coverage
Soil moisture	Daily	5 km	Europe



PRODUCT FACT SHEET: FAPAR Anomaly – EUROPE Version 3 (Sept. 2013)

FAPAR anomaly: Anomaly of Fraction of Absorbed Photosynthetically Active Radiation

Type	Temporal scale
Vegetation response	10-day product



PRODUCT FACT SHEET: SPI – EUROPE

SPI: Standardized Precipitation

Type	Temporal scale	Spatial scale
Precipitation	Monthly (for a range of accumulation periods)	Data derived from

Key message

....

Relevance of the Product to drought monitoring

....

Technical Information

1. Product

- Data sources:
- Geographic coverage:
- Spatial scale:
- Temporal scale:
- Frequency of data collection:

2. Methodology

a. Detailed Methodology for the Calculation of the Indicator

....

b. Reference Period for Calculating the Statistics

....

Quality Information

1. Strength & weaknesses

[+]

[-]

2. Performance of the indicator

....

References



Partially:

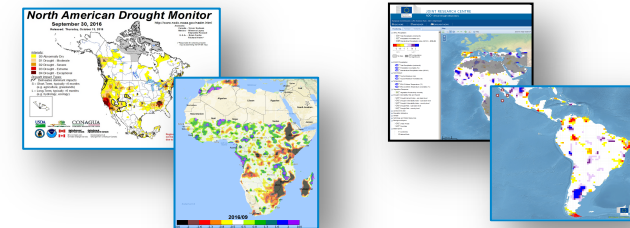
- Positive feedback from EC services, from national and regional organizations, and from industries
- Drought reports are heavily downloaded (> 1000) when issued
- In 2016 (January to October) the European system yielded 56,000 page views from 11,000 users

However:

- More sector specific combined indicators needed
- New network to be established
 - Yearly user & expert meetings (follow-up of the WS&D Expert Group)
 - More links to national, regional, “local” observatories to be established
 - Enlarge the set of standardized indicators
- Add “static” maps on drought hazard and risk (current & future)
- Add or link DBs on drought events and on drought impacts

→ **Goal is a comprehensive one-stop entry point for Europe and neighbouring countries**

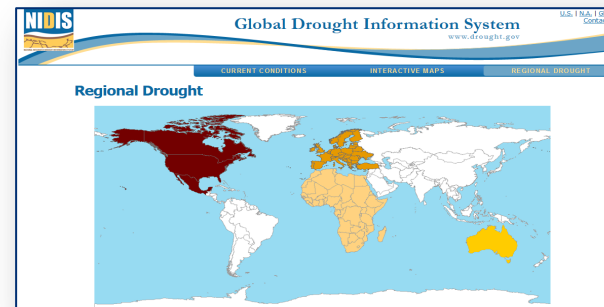
- Currently no comprehensive global system for drought monitoring and early warning
- Different systems provide individual indicators (e.g., SPEI Monitor, GPCC drought indicator)
- Several continental systems are existing, for example:
 - North American Drought Monitor
 - African Flood and Drought Monitor (Princeton)
 - African Drought Observatory (JRC)
 - South and Central American Drought Observatory (JRC)



• Global Drought Information System (GDIS):

Links

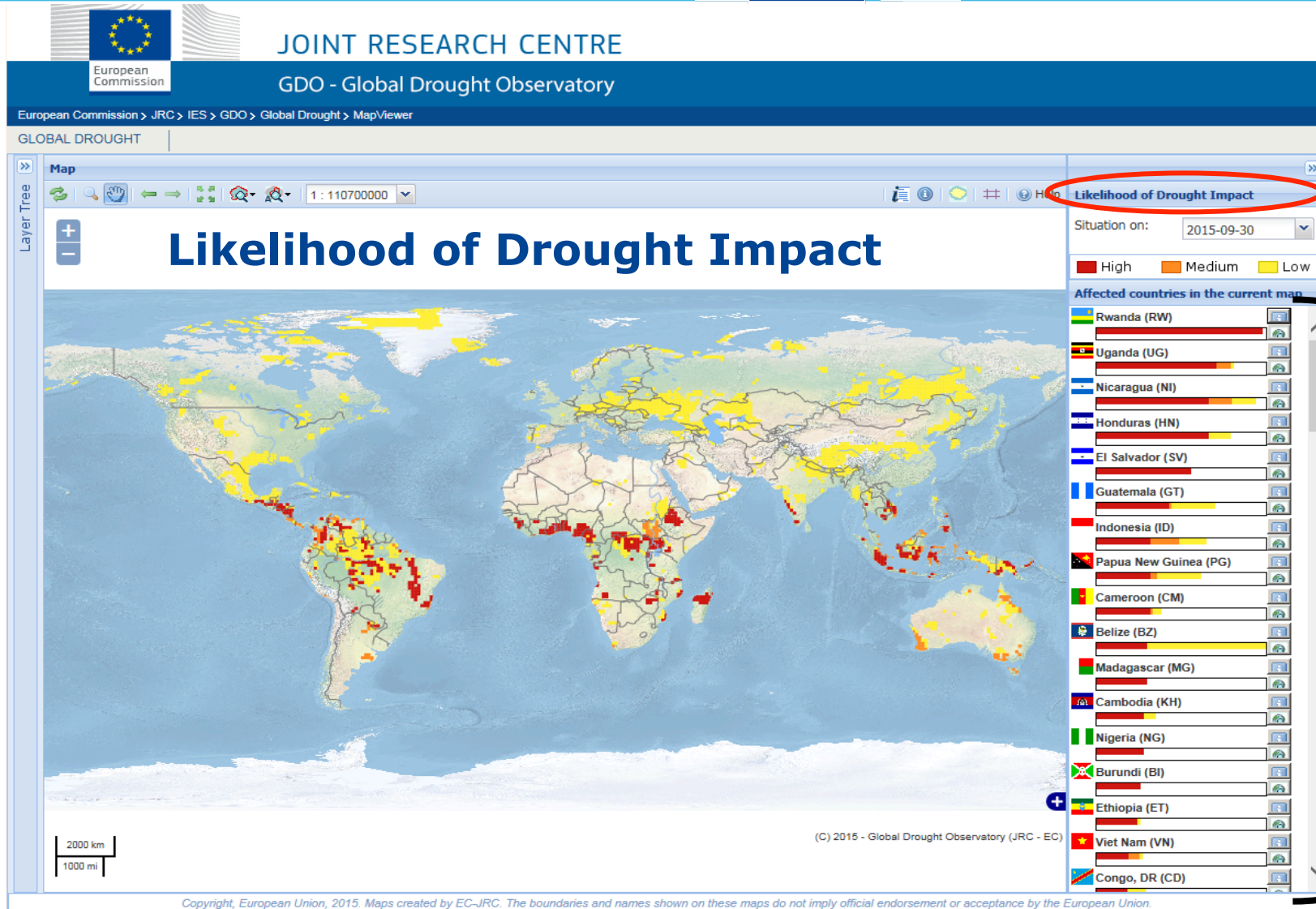
- the North American Drought Monitor
- The European Drought Observatory
- The African Flood and Drought Monitor
- The Australian Bureau of Meteorology



<https://www.drought.gov/gdm/>

→ **No system answers to specific requirements of DG ECHO (ERCC and humanitarian aid) in need of information of sectorial drought impacts**

Global Drought Observatory (GDO)



← Select a date

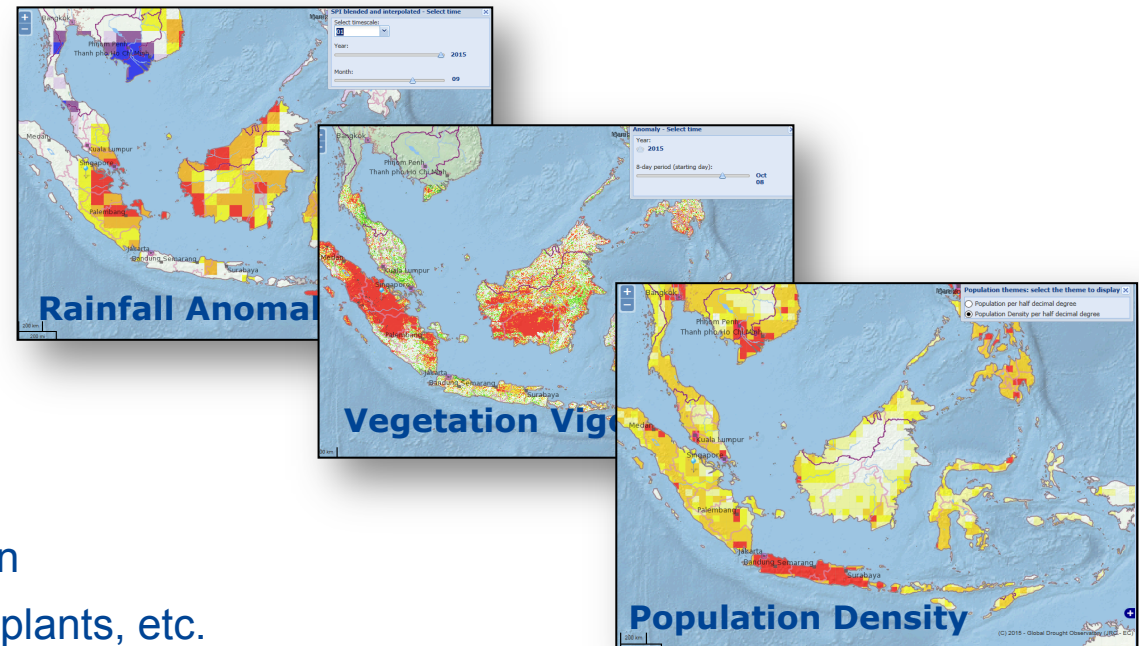
Hierarchical
list of affected
countries
(visible on the
map)

What is behind the Likelihood of Impact?



(A) Drought Severity

- Rainfall Anomalies
- Vegetation Vigor
- Temperatures
- Soil Moisture Anomalies
- Low Flows

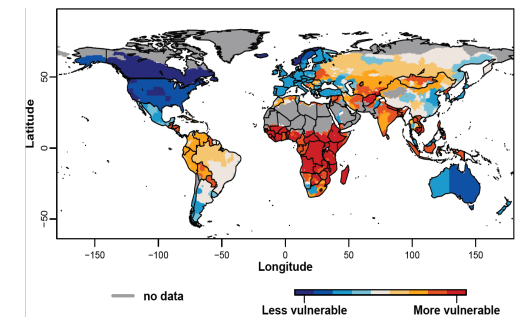


(B) Exposure

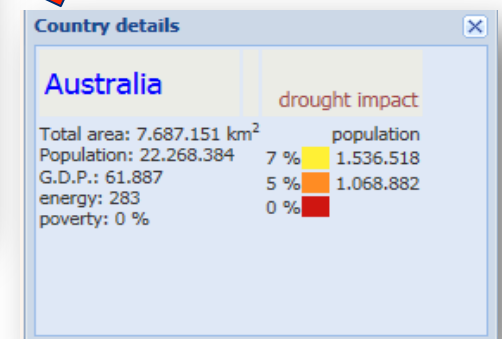
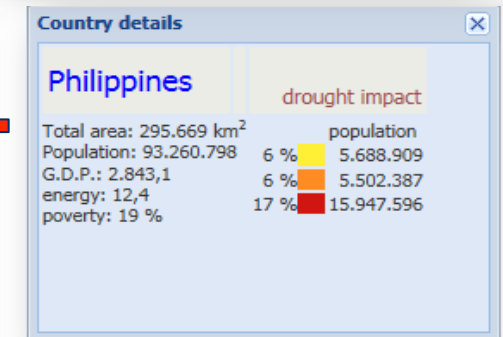
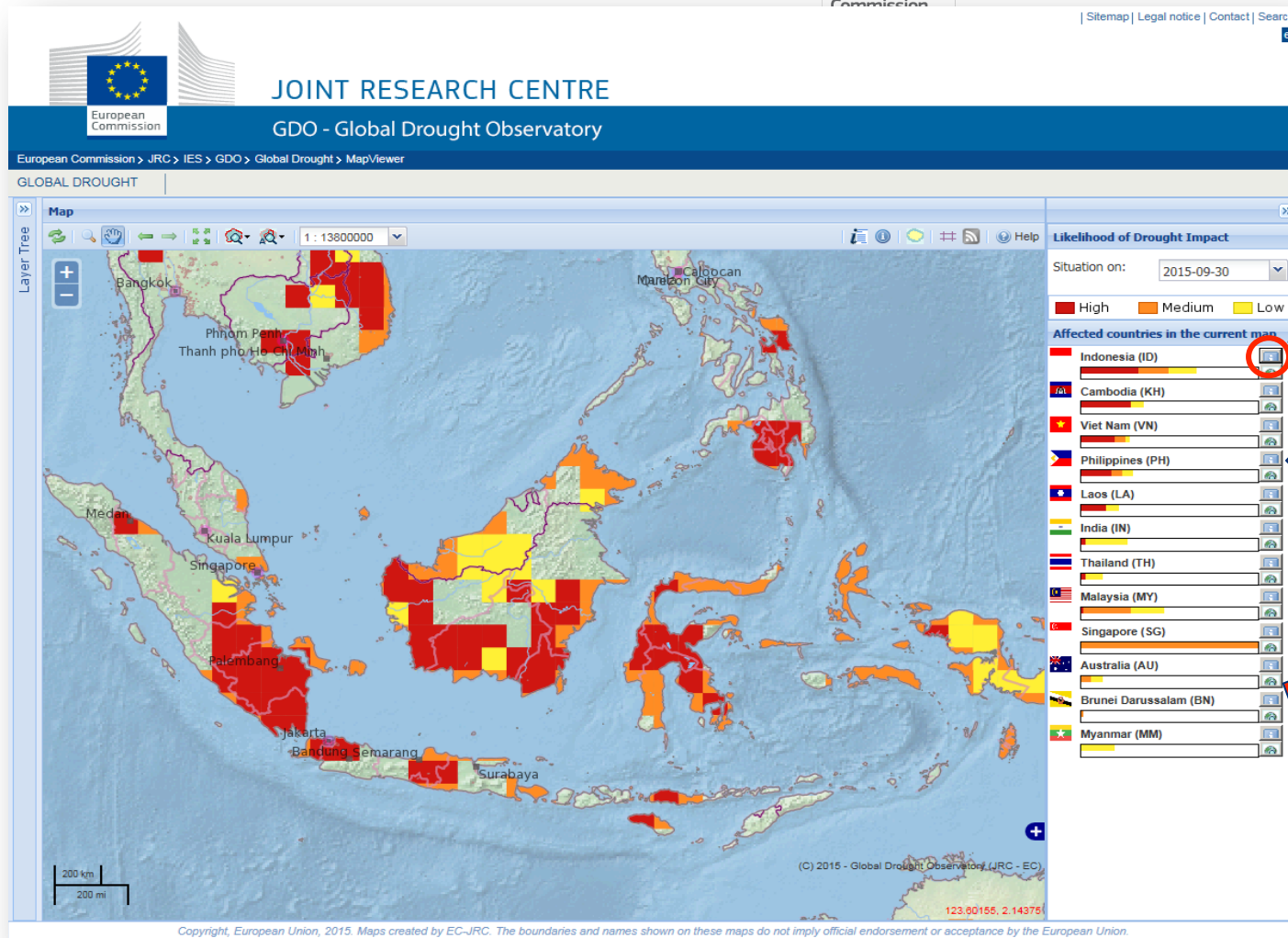
- Population density & Distribution
- Waterways, Reservoirs, Power plants, etc.

(C) Societal Vulnerability

- Social Indicators (Age, Poverty, Infant Mortality, etc.)
- Economic Indicators (GDP, Energy Consumption, etc.)
- Infrastructural Indicators (Irrigation, Road Density, etc.)

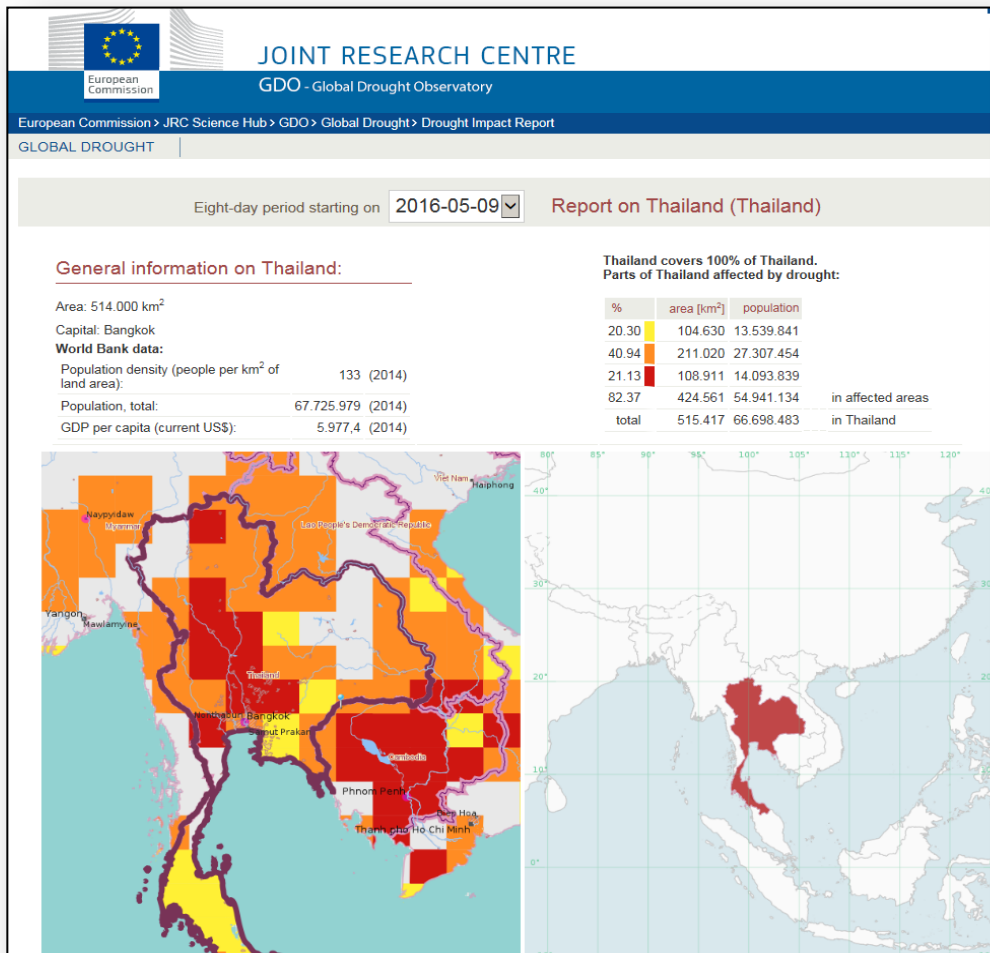


Country Summary

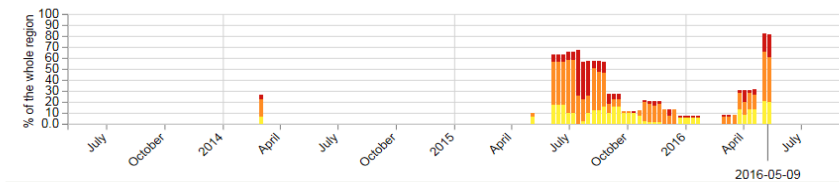


Report Generation

European
Commission



Likelihood of Drought Impact: development

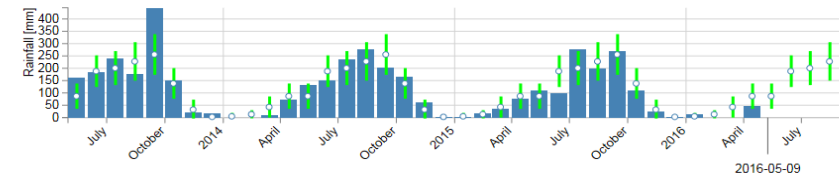


Precipitation situation in the last three years

(data refer to selected location [lon: 103.1, lat: 14.4], about 47 km from Nangrong)

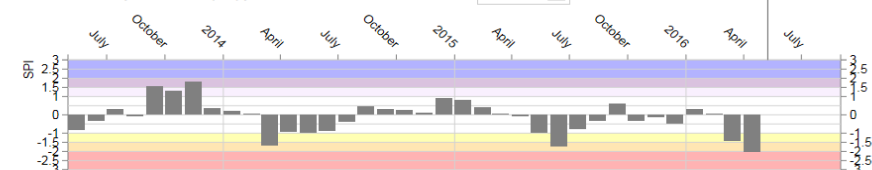
Total Rainfall per month in mm

Monthly cumulated rainfall Standard deviation of the monthly cumulated rainfall (1981-2010) Climatology mean of the monthly cumulated rainfall (1981-2010)



Standardized Precipitation Index (SPI) per cumulative number of months

3 month



Climate

(in affected area)

Af - Tropical/Rainforest	1.8 %
Am - Tropical/Monsoon	13.0 % 2.8 %
Aw - Tropical/Savannah	9.1 % 45.4 % 24.8 %

FAO land classifications in affected areas

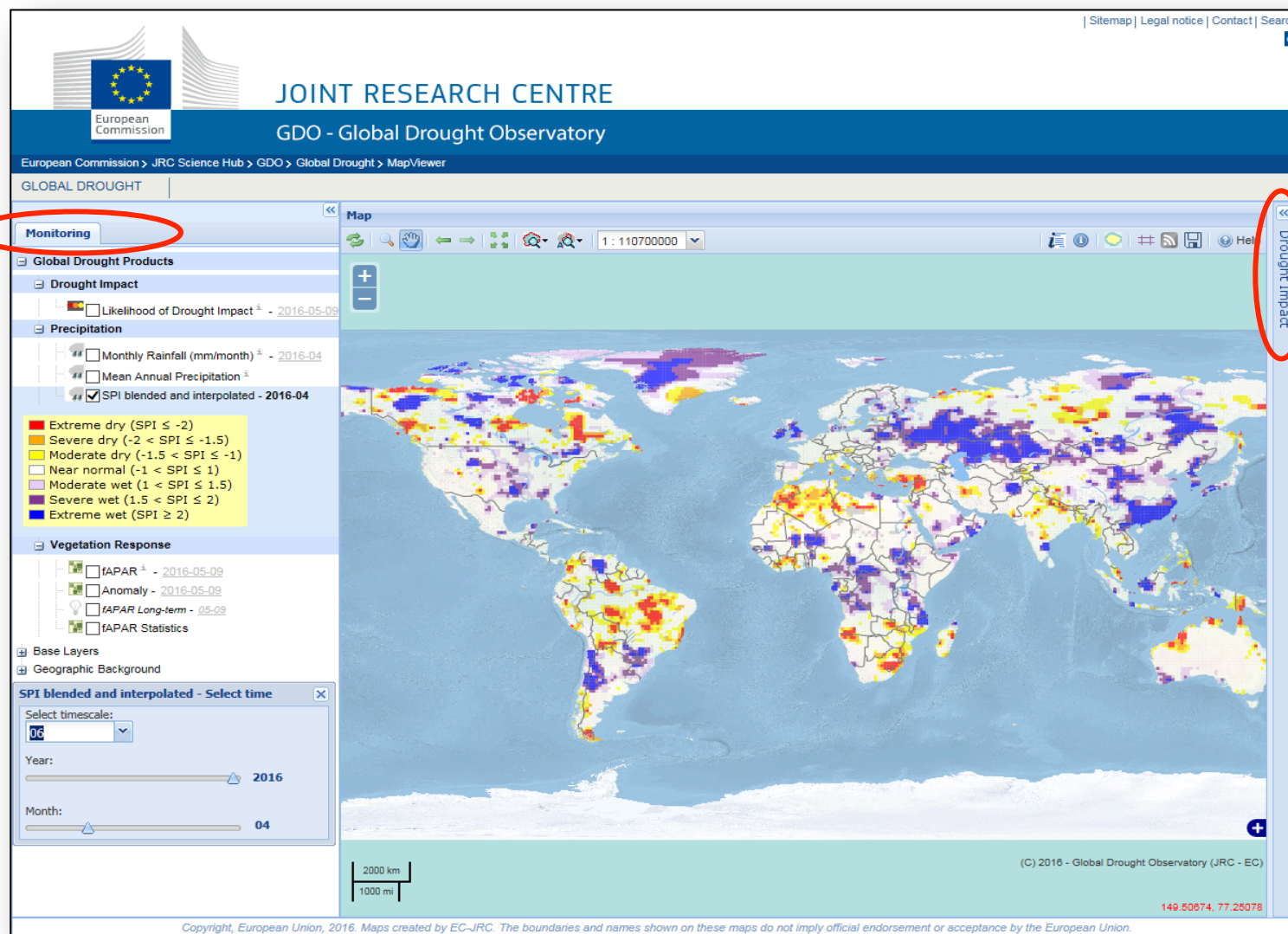
+ selectable pie charts on land cover types and other surface characteristics in the affected areas

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Detailed Indicator Information



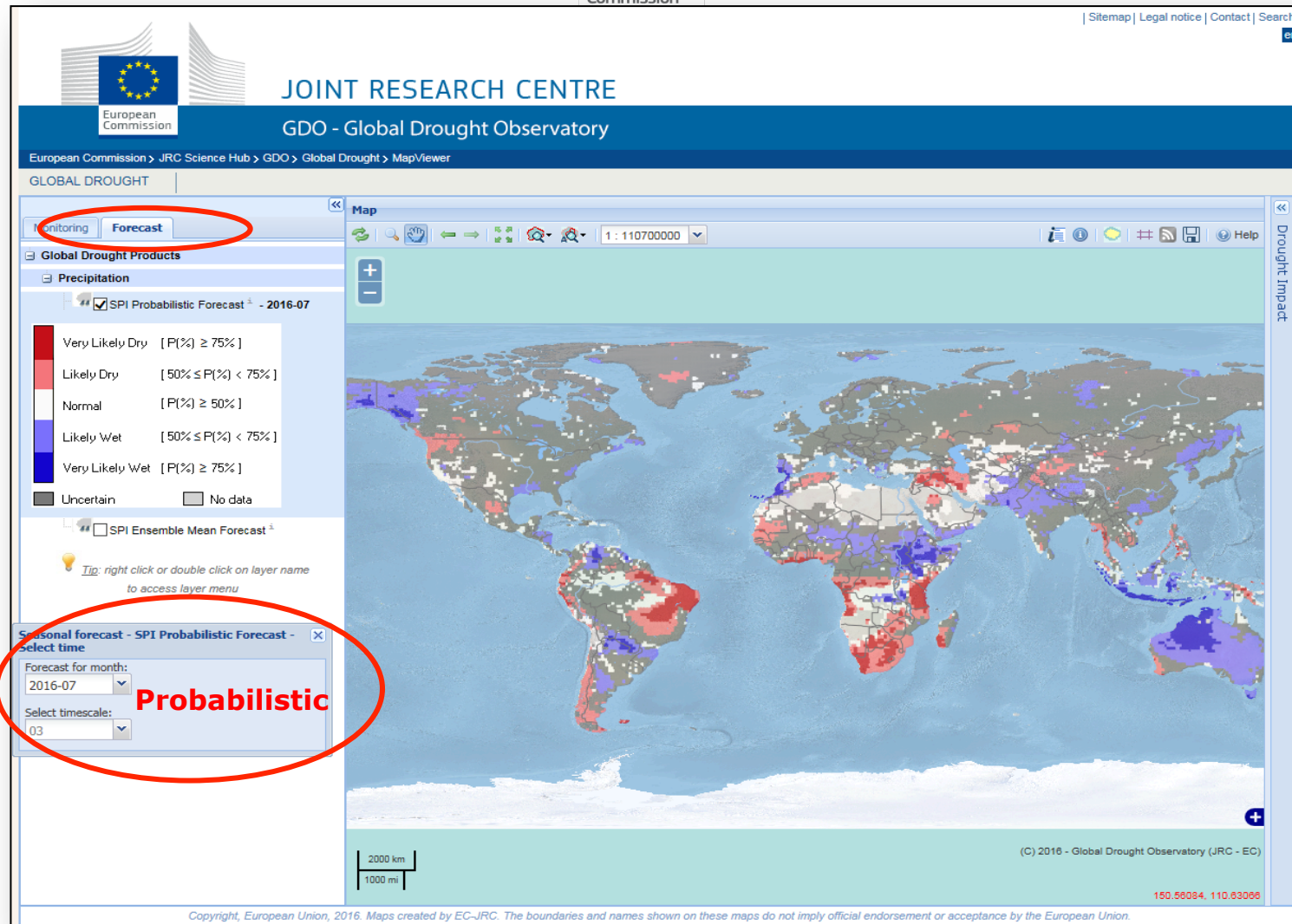
Layer
tree
menu
open



Impact
menu
hidden

Forecast
menu open

SPI-3
forecast for
July 2016





Partially:

- Positive feedback from EC customer
- Proved to provide useful information during the 2015-16 El Niño event
- Supported the production of ad-hoc analytical reports

However:

- More sector specific impact indicators needed
- Set of drought indicators to be completed (e.g., soil moisture, low-flows, ...)
- Forecasting and seasonal prediction to be tested and implemented
- Maps on drought hazard and risk (current & future) still missing
- DBs on drought events and on drought impacts to be linked (?)

→ arrive at a global monitoring and forecasting of drought events and their likely impacts



- Complete set of standardized indicators (harmonization of methods)
- Combined indicators (alert levels) for different sectors
- Vulnerability & risk assessments for different sectors
- Up-to-date data for the calculation of exposure and vulnerability (uneven quality and coverage of socio-economic indicators)
- Standardized data on drought events and drought impacts
- Improved forecasting and prediction
- Better links between continental, national, regional, local observatories
- Regular meetings of user & expert networks



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

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

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