Elinkeino-, liikenne- ja ympäristökeskus
Närings-, trafik- och miljöcentralen
Centre for Economic Development, Transport and the Environment

Utilization of EC CryoLand data for European drought monitoring

January 9th 2013

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- EU Drought Indicators
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- European Drought Observatory, EDO
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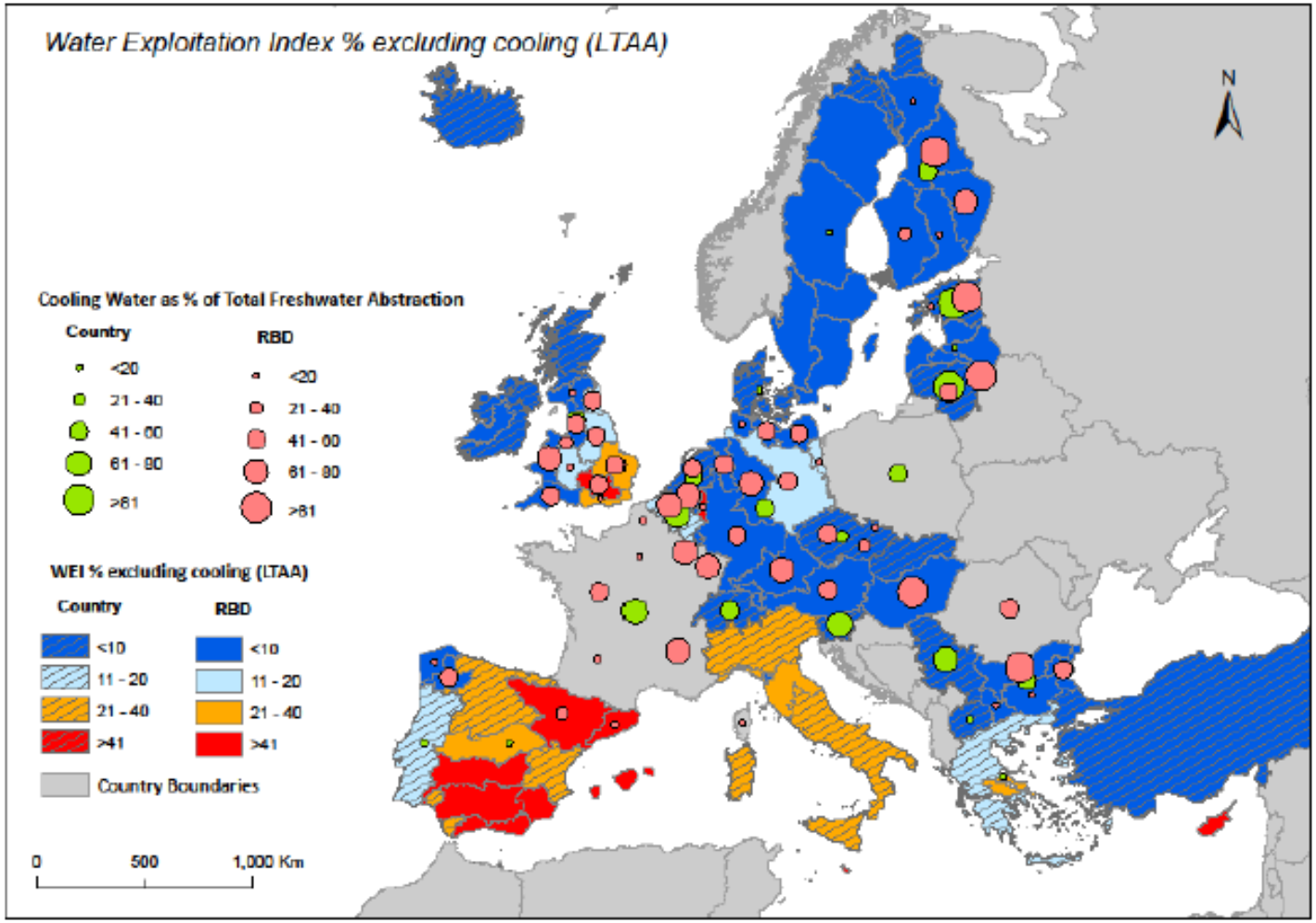
Water Scarcity and Drought in EU



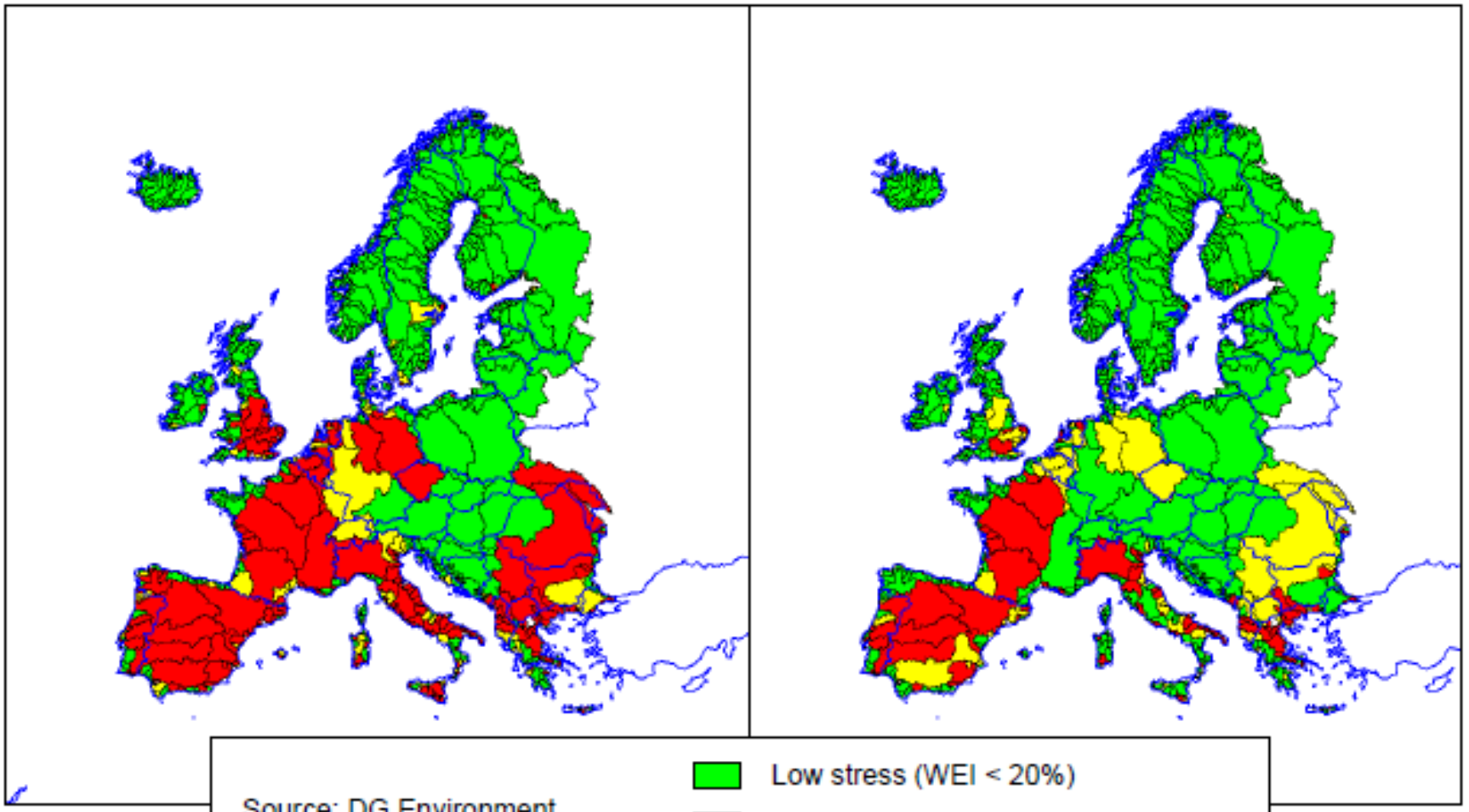
Source: European Environment Agency 2012

Scenarios for water stress 2050

Water Exploitation Index for the summer season and excluding water withdrawals for cooling power plants.

FP6 SCENES Scenario «Economy First» 2050

FP6 SCENES Scenario «Sustainability Eventually» 2050



What is the EU doing ?

- EC Communication (2007) to the European Parliament and the Council:

  Addressing the challenge of water scarcity and droughts in the European Union
  - Need to improve drought risk management among other issues
- Expert Group on Water Scarcity and Droughts (EG WS&D) to develop
  - Common indicators for water scarcity and droughts
  - Risk maps
  - Early warning systems

EU Drought Indicators

- Purpose of the indicators:
  - To give a common and comparable situation analysis about WS&D issues across EU
  - To raise awareness of the policy makers and the public about the WS&D issues
  - To establish mechanisms to detect WS&D situations as a starting point for the implementation of actions in the framework of Drought Risk Management Plans

- Following drought indicators agreed by EG WS&D
  - Standardized Precipitation Index, SPI
  - Standardized Runoff Index, SRI
  - Fraction of Absorbed Photosynthetically Active Solar Radiation, FAPAR
  - Groungwater Indicator, GW
  - Soil Moisture Indicator (to be agreed)
  - Standardized SnowPack Index, SSPI

Standardized SnowPack Index, SSPI

- Essential part of water cycle in the northern parts of Europe and in the mountains
  - Snowmelt is important part of runoff and ground water recharge during spring
  - E.g. several large Central Europe rivers' flow partly depends on the melting snowpack of the Alps
  - Lack on snowmelt can increase possibilities for drought during the spring and early summer

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ESA GlobSnow

• ESA-GlobSnow project: Production of novel hemispherical snow extent (SE) and snow water equivalent (SWE) climate data records.

• **Generation of long time-series employing FMI supercomputing facilities at Helsinki** (daily, weekly and monthly maps of SE and SWE for northern hemisphere) **+ NRT processing**

• Consortium members: Finnish Meteorological Institute (FMI) with ENVEO IT GmbH (Austria), GAMMA Remote Sensing (Switzerland), Norwegian Computing Center, Finnish Environment Institute (SYKE), and Environment Canada (EC). + Univ. Bern, MeteoSwiss, ZAMG & Norut

• GlobSnow-1 completed: 10/2008 – 10/2011 (36 months)
• GlobSnow-2 on-going: 05/2012 – 05/2014 (24 months)

• Details and products available at **www.globsnow.info**

esa enveo GAMMA REMOTE SENSING NR Norsk Regnesentral SYKE Environment Canada Environnement Canada

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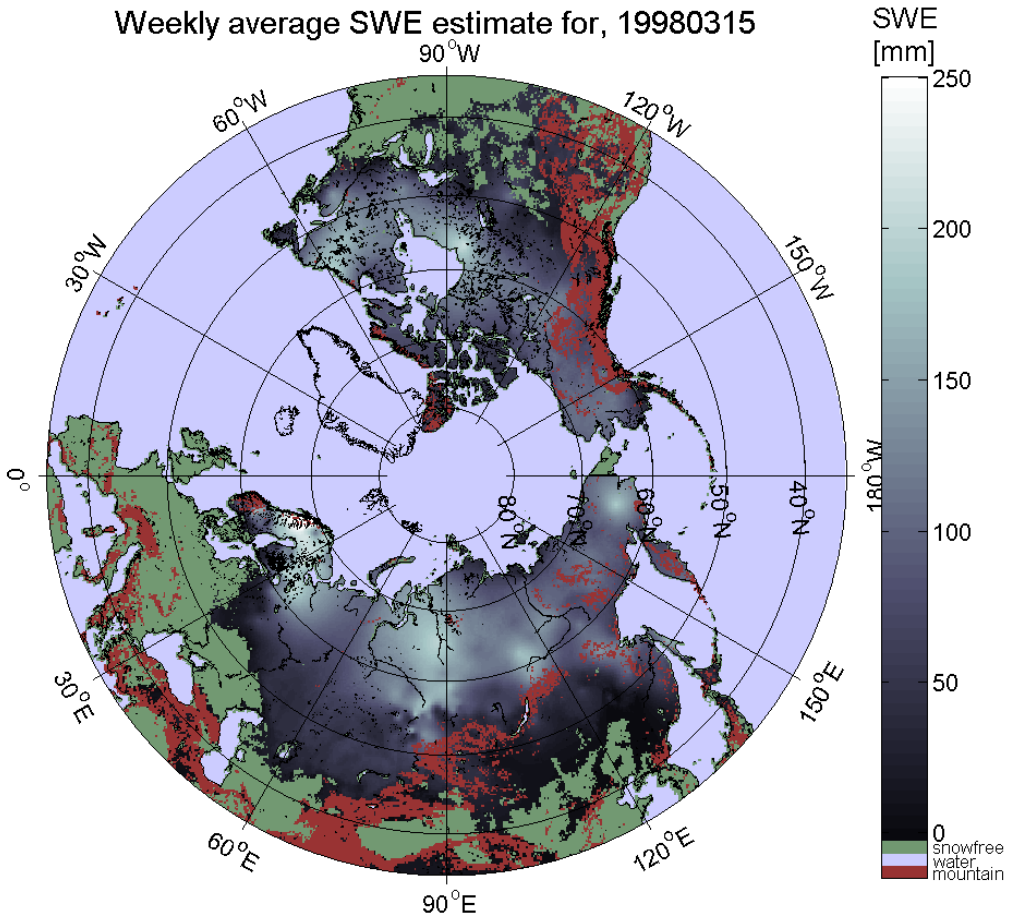
30 year-long CDR time-series on snow conditions of Northern Hemisphere (ESA-GlobSnow SWE)

- First time reliable daily spatial information on SWE (snow cover):
  - SWE for the permanent seasonal snow area (25 km spatial resolution)
  - Snow Extent and melt (+grain size)
  - Time-series for 1979-2012
- Passive microwave radiometer data combined with ground-based synoptic snow observations
  - Variational data-assimilation
- Available at open data archive (www.globsnow.info) (+ FTP)
- Demonstration of NRT processing started on October 2010
- Greenland & glaciers masked out
- Accuracy for mountains is limited



Takala, M., Luojus, K., Pulliainen, J., Derksen, C., Lemmetyinen, J., Kärnä, J.-P, Koskinen, J., Bojkov, B., "Estimating northern hemisphere snow water equivalent for climate research through assimilation of spaceborne radiometer data and ground-based measurements", Remote Sensing of Environment, Vol. 115, Issue 12, 15 December 2011, doi: 10.1016/j.rse.2011.08.014

From SWE data to SSPI…

- SSPI developed in EC CryoLand project in FMI
- The SSPI is defined as the unit standard normal deviate associated with the percentile of snowpack accumulated over a specific duration
  - Normalized values between -2 and below to 2 and above
  - ten-day and monthly moving averages of GlobSnow SWE product used
- Why normalization?
  - Normalized values are easier to enterprete among public and DM's
  - Using anomalies instead of absolute values gets rid of the data accuracy problem in the mountains
    - the data underestimates high snowpack values in the mountains but it still has consistent behaviour
  - SPI, FAPAR, SRI, Soil moisture indicators use the same methodology
    - makes comparison and compilation of the indicators easier

Standardized Snow Pack Index (SSPI) Retrieval Algorithm

$SSPI_{y,m}$ is the Standardized Snow Pack Index for a given year y and month m:

$$SSPI_{y,m} = \frac{SWE_{y,m} - SWE_{avg,m}}{SWE_{std,m}} \quad (1)$$

where $SWE_{y,m}$ is the SWE for year y and month m, and $SWE_{avg,m}$ is the average SWE for month m based on years 1979-2010:

$$SWE_{avg,m} = \frac{1}{n}\sum_{i=1979}^{n=32} SWE_{i,m} \quad (2)$$

and $SWE_{std,m}$ is the standard deviation of SWE for month m based on years 1979-2010:

$$SWE_{std,m} = \sqrt{\frac{1}{n-1}\sum_{i=1979}^{n=32} (SWE_{i,m} - SWE_{avg,m})^2} \quad (3)$$

SSPI gategories

SSPI Values	Category	Cumulative Probability	Probability of Event [%]
SSPI ≥ 2.00	Highly more than normal	0.977 – 1.000	2.3%
1.50 < SSPI ≤ 2.00	Much more than normal	0.933 – 0.977	4.4%
1.00 < SSPI ≤ 1.50	More than normal	0.841 – 0.933	9.2%
-1.00 < SSPI ≤ 1.00	Near normal	0.159 – 0.841	68.2%
-1.50 < SSPI ≤ -1.00	Less than normal	0.067 – 0.159	9.2%
-2.00 < SSPI ≤ -1.50	Much less than normal	0.023 – 0.067	4.4%
SSPI < -2.00	Highly less than normal	0.000 – 0.023	2.3%

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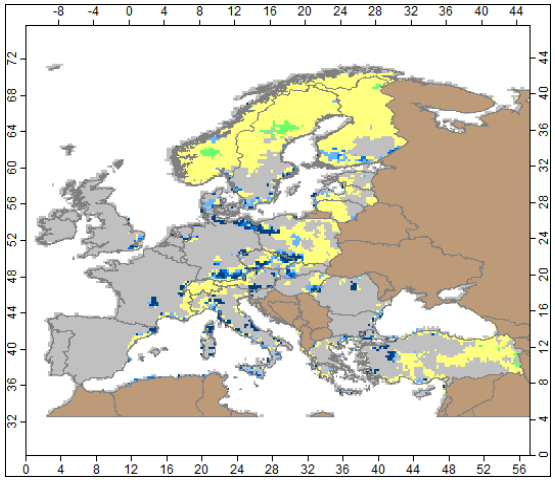
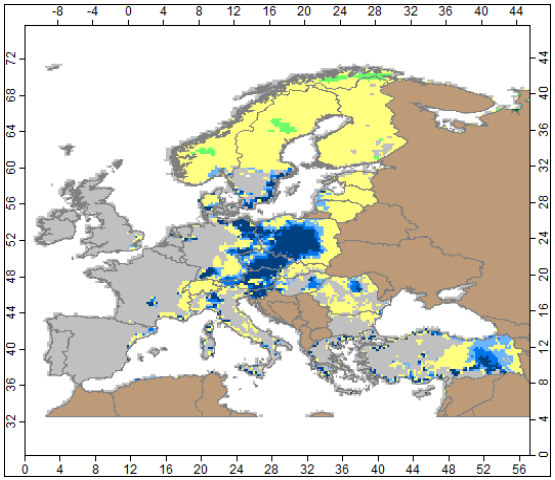
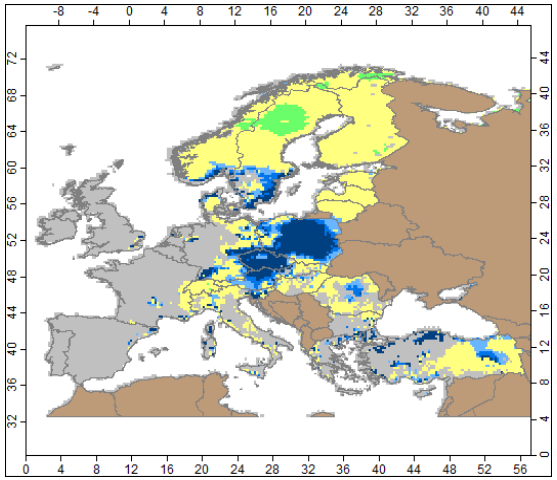
Monthly Average SSPI Winter 2005 - 2006



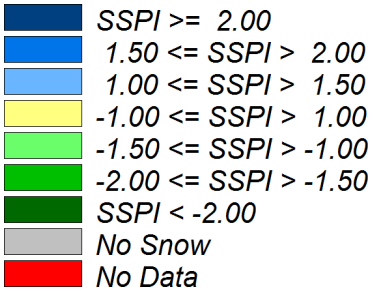
December 2005

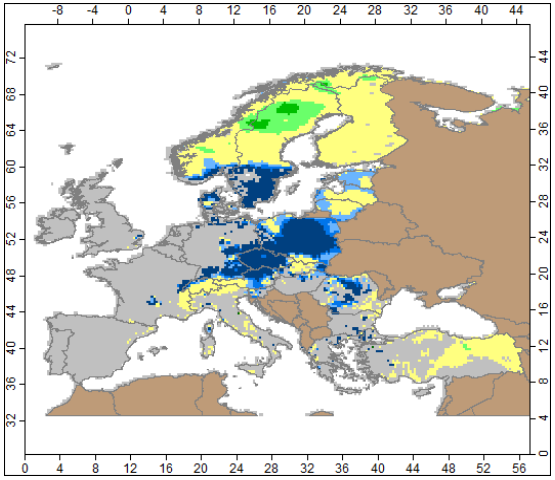


January 2006

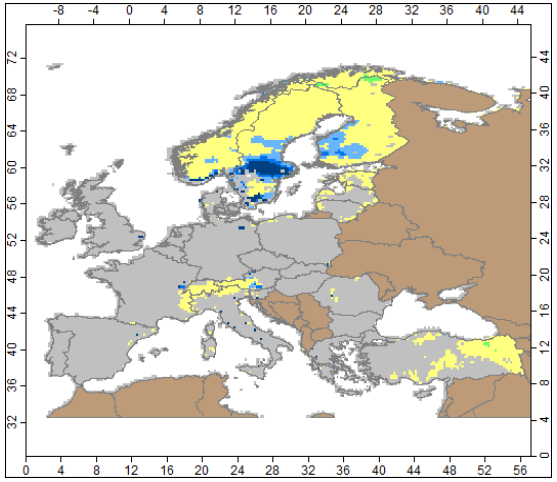


February 2006





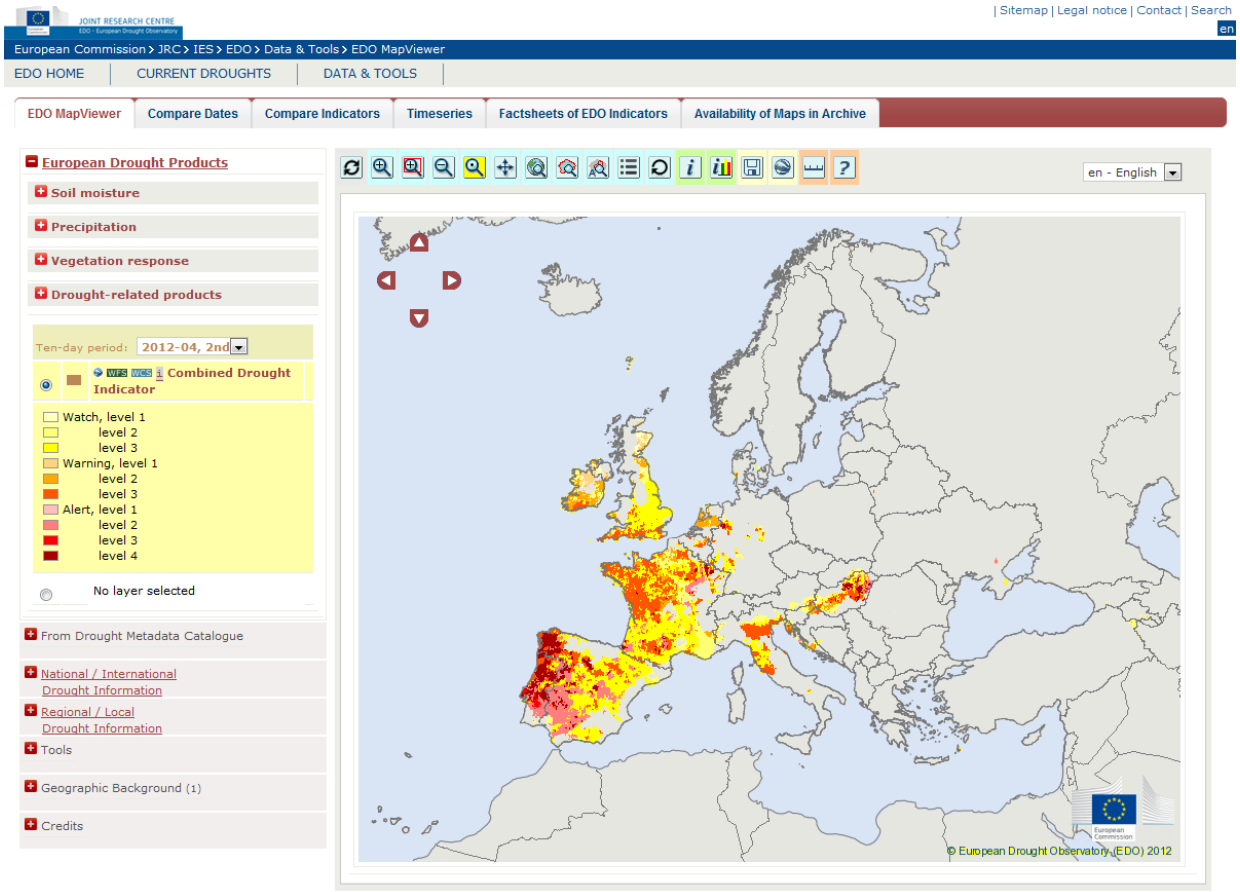
March 2006



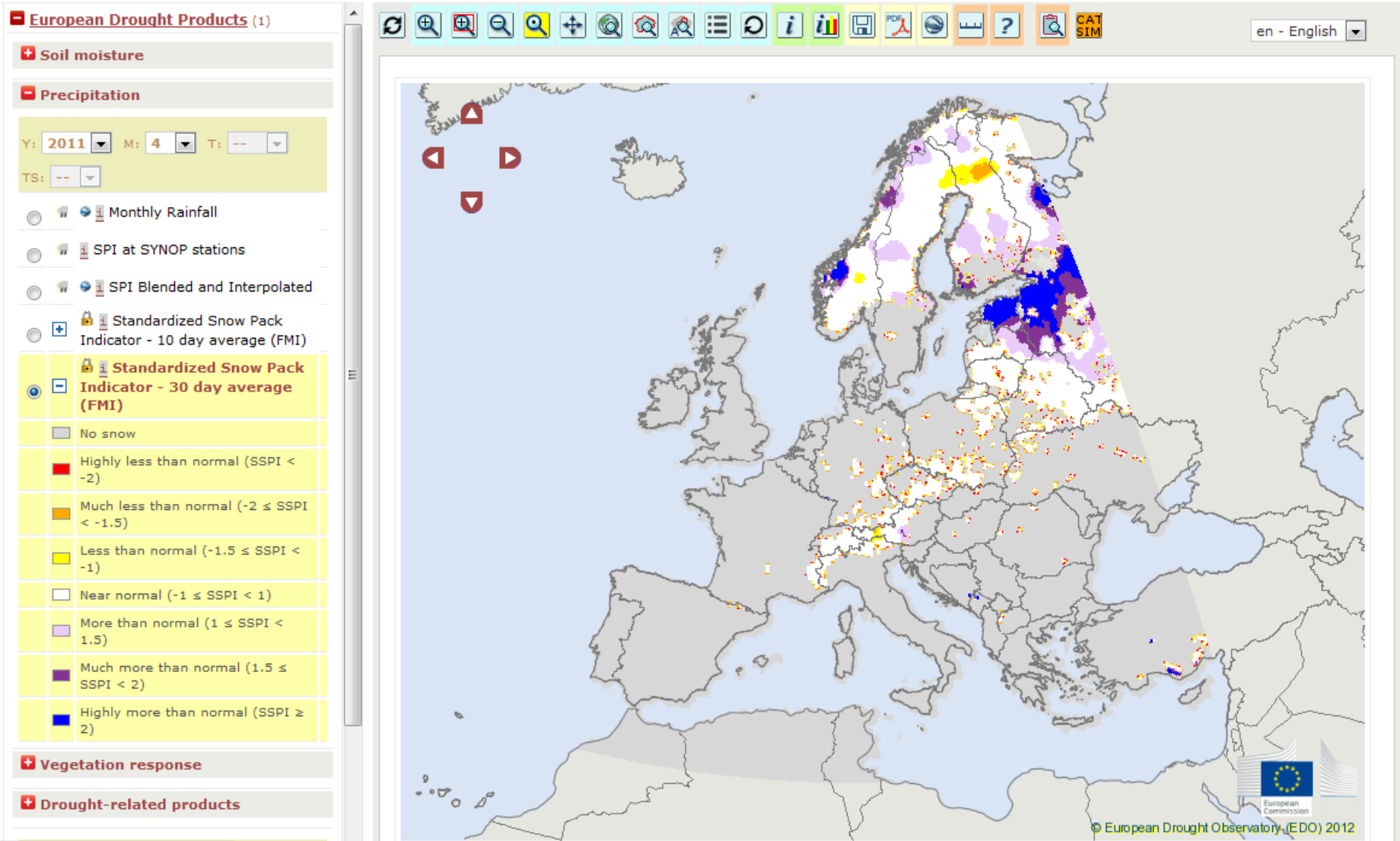
April 2006

European Drought Observatory, EDO

- Established under EU Joint Research Center (JRC)
  - Drought monitoring using indicators and media
  - Drought news and reports
  - Map viewer
- SPI, FAPAR, Soil Moisture presented with one month delay
  - → Combined Drought Indicator
- SSPI to be presented in February 2013
  - Near real time indicator (one day delay)



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



Experiences of using EC CryoLand data in EU context

- Problems with most EU wide environmental data sets
  - Coverage
  - Comparability/methods
  - Consistency
  - Compilation
- The used SWE data is highly useful for several reasons
  - Daily values and long consistent time series (since 1979)
  - Consistent data covering the whole Europe
  - Near real time from observations to end user (one day delay)
- This is so far the only data that enables real-time consistent drought monitoring throughout the Europe
  - Enables also developing of early warning systems
  - Also relevant to flood risk management