

European Drought Events

(Database of meteorological drought events)

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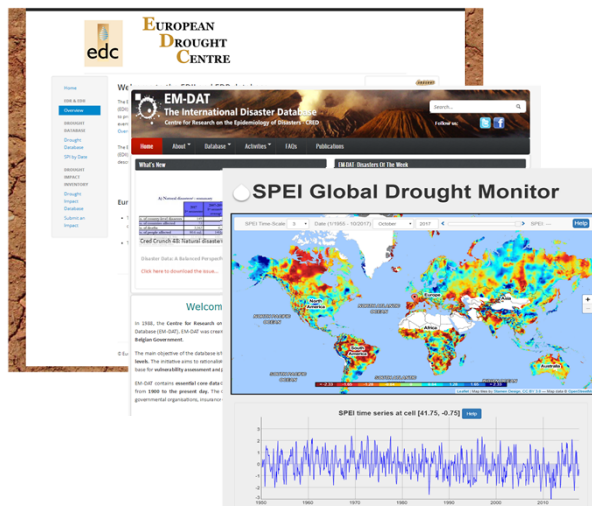
Context and Motivations



EDO / GDO

Data, maps, info on past, present, and forecasted drought

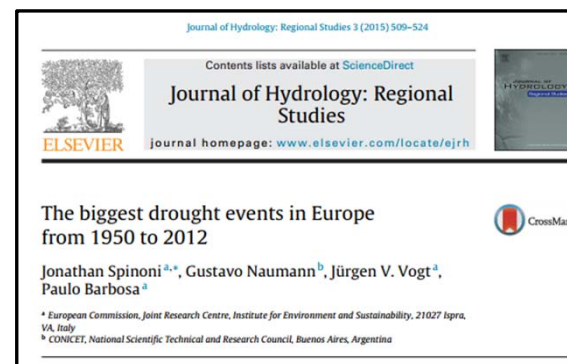
But no historical database of drought events



Other drought DBs

European and Global data on drought events are available

But they are rarely validated, not regularly updated, and usually hard to handle



An overview of drought events in the Carpathian Region in 1961–2010

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Two databases already collected

- Drought events in the Carpathians (1961-10)
- Drought events in Europe (1950-2012)

Objectives and Goals

- Create an historical European/Global database of drought events
- Regularly update the database to include most recent events
- Compare the newest droughts with the historical events
- Make the database user-friendly and include it in EDO/GDO
- Use the database to study past and present drought tendencies
- Use the database to estimate impacts due to drought events

Data and Methods (1)

Input Data

- GPCCV7.0

Monthly precipitation // 1951-2013 // 0.5°

- CRUTSV4.01

Monthly PET_{Penman-Monteith} // 1951-2016 // 0.5°

Monthly precipitation // 2014-2016 // 0.5°

Drought Indicators

- **Standardized Precipitation Index (SPI)**

Baseline: 1951-2016

Underlying distribution: Gamma function

Time-scales: 3, 6, 12, 24, 48 months

Spatial resolution: 0.5° (no data over the oceans)

- **Standardized Precipitation-Evapotranspiration Index (SPEI)**

Baseline: 1951-2016

Underlying distribution: Log-logistic function

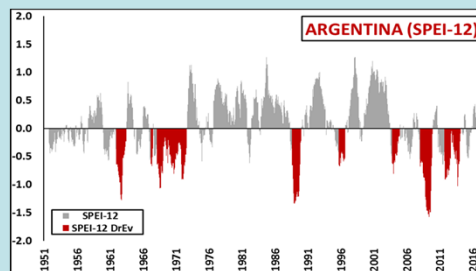
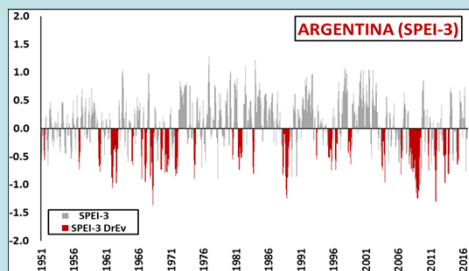
Time-scales: 3, 6, 12, 24, 48 months

Spatial resolution: 0.5° (no data over the oceans)

Data and Methods (2)

Drought Event

A drought event occurs every time the drought indicator falls below the drought threshold (-1 at grid-point level) for at least two consecutive months. It ends when the indicators turns above 0.



Features of a drought event

- **Start – End / Duration**

MM and YY corresponding to first and last month. Duration is expressed in number of months.

- **Severity**

Sum of all the indicator values during the event. For countries and regions it is normalized by dividing the sum for the drought threshold (which is not -1 in these cases).

- **Intensity**

Severity/Duration

- **Area in drought**

For countries and regions only: average area in drought conditions during the drought event.

- **Peak**

Lowest indicator value during the event. Peak month corresponds to the month in which the indicator is lowest.

- **Widest area**

For countries and regions only: widest area in drought conditions during the drought event. Peak month and widest area month can be different.

Results (1)

Drought Events (countries)

- **List of drought events per country**

Different databases for Spei-3, Spei-12, Spi-3, Spi-12

- **Drought indicator series per country**

Series available for all time-scales (from 3 to 48)

- **Areas in drought series per country**

Series available for many time-scales (from 3 to 12)

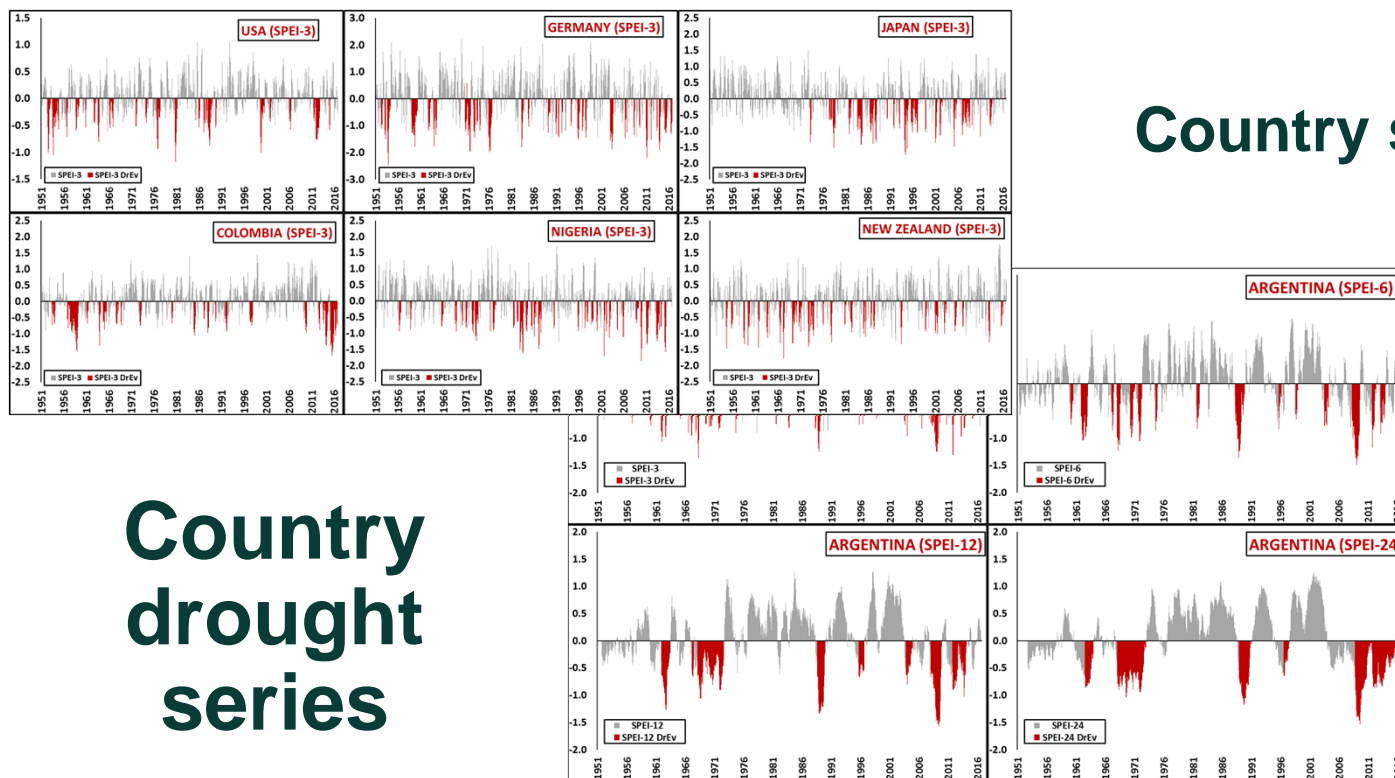
Every single event has a unique 30-character code

```
"Spei-3" "ZWE" 4809 10 12 1982 6 1983 7 8.5 1.21 54.62 -1.48 2 1983 88.24 2 1983 12
"Spei-3" "ZWE" 4810 11 1 1984 4 1984 4 4.01 1 46.88 -1.21 1 1984 77.94 1 1984 6
"Spei-3" "ZWE" 4811 12 2 1987 8 1987 7 11.5 1.64 79.2 -1.95 6 1987 97.79 5 1987 15
"Spei-3" "ZWE" 4812 13 11 1990 3 1991 5 4.46 0.89 40.44 -1.17 12 1990 74.26 11 1990 6
"Spei-3" "ZWE" 4813 14 8 1991 11 1992 16 19.56 1.22 58.13 -1.76 2 1992 96.32 3 1992 15
"Spei-3" "ZWE" 4814 15 4 1994 7 1994 4 6.29 1.57 72.24 -1.84 5 1994 99.26 5 1994 14
"Spei-3" "ZWE" 4815 16 1 1995 6 1995 6 6.29 1.05 49.76 -1.28 1 1995 71.32 1 1995 9
"Spei-3" "ZWE" 4816 17 4 1998 8 1998 5 8.91 1.78 75.44 -2.17 7 1998 100 7 1998 17
"Spei-3" "ZWE" 4817 18 2 2002 5 2002 4 5.49 1.37 65.26 -1.83 3 2002 100 3 2002 11
"Spei-3" "ZWE" 4818 19 12 2002 4 2003 5 4.84 0.97 45.88 -1.34 1 2003 79.41 2 2003 7
"Spei-3" "ZWE" 4819 20 3 2005 11 2005 9 15.48 1.72 74.43 -2.27 10 2005 100 10 2005 18
"Spei-3" "ZWE" 4820 21 7 2007 10 2007 4 5.37 1.34 58.64 -1.48 7 2007 86.76 7 2007 10
"Spei-3" "ZWE" 4821 22 6 2008 11 2008 6 7.51 1.25 66.67 -1.59 10 2008 93.38 10 2008 11
"Spei-3" "ZWE" 4822 23 9 2011 11 2011 3 2.56 0.85 32.11 -0.89 10 2011 43.38 9 2011 3
"Spei-3" "ZWE" 4823 24 6 2012 12 2012 7 8.28 1.18 56.2 -1.59 7 2012 97.79 7 2012 11
"Spei-3" "ZWE" 4824 25 8 2013 11 2013 4 4.44 1.11 44.85 -1.36 9 2013 79.41 9 2013 8
"Spei-3" "ZWE" 4825 26 7 2014 4 2015 10 11.29 1.13 47.5 -2.08 11 2014 100 11 2014 12
"Spei-3" "ZWE" 4826 27 7 2015 4 2016 10 19.83 1.98 81.47 -2.27 7 2015 100 2 2016 21
"Spei-3" "ZWE" 4827 28 9 2016 12 2016 4 4.55 1.14 50.92 -1.41 10 2016 83.09 10 2016 9
```

List of events and explanation

Ind	c/r	Ev	EvC	SM	SY	EM	EY	DD	DS	DI	DA	P	PM	PY	PA	AM	AY	S
Spei-3	AFG	1	1	11	1952	5	1953	7	5.55	0.79	18.3	-0.94	12	1952	39.1	12	1952	3
Ind: indicator																		
c/r: country or region																		
Ev: number of event																		
EvC: number of event for that country or region																		
SM: Start of the event (month)																		
SY: Start of the event (year)																		
EM: Start of the event (month)																		
EY: Start of the event (year)																		
DD: duration (months)																		
DS: severity (normalized over drought threshold for that country or region)																		
DI: intensity (severity/duration)																		
PM: peak of the event (month)																		
PY: peak of the event (year)																		
PA: widest area in drought during the event (%)																		
AM: peak area of the event (month)																		
AY: peak area of the event (year)																		
S: special score to classify droughts (0-25)																		

Results (2) – Drought Events (countries)



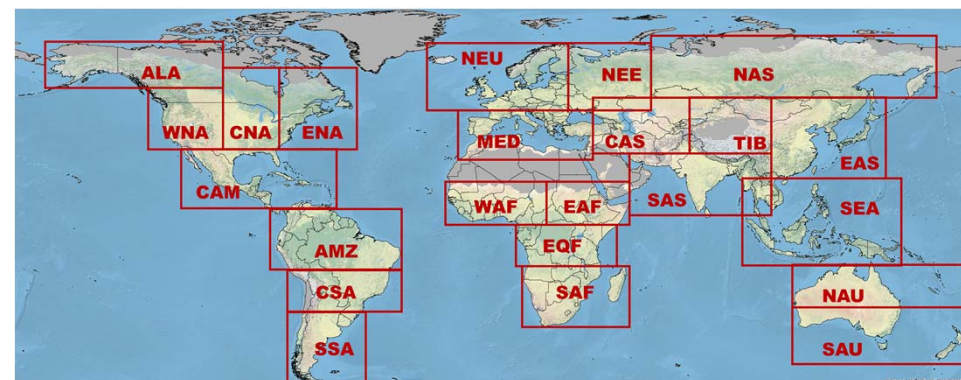
Country stats

Top-10 countries for in/decrease in ΔDF			
SPEI-12	ΔDF	SPI-12	ΔDF
ITA	2.37	SSD	2.81
SLB	2.29	SLB	2.29
TCD	2.24	CMR	2.24
CMR	2.18	CAF	2.24
TUN	2.18	ETH	2.13
MNE	1.98	ESP	2.08
LBR	1.95	NIC	1.90
NER	1.95	TCD	1.66
CAF	1.90	ALB	1.56
ESP	1.85	GHA	1.56
GEO	-0.94	LVA	-1.27
BLZ	-0.94	FIN	-1.33
ARM	-0.99	MNG	-1.46
TLS	-0.99	JOR	-1.51
ISL	-0.99	POL	-1.56
SWE	-1.27	ISL	-1.79
SOM	-1.33	DJI	-1.90
FIN	-1.33	SWE	-1.90
GTM	-1.38	ERU	-1.90
ERU	-1.90	GTM	-2.18

Results (3)

Drought Events (regions)

- **List of drought events per region**
Different databases for Spei-3, Spei-12, Spi-3, Spi-12
- **Drought indicator series per region**
Series available for all time-scales (from 3 to 48)
- **Areas in drought series per region**
Series available for many time-scales (from 3 to 12)
- **Statistics on drought per region**
23 macro-regions to rank the top events in 1951-2016



Map of 23 macro-regions

Event Feature	Range	Points	Condition
Severity (normalized)	0-5	5	DS ≥ 90%ile over all the events recorded
		4	70%ile ≤ DS < 90%ile over all the events recorded
		3	50%ile ≤ DS < 70%ile over all the events recorded
		2	30%ile ≤ DS < 50%ile over all the events recorded
		1	10%ile ≤ DS < 30%ile over all the events recorded
		0	DS < 10%ile over all the events recorded
Intensity	0-5	5	DS ≥ 90%ile over all the events recorded
		4	70%ile ≤ DS < 90%ile over all the events recorded
		3	50%ile ≤ DS < 70%ile over all the events recorded
		2	30%ile ≤ DS < 50%ile over all the events recorded
		1	10%ile ≤ DS < 30%ile over all the events recorded
		0	DS < 10%ile over all the events recorded
Area	0-5	5	DS ≥ 90% of the ctr/reg area
		4	70%ile ≤ DS < 90%ile of the ctr/reg area
		3	50%ile ≤ DS < 70%ile of the ctr/reg area
		2	30%ile ≤ DS < 50%ile of the ctr/reg area
		1	10%ile ≤ DS < 30%ile of the ctr/reg area
		0	DS < 10%ile of the ctr/reg area
Top event	0-4	4	Longest event for its country/region
		3	Most severe event for its country/region
		2	Most intense event for its country/region
		1	Widest event for its country/region
Peak intensity	0-3	3	Lowest indicator value ≤ -2.5σ (σ is drought threshold)
		2	-2σ ≤ Lowest indicator value < -2.5σ
		1	-1.5σ ≤ Lowest indicator value < -2σ
		0	Lowest indicator value > -1.5σ
Peak Area	0-3	3	Widest area ≥ 1M Km ² for countries (3M Km ² for regions)
		2	500k Km ² (2M Km ²) ≤ Widest area < 1M Km ² (3M Km ²)
		1	250k Km ² (1M Km ²) ≤ Widest area < 500k Km ² (2M Km ²)
		0	Widest area < 250k Km ² for countries (1M Km ² for regions)
Total	0-25	12-25	Extreme Drought Event
		8-11	Remarkable Drought Event
		0-7	Moderate Drought Event

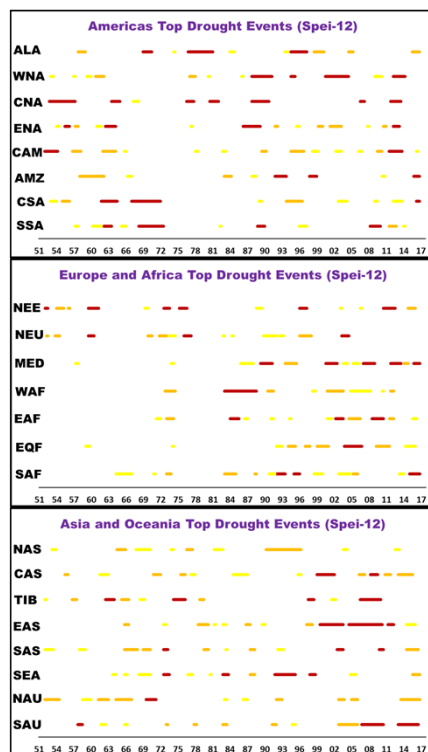
Special score (0 to 25)

Extreme Drought Event

Remarkable Drought Event

Moderate Drought Event

Results (4) – Drought Events (regions)



Macro-region drought tendencies

SPEI-12	ΔDF	ΔDS	SPI-12	ΔDF	ΔDS
ALA	0.7	-9.3	ALA	0.4	-8.3
WNA	-0.3	17.6	WNA	-0.9	15.0
CNA	-0.6	-8.1	CNA	-1.2	-11.2
ENA	-0.1	8.0	ENA	0.3	-13.9
CAM	0.9	-6.2	CAM	0.8	-7.0
AMZ	1.3	-10.6	AMZ	1.3	2.7
CSA	0.7	-25.9	CSA	1.7	-24.4
SSA	0.0	-0.3	SSA	-0.9	6.5
NEU	-0.7	-4.7	NEU	-1.0	-16.3
NEE	-1.3	-4.8	NEE	-1.9	-13.3
MED	1.9	21.0	MED	0.6	13.7
WAF	1.7	-4.1	WAF	1.0	9.1
EAF	2.5	1.4	EAF	1.7	-6.1
EQF	1.3	18.1	EQF	0.8	15.8
SAF	1.9	7.4	SAF	1.3	0.5
NAS	-0.6	8.5	NAS	-0.6	0.3
CAS	0.3	12.3	CAS	0.3	4.2
TIB	-1.2	4.6	TIB	-1.5	-8.4
EAS	1.9	13.8	EAS	0.9	6.0
SAS	-0.3	-2.5	SAS	-0.3	-1.1
SEA	-0.3	13.4	SEA	-0.3	10.6
NAU	0.0	-10.6	NAU	0.7	-17.5
SAU	0.0	19.2	SAU	0.0	-0.2

SPEI-12	ΔDF	ΔDF (extr)	SPI-12	ΔDF	ΔDF (extr)
ALA			ALA		
WNA			WNA		
CNA			CNA		
ENA			ENA		
CAM			CAM		
AMZ			AMZ		
CSA			CSA		
SSA			SSA		
NEU			NEU		
NEE			NEE		
MED			MED		
WAF			WAF		
EAF			EAF		
EQF			EQF		
SAF			SAF		
NAS			NAS		
CAS			CAS		
TIB			TIB		
EAS			EAS		
SAS			SAS		
SEA			SEA		
NAU			NAU		
SAU			SAU		

Results (5)

Drought Events (Global)

- **Global drought indicator series**

Series available for all time-scales (from 3 to 48)

- **Global areas in drought series**

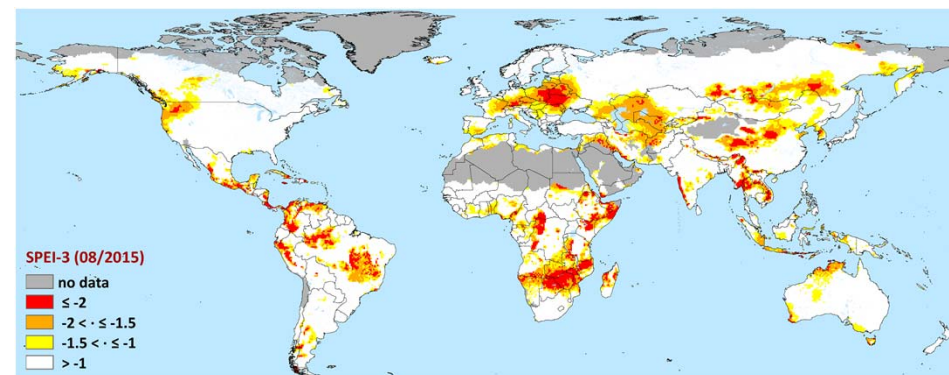
Series available for many time-scales (from 3 to 12)

- **Statistics on global drought tendencies**

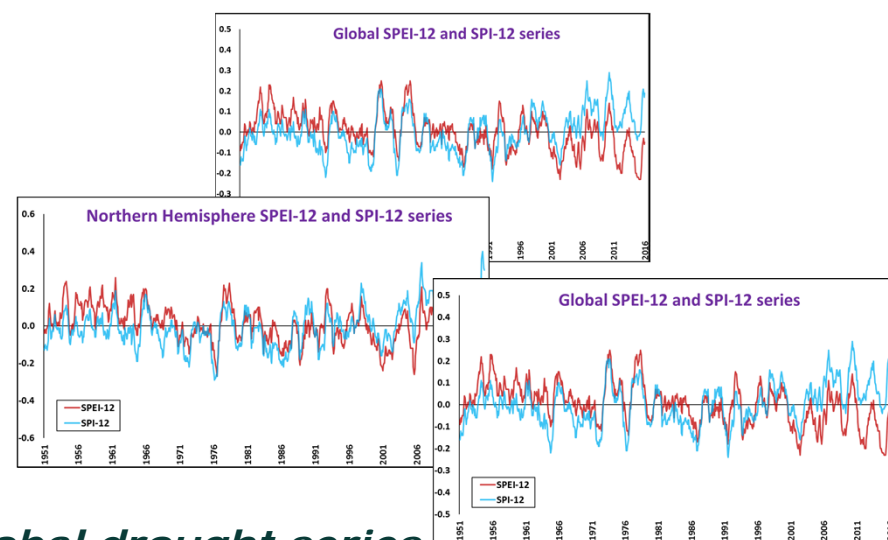
Focusing on Spei-12 and Spi-12 (and comparing)

- **Maps and charts on global drought trends**

Drought frequency, duration, severity, intensity, hazard



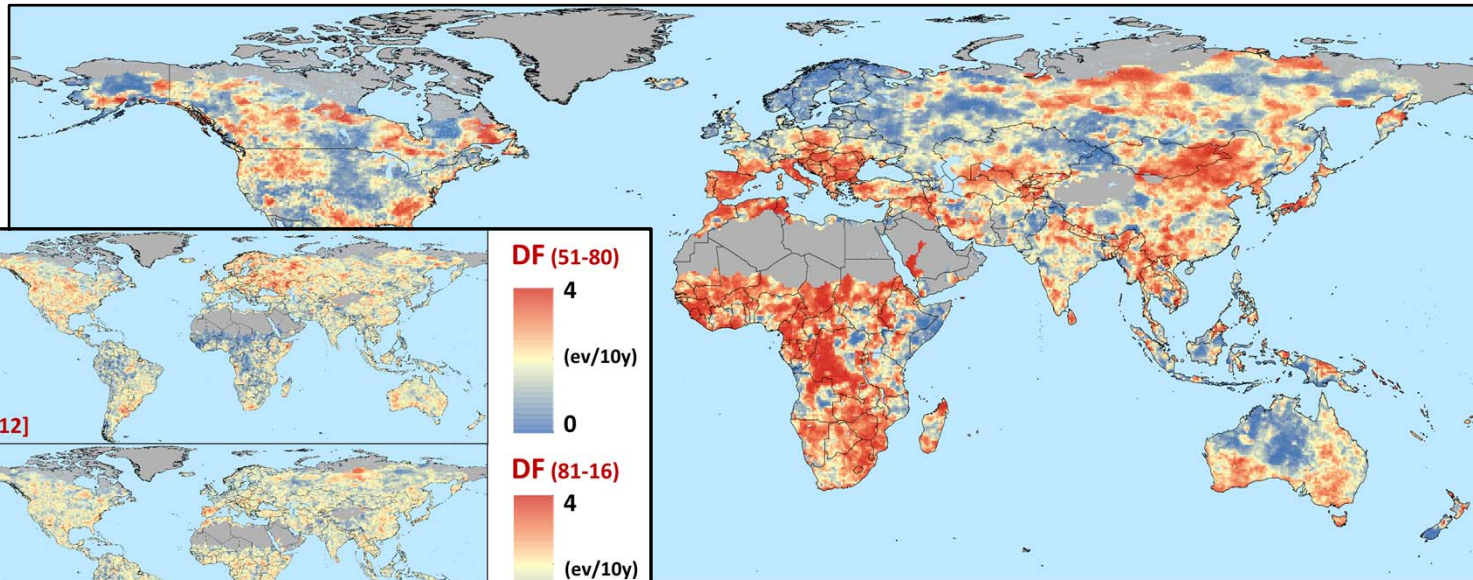
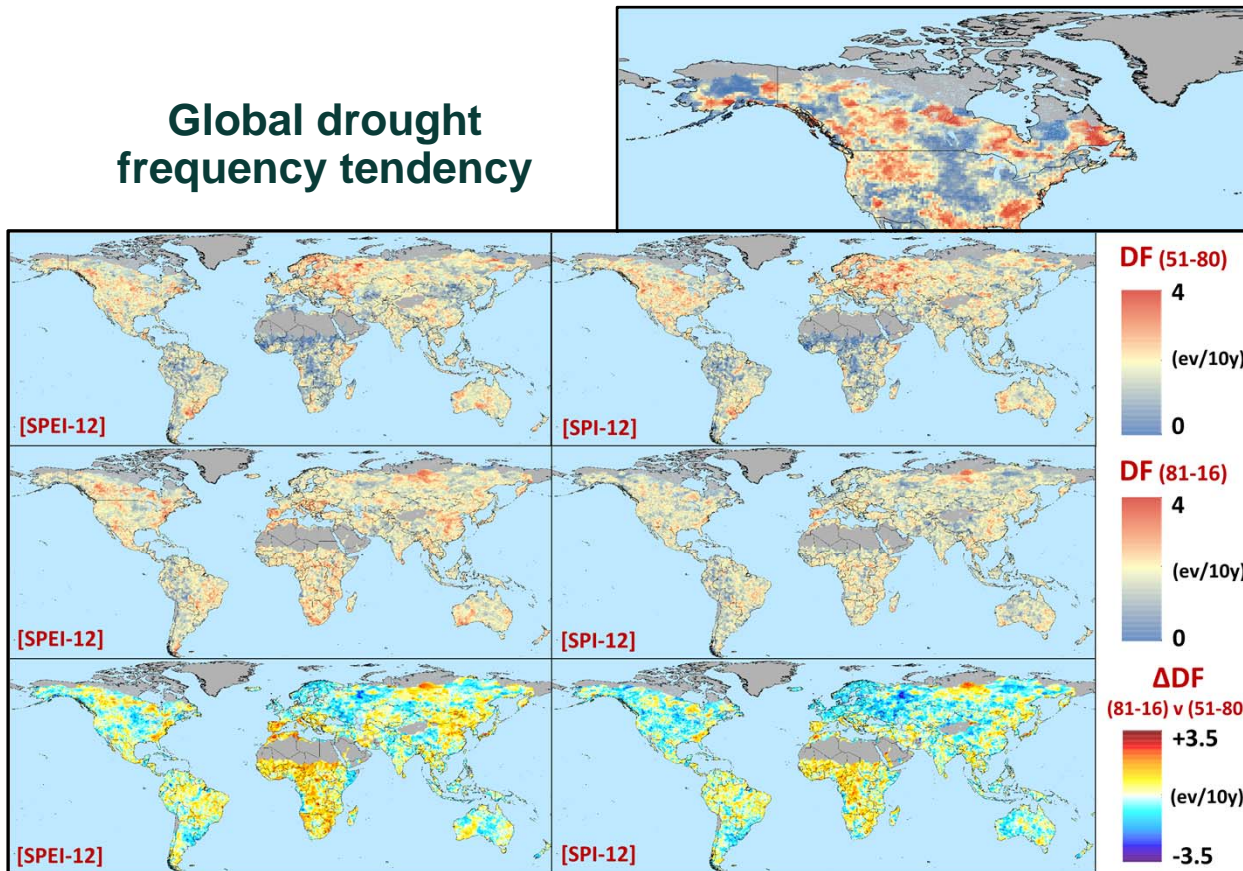
Widest areas on drought (08/2015)



Global drought series

Results (8) – Drought Events (global)

Global drought frequency tendency



Global drought hazard tendency (WASPEI-3)

Next steps

- Implement the results in EDO/GDO
- Write paper(s) to describe this study
- **Link the drought events database with drought impacts databases (MunichRe, DesInventar, EDII, EM-DAT)**
- Validate/use the outputs of this study in the upcoming PESETA-4 project (?)
- Include vegetation-based indicator(s)

Published Papers

- Spinoni J., Naumann G., Vogt J., Barbosa P., Dosio A.: *Will drought events become more frequent and severe in Europe? International Journal of Climatology. Early view online, published on 9 October 2017. DOI: 10.1002/joc.5291*
- Naumann G., Spinoni J., Vogt J., Barbosa P.: *Assessment of drought damages and their uncertainties in Europe. Environmental Research Letters 12(10), 124013, 2015.*
- Spinoni J., Naumann G., Vogt J., Barbosa P.: *The biggest drought events in Europe from 1950 to 2012. Journal of Hydrology: Regional studies DOI:10.1016/j.ejrh.2015.01.001, 2015.*
- Spinoni J., Antofie T., Barbosa P., Bihari Z., Lakatos M., Szalai S., Szentimrey T., Vogt J.: *An overview of drought events in the Carpathian Region in 1961-2010. Adv. Sci. Res., 10, 21-32, 2013.*



Any questions?

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