# Potential cooperation on drought early warning

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# Few questions of Drought Forecasting System

1. Necessity, importance

- impact across a number of sectors, and the impact of drought can not be understood without
- usually measurable damage

2. Two basic modules:

- drought monitoring system (observed precipitation, ET, soil moisture etc.)
- drought early warning system (this integrated + model)

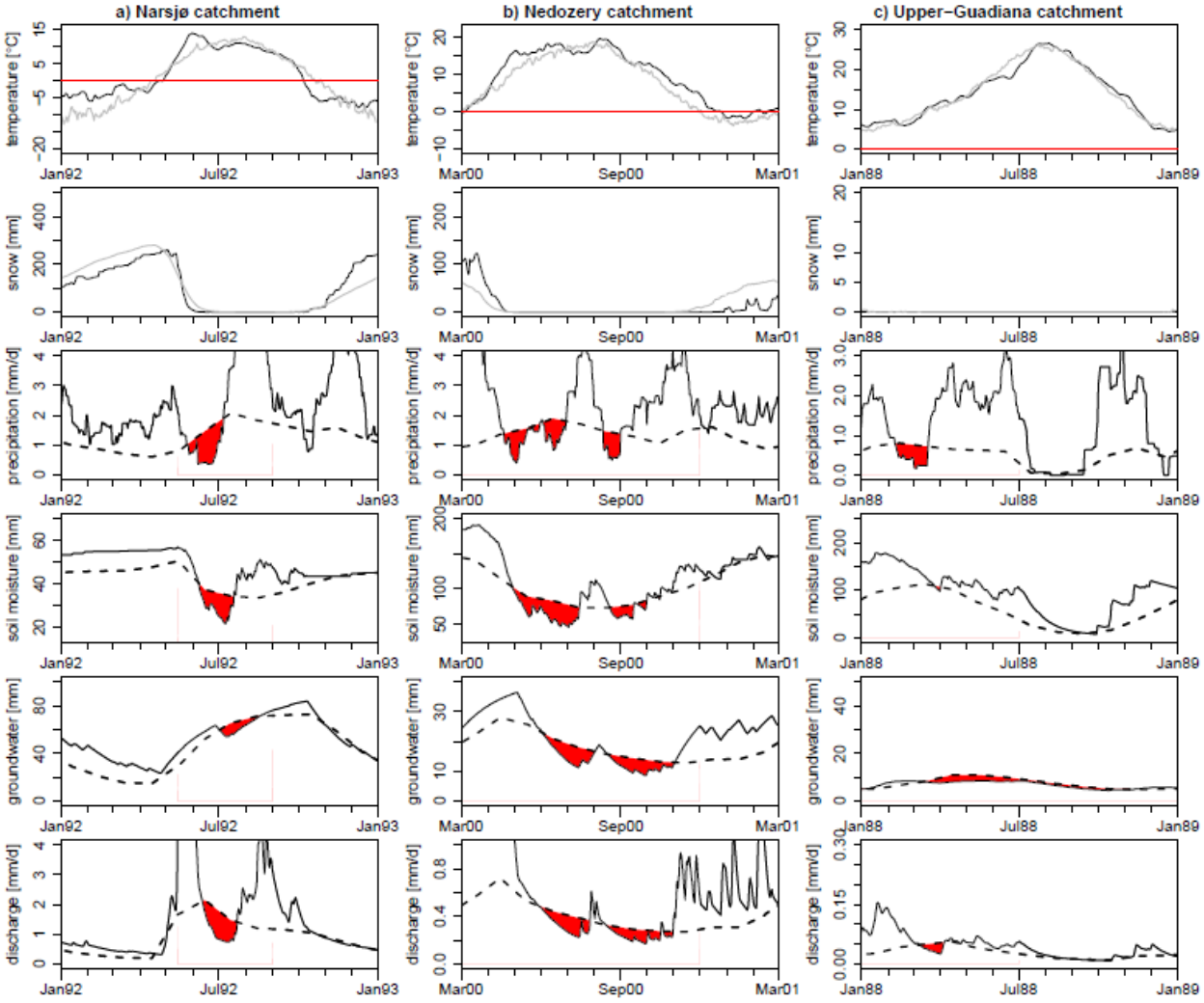
# General questions

- meteorological drought > humidity of soil > hydrological drought
- Today: to find the most adequate index, but more than 40-50 indexes – Niemeyer 2008
- Drought is a complex process, one index is not enough, regionally more would be important
- New technology – eg. Wardlow 2012 RS
- A distinction should be between droughts, there is no general pattern, eg what is the hydrological drought

# Types of the hydrological droughts

- **rain-to-snow-season drought** – rainfall deficit in rainy season, which continues in the winter as well. The soil moisture and groundwater level is not reset at the beginning of the rainy period. Recession start from deeper level
- **wet-to-dry-season drought** is caused by a rainfall deficit (meteorological drought) in the wet season that continues into the dry season. The meteorological drought ends with precipitation, which, however, is completely lost to evapotranspiration because potential evaporation in this season is higher than precipitation. Consequently, soil moisture and groundwater stores are not replenished by recharge in the wet season
- cold snow season drought, warm snow ~ ~, composite ~

# Classical rainfall deficit drought




Anytime appear - can be any length

# Forecasting model1

- TRADITIONALLY - drought planning system – for agrarian aims - short term, for hydrological aims – long term forecasting
- Everyone prove that his method niche and may use - replacement (eg GDEWS - Pozzi, 2013). Arch/link over national/regional EWS
- Exist international, regional solution there are not enough? (national level would be important from agrar point of view)

Pozzi et al. 2013

# Spatial and temporal differentiation

# Time scale of drought

Droughts span an enormous range of time scales, from short-term "flash droughts" that can have major agricultural impacts to multi-year or even decadal droughts (1930s, 1950s, *etc.*).


**Heat Waves**
**Floods**
**Storm Track Variations**
**Madden-Julian Oscillation**

**El Niño-Southern Oscillation**

**Decadal Variability**
**Solar Variability**
**Deep Ocean Circulation**
**Greenhouse Gases**

www.drought.gov

# Forecasting model2a

- number of early warning system
  - mostly integrate meteorological data, RS vegetation condition, crop productivity, prices of crops
  - for international, regional, national stakeholders (Smucker 2012)
- background: International effort from 1994 UNCCD (United Nations Convention to Combat Desertification) and Rio+20
- EU Drought Policy (Field of water policy 2000), Drought strategy for Hungary 2012, Report for Serbia 2013

# Forecasting model2b

Short and long term forecasting:

- Short horizon -> early warning system,
- Long -> prognosis

**Portugal** - (meteorological) T and P values, averaged SPI and PSDI, free data, but evaluated 4 times along the hydrological year, rives basins and soil water content (Instituto Superior de Agronomia, Portugal ISA, 2013)

**Italy** - (aim hydrological) DEWS-Po: (i) river levels and discharges (rating curves are available), (ii) water storage levels in reservoirs, and (iii) water uses. Daily T, P data. The drought system based on SPI, Standard Runoff Index (SRI), Length of the dry period (without rainfall) indexes (Universita Commerciale 'Luigi Bocconi' Italy - UB-CERTeT 2013)

**Netherland** - (hydrological) – not real drought, is rellect the low-water situation in the Rhine or Meuse rivers. Daily data from Water Management Centre (Alterra)

**Greece** - the drought system is not operating. SPI and RDI konown, but only some test area applied - Tigkas (2008),Vassiliadis (2010)

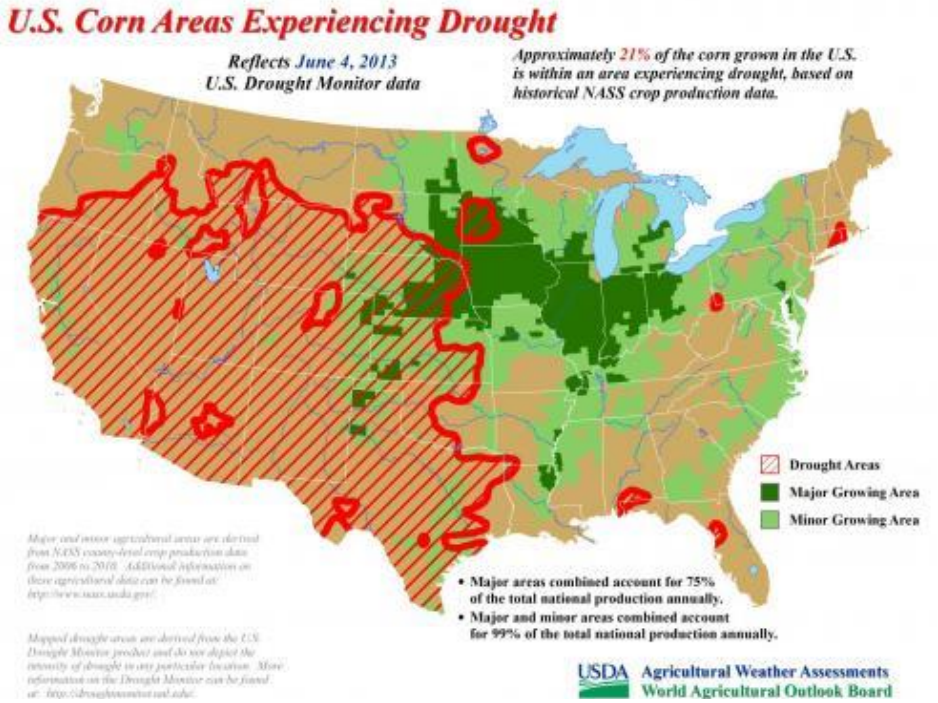
**Spain** –(hydrological) – real warning system based on state index. Small river basin, indicators based on: (a) Rainfall, (b) Runoff, (c) Storage and (d) Piezometry.

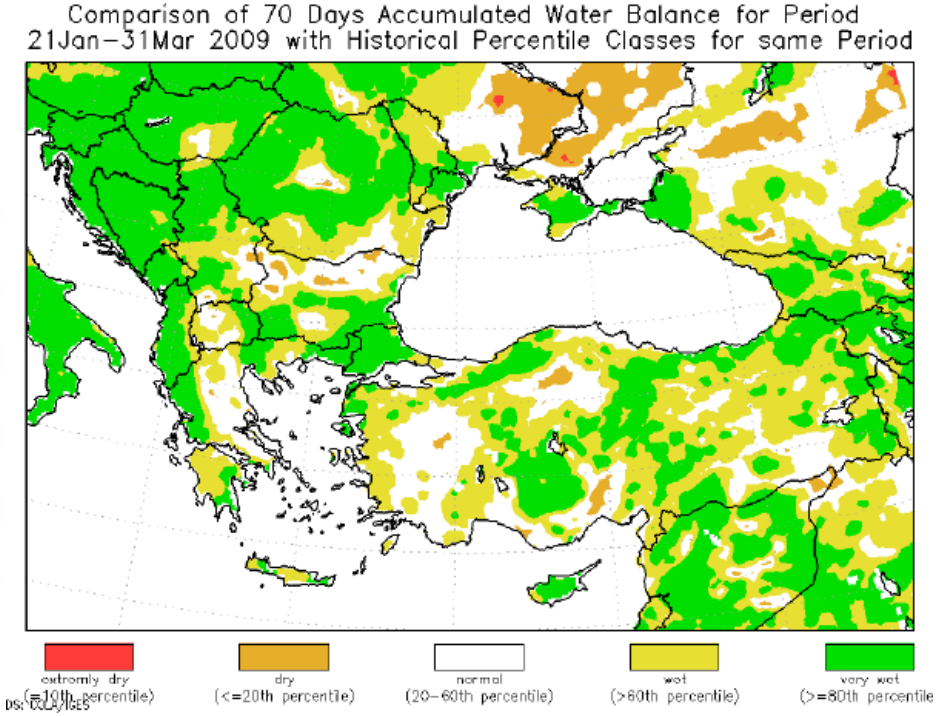
# Forecasting model2c

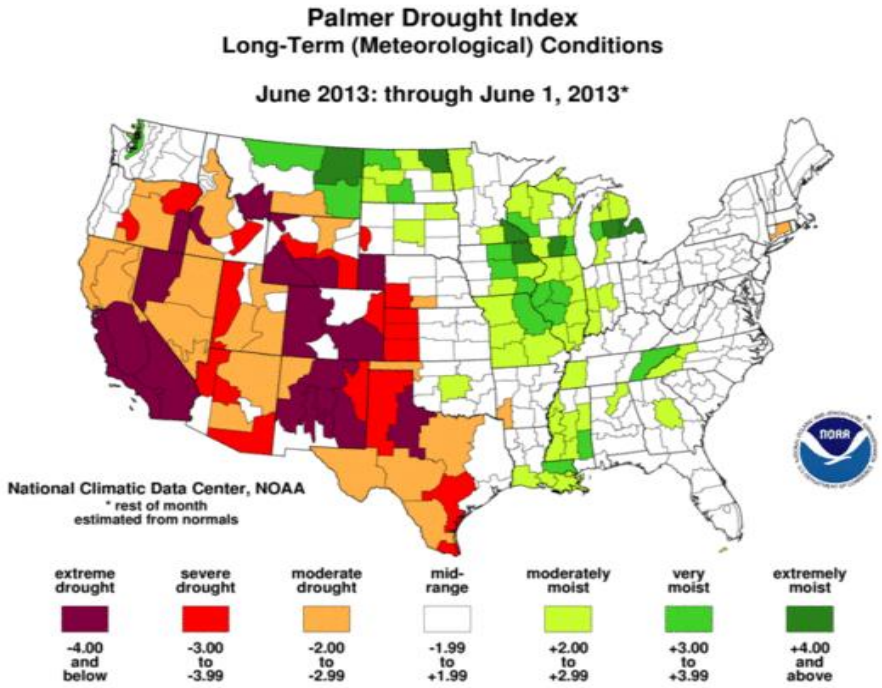
USA – short-term – 1-2 weeks, long-term seasonal forecasting based on Palmer index - www.drought.gov – forecasting for two weeks/seasonal (soil moisture, temperature, Palmer Index, precipitation)

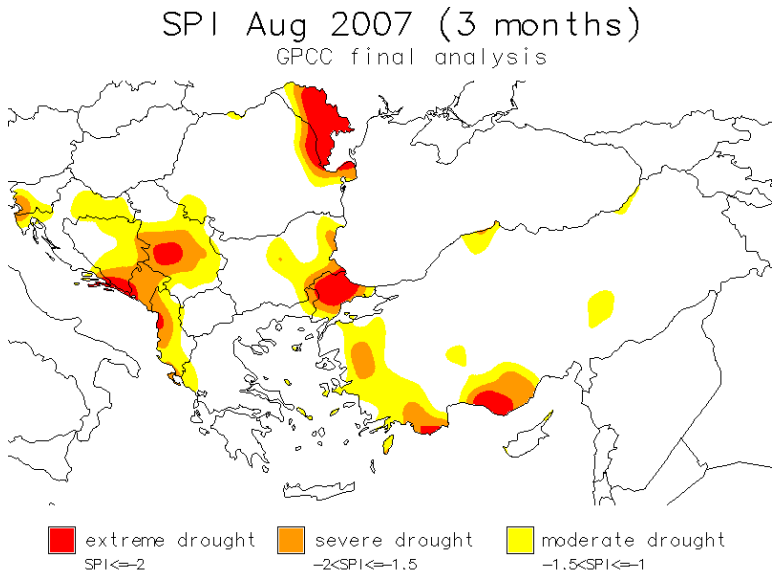
DMCSEE – 4 weeks – 3 months, SPI, GPCC, dwd.de, not forecasting but monitoring – data www.dmcsee.org

EU -10 days – 2 weeks forecatinf from EU Drought Observatory System – SPI, fAPAR, soil mositure www.edo.jrc.ec.europa.eu


U.S. Corn Areas Experiencing Drought
Reflects June 4, 2013
U.S. Drought Monitor data
Approximately 21% of the corn grown in the U.S. is within an area experiencing drought, based on historical NASS crop production data.
Drought Areas
Major Growing Area
Minor Growing Area
• Major areas combined account for 75% of the total national production annually.
• Major and minor areas combined account for 99% of the total national production annually.
USDA Agricultural Weather Assessments
World Agricultural Outlook Board

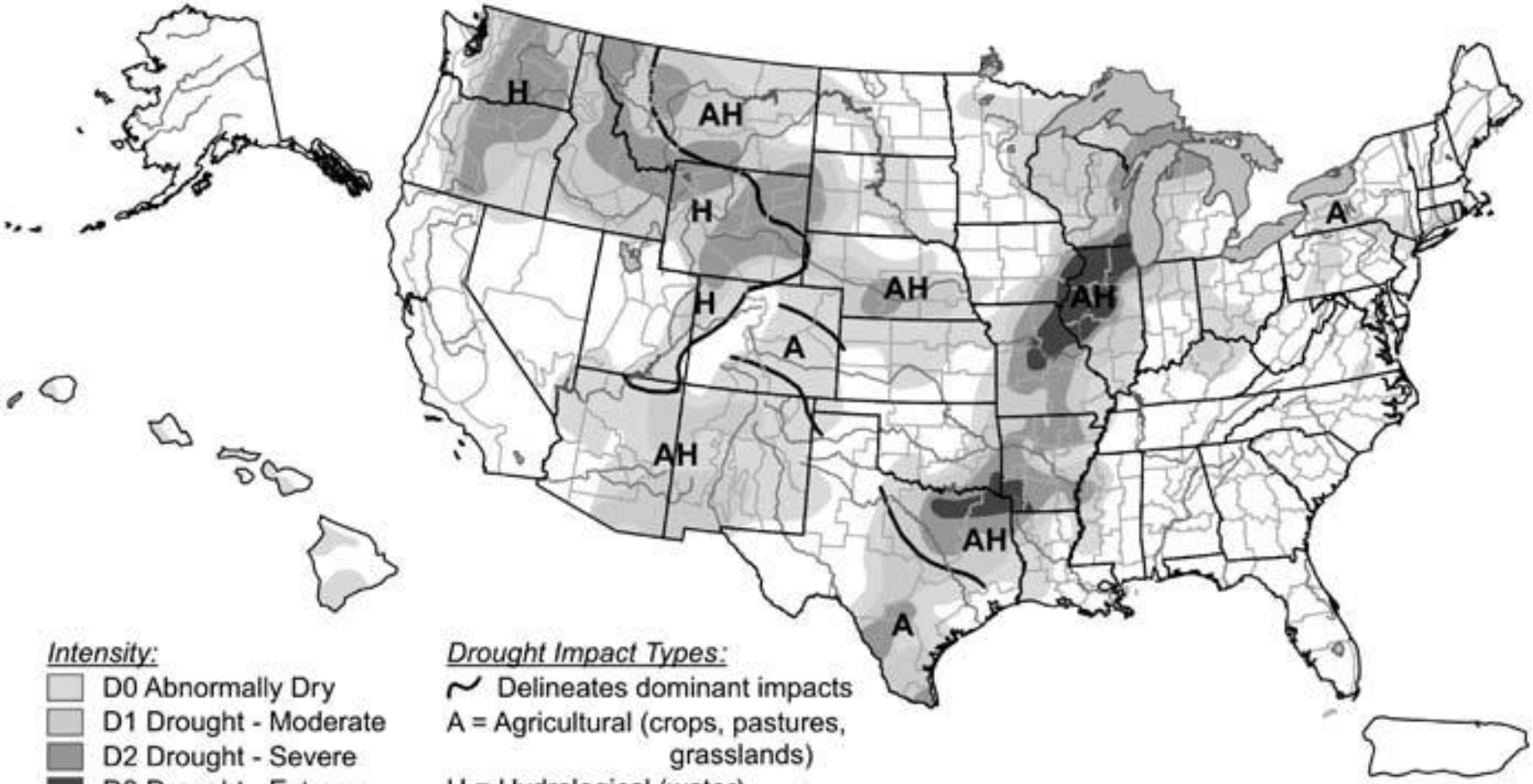

Comparison of 70 Days Accumulated Water Balance for Period
21Jan–31Mar 2009 with Historical Percentile Classes for same Period
extremly dry (<=10th percentile)
dry (<=20th percentile)
normal (20–60th percentile)
wet (>80th percentile)
very wet (>=80th percentile


Palmer Drought Index
Long-Term (Meteorological) Conditions
June 2013: through June 1, 2013*
National Climatic Data Center, NOAA
* rest of month estimated from normals
extreme drought
severe drought
moderate drought
mid-range
moderately moist
very moist
extremely moist
-4.00 and below
-3.00 to -3.99
-2.00 to -2.99
-1.99 to +1.99
+2.00 to +2.99
+3.00 to +3.99
+4.00 and above


SPI Aug 2007 (3 months)
GPCC final analysis
extreme drought
SPI<=-2
severe drought
-2<SPI<=-1.5
moderate drought
-1.5<SPI<=-1

# U.S. Drought Monitor

**August 2, 2005**
Valid 8 a.m. EDT




*Intensity:*
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

*Drought Impact Types:*
- ~ Delineates dominant impacts
- A = Agricultural (crops, pastures, grasslands)
- H = Hydrological (water)
- (No type = Both impacts)

*The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.*

USDA National Drought Mitigation Center

***Released Thursday, August 4, 2005***
***Author: Michael Hayes, NDMC***

**http://drought.unl.edu/dm**

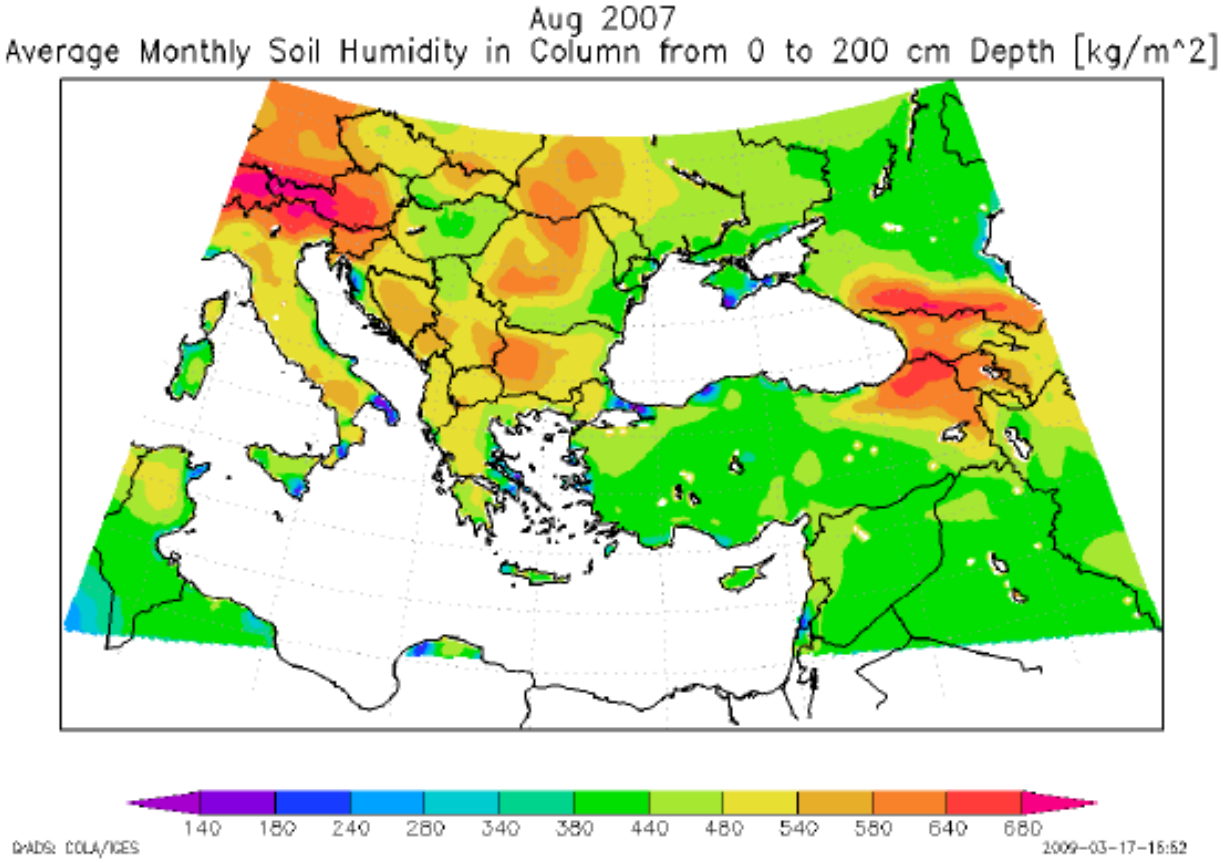
NEW!

# APPLICATION OF NUMERICAL WEATHER SIMULATION MODELS FOR DROUGHT MONITORING

## OUTPUT:

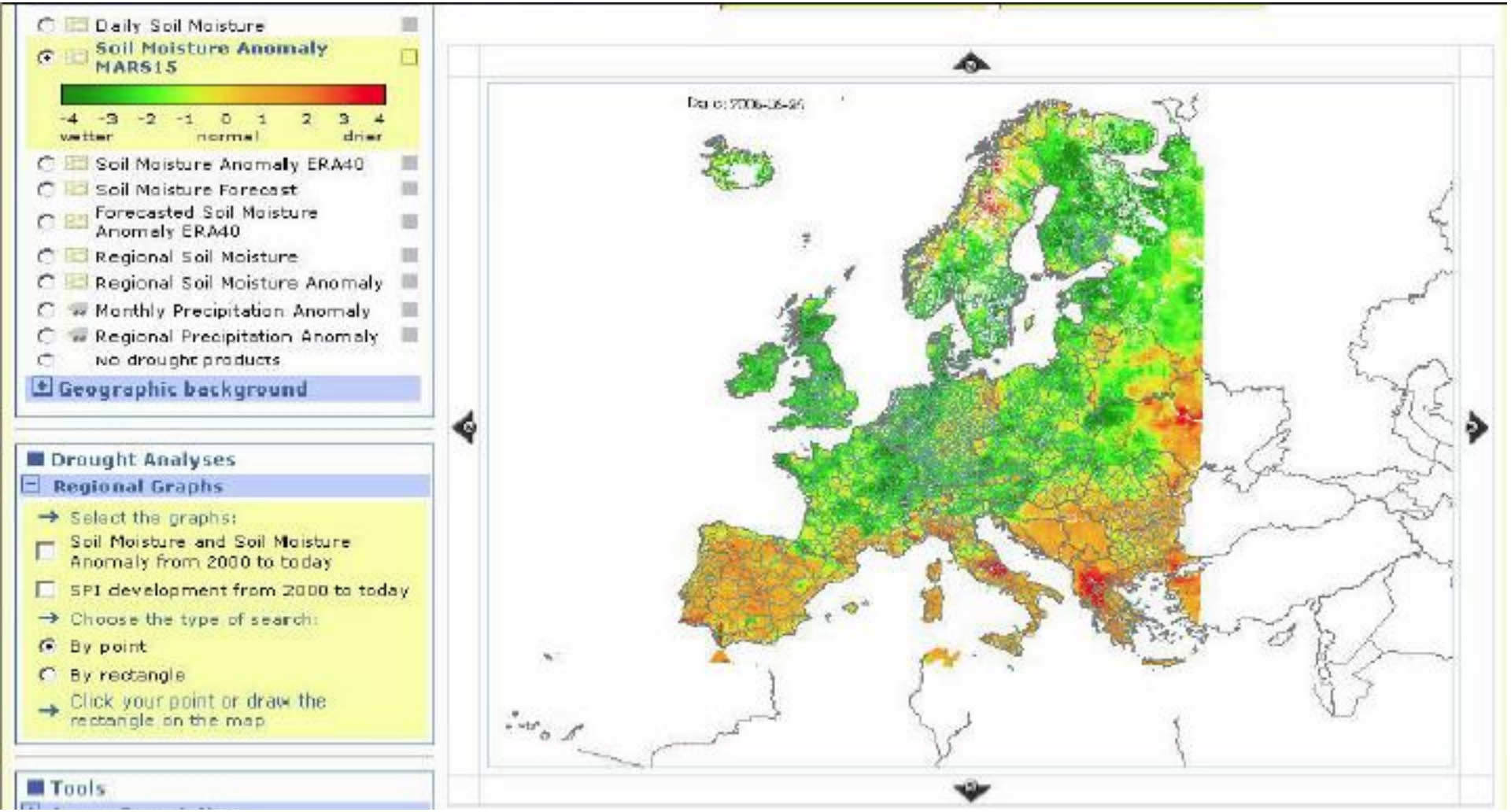
Simulated and averaged variables (air and soil) – daily aggregates 1989-2008

precip daily sum (00-24h), mm
evaporation (and transpiration) daily sum (00-24h), mm
potential evaporation (and transpiration) daily sum (00-24h), mm
liquid soil moisture volumetric fraction 0-10cm (24h)
liquid soil moisture volumetric fraction 10-40cm (24h)
liquid soil moisture volumetric fraction 40-100cm (24h)
liquid soil moisture volumetric fraction 100-200cm (24h)
total soil moisture volumetric fraction 0-10cm (24h)
total soil moisture volumetric fraction 10-40cm (24h)
total soil moisture volumetric fraction 40-100cm (24h)
total soil moisture volumetric fraction 100-200cm (24h)
total soil moisture content (kg/m2) in 0-200cm layer (24h)
geopotential height on 850hPa (12h), m
temperature on 850hPa (12h), K
daily average 10m wind, m/s
daily average 10m wind gusts, m/s
daily min. temperature, K
daily max. temperature, K
daily min. relative humidity, %
daily max. relative humidity, %




DMCSEE
Drought Management Cent
for Southeastern Europe

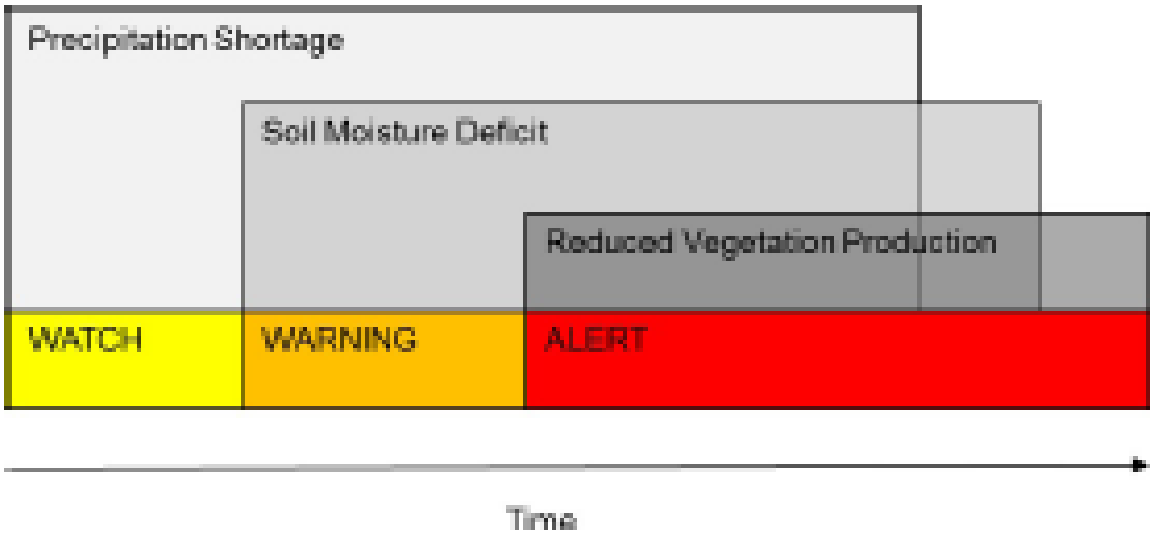
# JRC – regional resolution – monitoring system 2012 -




http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000

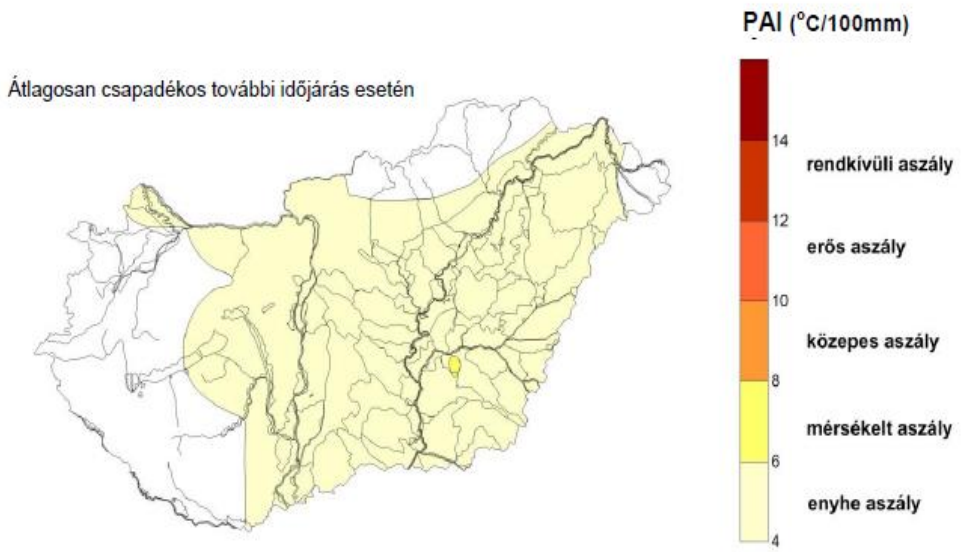
# Categories of the Combined Drought Indicator

| Category | Characteristics | Definition |
|---|---|---|
| Watch | Precipitation deficit | SPI-3 $< -1$ |
| Warning | Soil moisture deficit | Anomaly pF $> 1 +$ SPI-3 $< -1$ |
| Alert 1 | Vegetation stress following precipitation deficit | Anomaly fAPAR $< -1 +$ SPI-3 $< -1$ |
| Alert 2 | Vegetation stress following precipitation/soil moisture deficit | Anomaly fAPAR $< -1 +$ Anomaly pF $> 1 +$ SPI-3 $< -1$ |



# Hungarian example

- data: T, P, soil water content; monthly and summarized for 3 months and year
- 3 monthly forecasting possible for a month
- PAI index
- 3 scenarios for forecasting
- yearly forecasting
- [www.vizugy.hu](http://www.vizugy.hu)



# Key parameters

- not only accurate data, but approx. real-time data necessary
- Evaporation (ECMWF), soil, water content in soil (A and B depth), precipitation, soil pF, NDVI?
- RS based data sources

# Forecasting model3

## STATISTICAL

Based on observed historical correlations between global variables and regional weather patterns

easy to calculate (no need of the "complicated" physical models)

historical correlation between global variables and regional climate is stationary (Climate changing !!??)

## NUMERICAL

Based on the use of WPMs

Physical equations used for describing the connections between variables

Probabilistic approach using number of model simulations

Chaotic behaviour of the climate systems produce uncertainty for long range forecasts



Kurnik 2009

# Key persons

- Representative of Serbia with WMO – M. Dacic (Hydrometeorological service), Ass. Head of Sector for Emergency Management - I. Baras (Ministry of Interior of Rep of Serbia)
- Responsibility - e.g. DMCSEE Serbian Contact - http://www.agrifaculty.bg.ac.yu/ (new - *www.agrif.bg.ac.rs/*), *http://www.hidmet.sr.gov.yu/index_eng.php (new -* www.hidmet.gov.rs/index_eng.php), http://www.mntr.sr.gov.yu/eng/ (new - http://www.mntr.sr.gov.yu/eng
- Excellent publications – ~meteorological 1. Hrnjak, T. Lukić ,M. B. Gavrilov 2. Milan Gocic, Slavisa Trajkovic 3. Unkasevic, M., Tosic 4. Country report 2013 5. Spasov P., Spasova D., Petrović etc…
- Persons

**Key further contacts:**

- Agricultural Chamber or similar
- Irrigation contact

**Problems of the new IPA**

- limited possibility for universities because the
  - R+D –80-90 %
  - Priority for SME-s
- but the climatic change is new direction
- the Bega Channel 10 MEuro serious money

# 1 to 4 TPs are to be selected from the below:

1. Promoting employment, labour mobility and social and cultural inclusion across the border
2. Protecting the environment, promoting climate change adaptation and mitigation, risk prevention and management
3. Promoting sustainable transport and improving public infrastructures;
4. Encouraging tourism and cultural and natural heritage;
5. Investing in youth, education and skills;
6. Promoting local and regional governance, planning and administrative capacity building;
7. ***Enhancing competitiveness, business and SME development, trade and investment;***
8. *Strengthening research, technological development, innovation and ICT*
0. Technical Assistance

I hope we will be able to create an early warning system