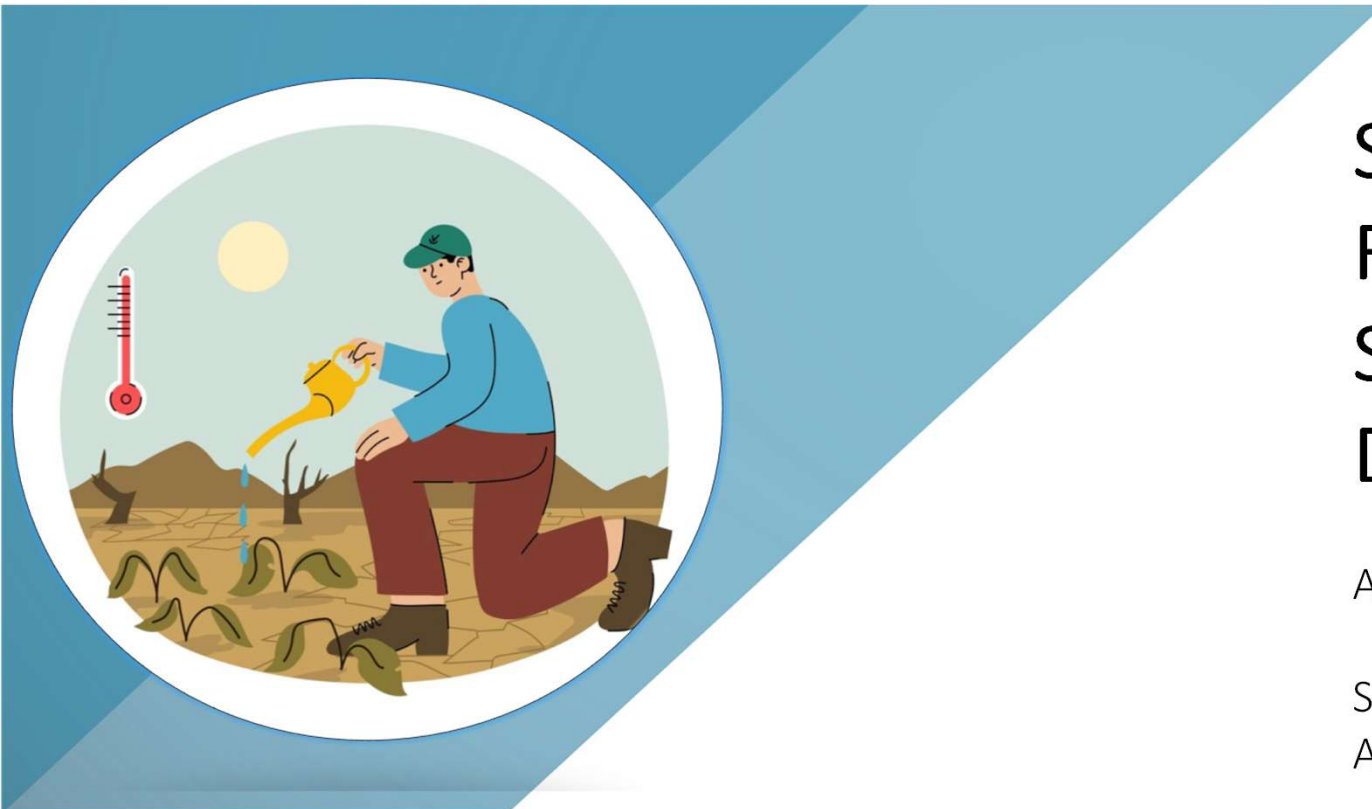




ARSO METEO
Slovenian Environment Agency



Strengthening Drought Resilience with Climate Services in Slovenia & DMCSEE

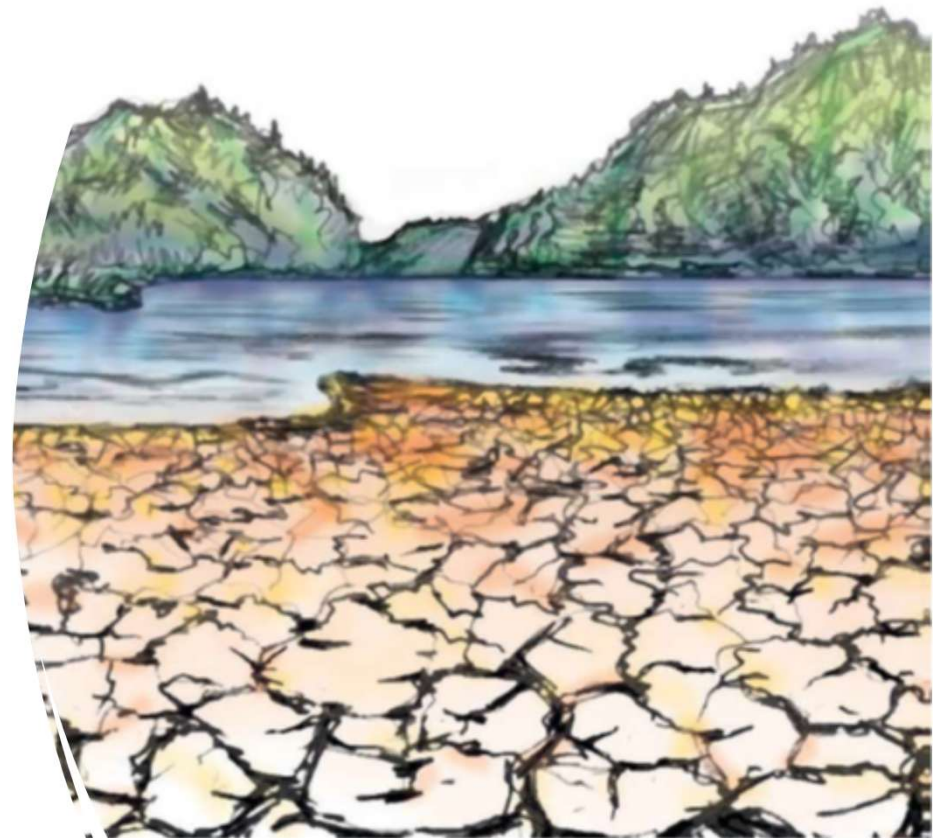
Andreja Sušnik

Section for Meteorological Support to Agriculture

COST CA23108 (MEDUSSE) meeting, UL, Ljubljana, 10 September 2025

Outline

- I. Drought – increasing problem in SEE & Slovenia
- II. Character of drought is changing
- III. DMCSEE mission
- IV. Drought monitoring in Slovenia and SEE



What is drought?

- A complex and little-understood phenomena among those in “weather and climate extremes”;
- slow (not sudden) development;
- difficult to define its start and end;
- diverse, non-structural impacts;
- high spatial and temporal variability.

Credit: WMO-CAGM (2018)

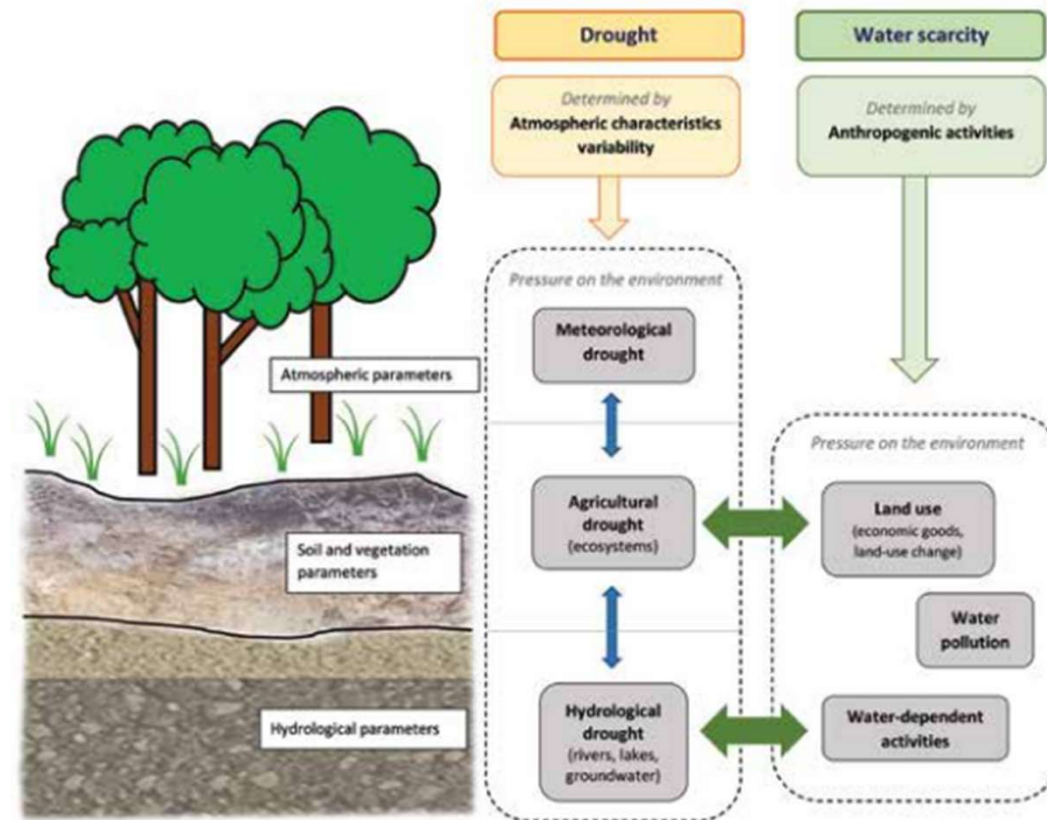
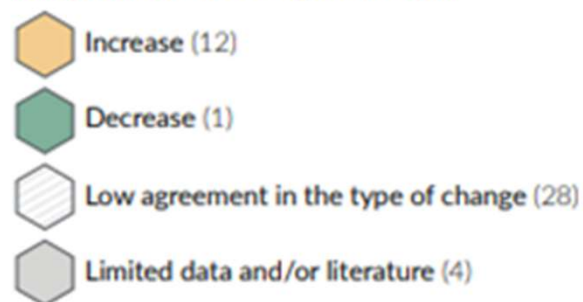


Figure 1: Difference between drought and water scarcity, and their inter-linkage on greater damages.

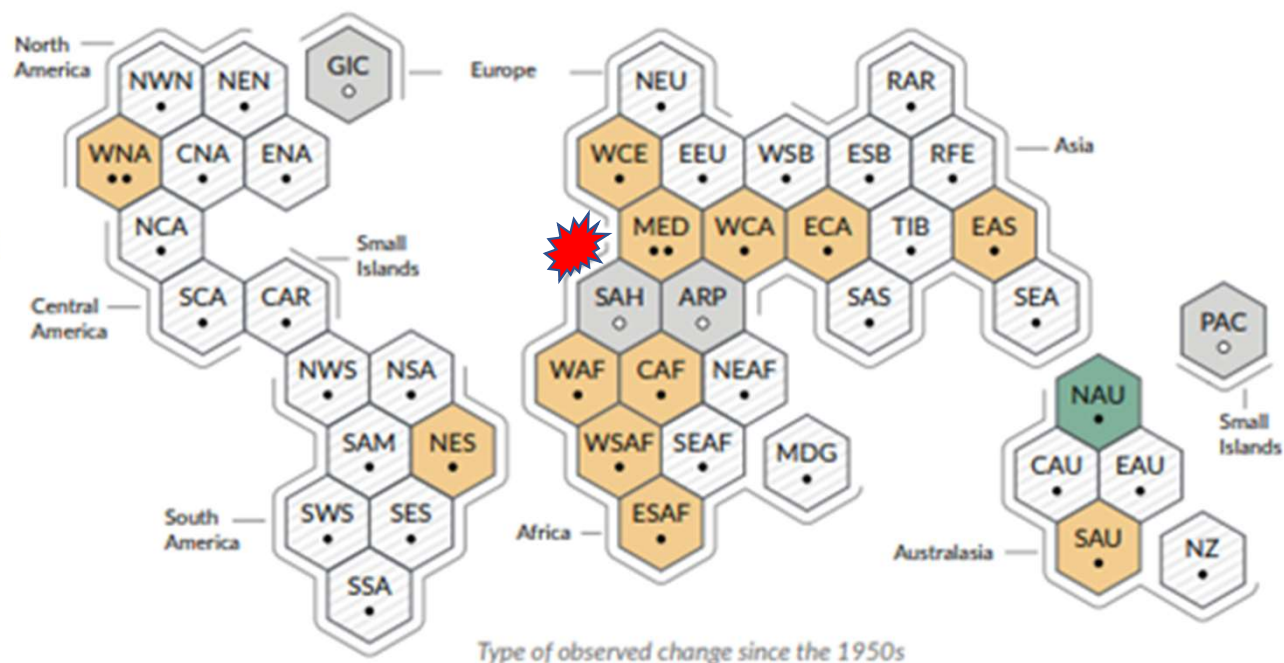
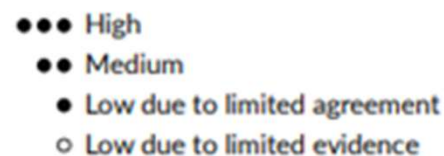
Assessment of observed changes in agricultural and ecological drought

(c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in agricultural and ecological drought



Confidence in human contribution
to the observed change



Yellow hexagons indicate regions where there is at least medium confidence in an observed increase in this type of drought.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of WG1 to the Sixth Assessment Report.

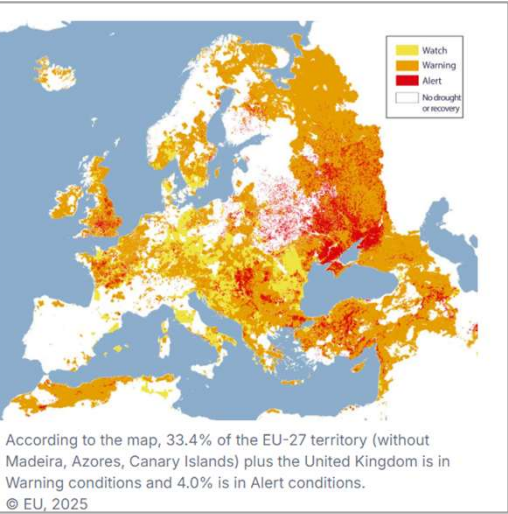
The drought problem is worsening in SE Europe

Danube River Basin (SEE) droughts between 2016-2023
(Source: DMCSEE Drought Bulletins, EDO Drought Reports, ICPDR Questionnaire / Map: WWF)

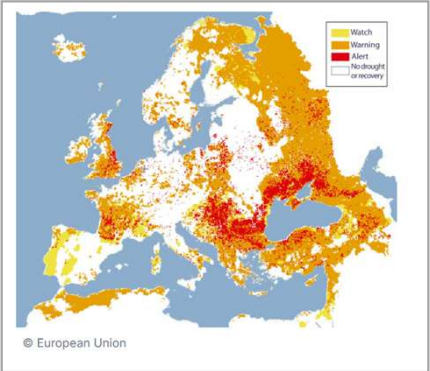
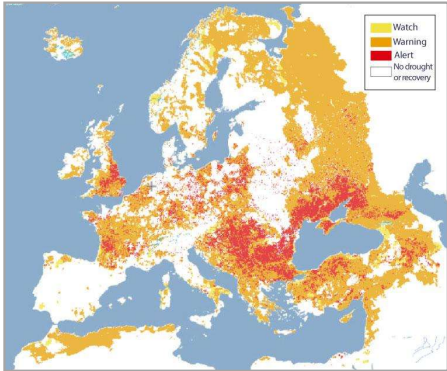
June 2025

July 2025

August 2025

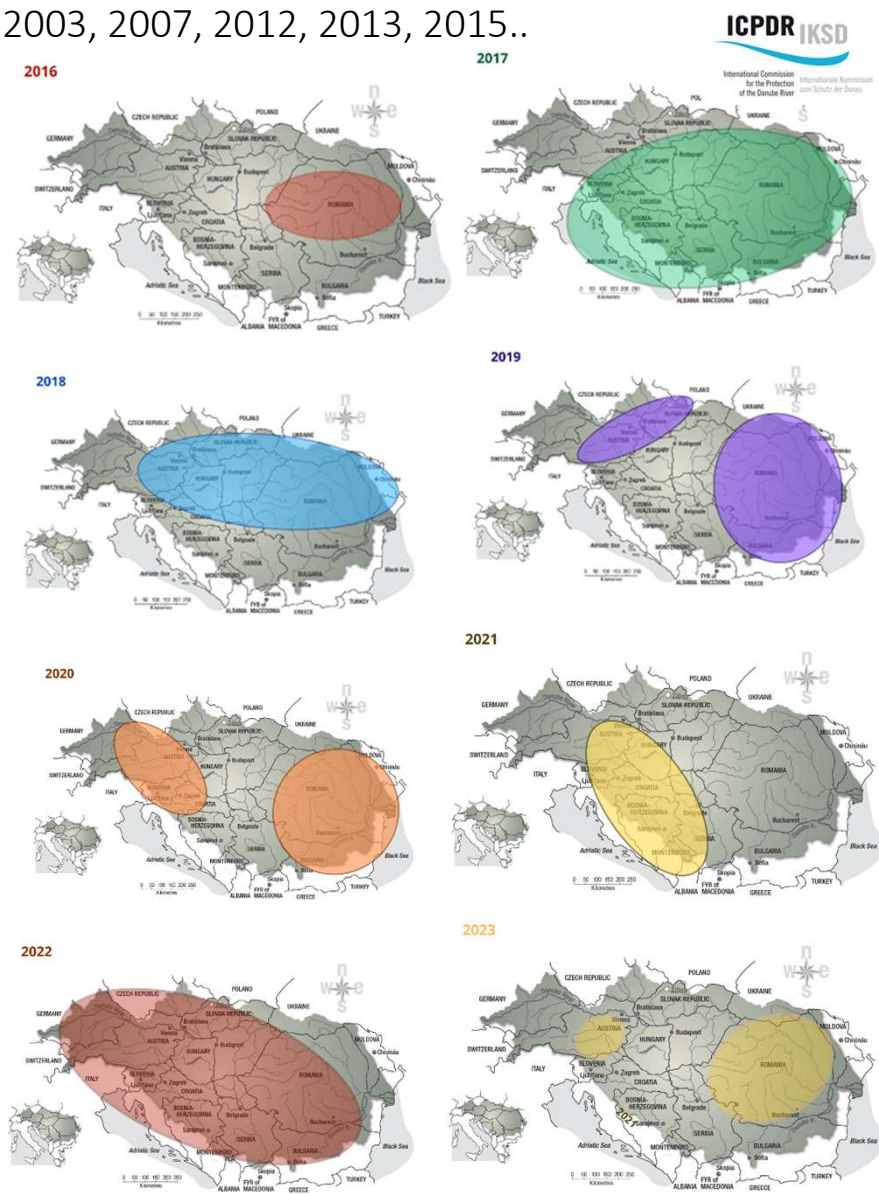


According to the map, 33.4% of the EU-27 territory (without Madeira, Azores, Canary Islands) plus the United Kingdom is in Warning conditions and 4.0% is in Alert conditions.
© EU, 2025



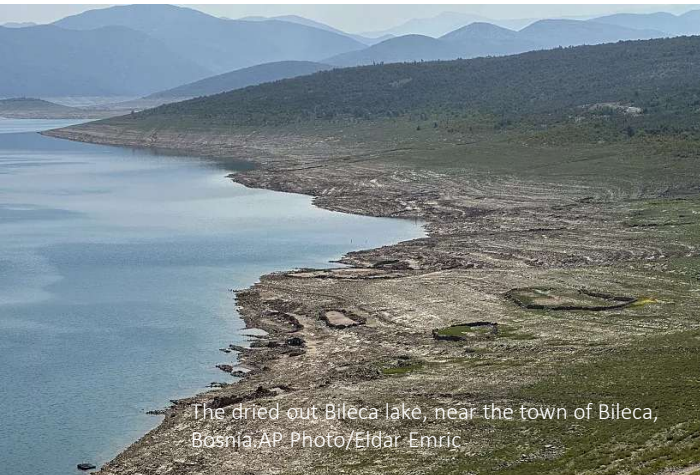
Drought development from June to July 2025 in Europe (CDI indicator) (Source: EDO/JRC)

2003, 2007, 2012, 2013, 2015..



..very intense development in 2024 & 2025

Symptoms of of droughts in recent years



The dried out Bileća lake, near the town of Bileća, Bosnia. AP Photo/Eidar Emric

Suša ustavila plovbo po Donavi, ujetega na tisoče ton blaga

Vir: [Suzana Pelito in Pia Bedene](#)
30. avgusta 2022, 08:52

- V Bolgariji ostalo 'ujetega' več kot 1,2 milijona tona premoga in 30 tisoč ton nafte
- Ostalo je tudi 900 tisoč ton surovin, ki se uporabljajo za proizvodnjo umetnih gnojil
- Bolgarska vlada bo srbakim gradbenim strojem omogočila opravljanje del na kritičnih točkah



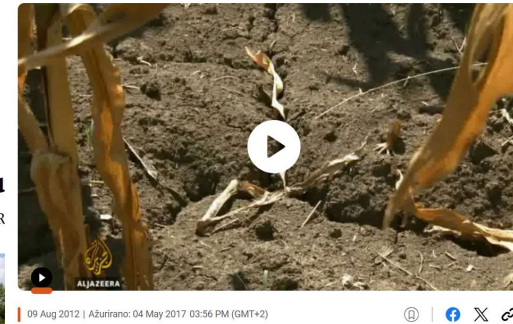
Suša v slovenski Istri: vojna v času miru

V Rižanskem vodovodu so ponosni, da še vedno zagotavljajo pitno vodo. R Rižana ne sme presahneti.



Brez namakanja v kmetijstvu ne gre. A če ni vode za namakanje, se...

Velika suša uništava poljoprivredu regiona



09 Aug 2012 | Ažurirano: 04 May 2017 03:56 PM (GMT+2)



Balkans braces for more blazes as heatwave intensifies



BSS, 2025

Smučarji se sonca ne veselijo več: slovenska smučišča prisiljena k zapiranju prog

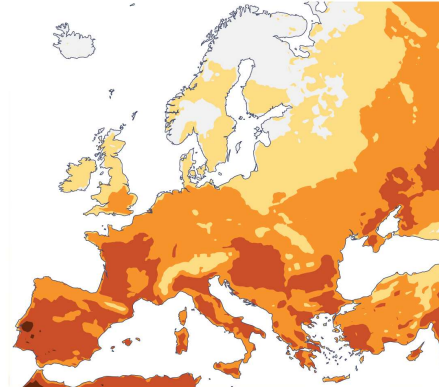
6. 1. 2023, 12:08 | Vir: STA | A. B.

DELI



Maximum heat stress category experienced in June 2025

Data: ERA5-HEAT Universal Thermal Climate Index (UTCI) • Credit: C3S/ECMWF



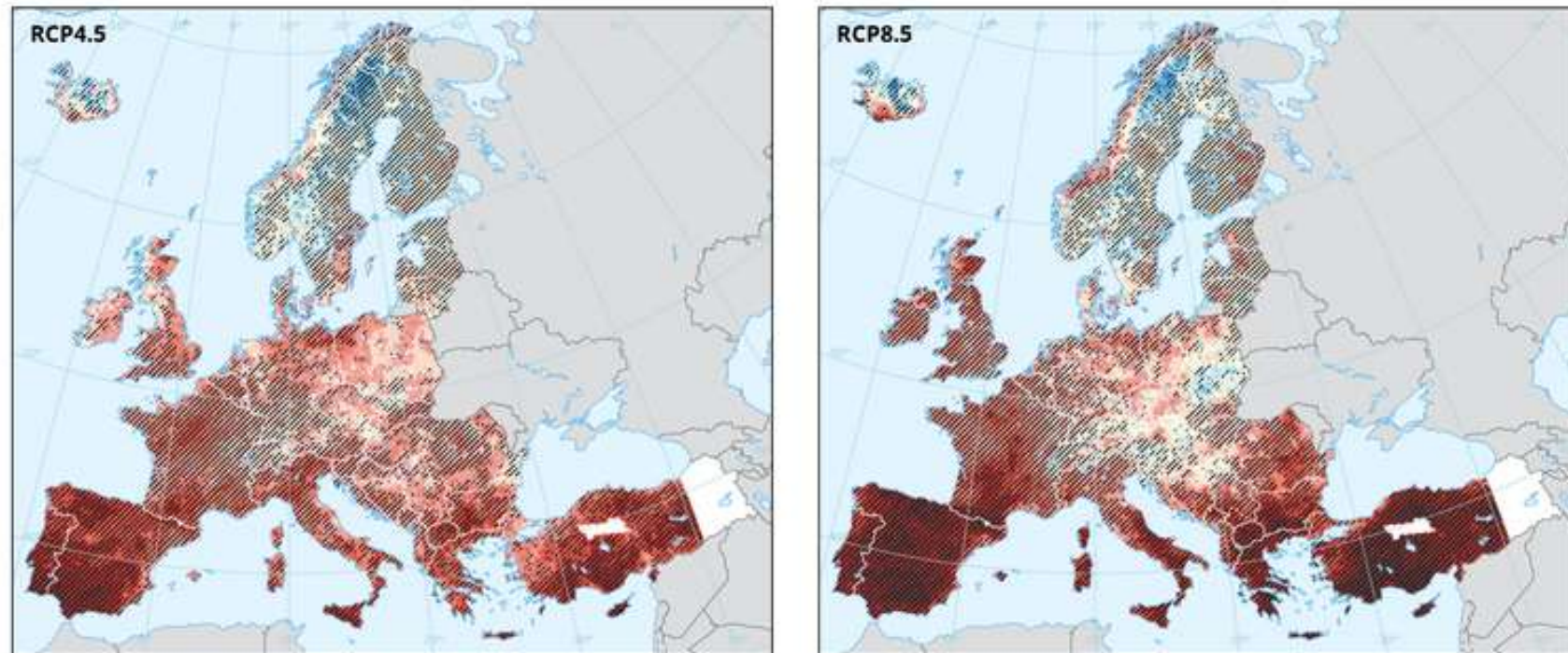
Feels-like temperature



PROGRAMME OF THE EUROPEAN UNION Copernicus

- Heat waves & summer droughts – **rapid droughts**
- Dry springs and autumns
- Drop of river discharges all over Europe (Po, Rhine, Danube, Alpine streams etc.) and lakes
- In Alpine space „green winters or **snow drought**“
- Multiyear drought
- **Compound and cascading extreme events** (forest fires, flash floods)

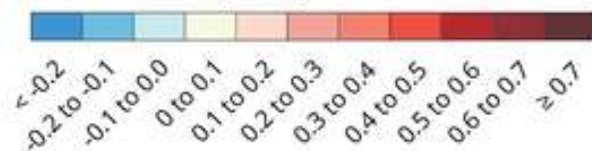
Projected higher drought frequency in Europe



Reference data: ©ESRI Data: ©European Commission. Source: Joint Research Centre

Projected change in meteorological drought frequency between the periods 1981-2010 and 2041-2070 under two climate change scenarios

Number of events per 10 years



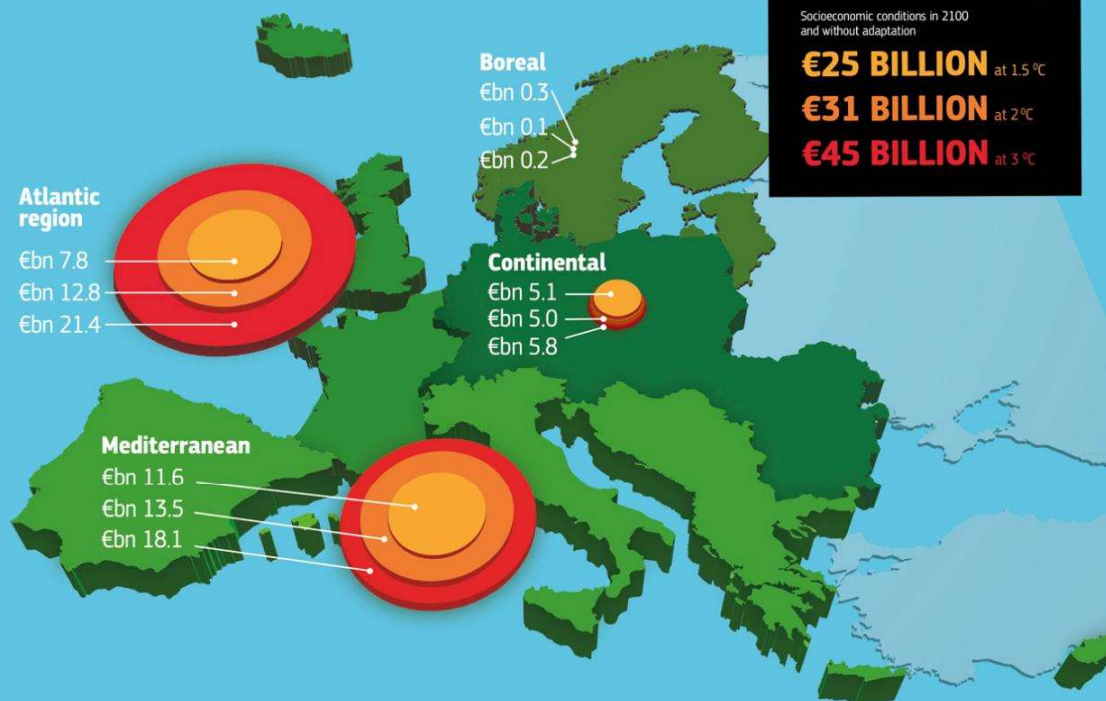
- At least two-third of the simulations used agree on the sign of change
- No data
- Outside coverage

Source: EEA, 2024

0 500 1 000 1 500 km

Drought in a changing climate

A **first-ever** pan-European quantitative assessment of the economic impacts of drought in Europe.



Modelled expected annual losses (billion €) for the present (1981 - 2010)

Mediterranean	Atlantic region	Continental	Boreal
3.6	2.5	2.6	0.3

Projected expected annual damages (billion €) based on socioeconomic conditions in 2100 and without adaptation, at:



IMPACT ON SECTORS CONSIDERED



Agriculture

- Damages to crops and livestock losses
- Irrigation restrictions due to water scarcity



Power generation

- Reduction in hydroelectricity production
- Reduced capacity of cooling systems
- Possible shutdown of thermal and nuclear power plants



Public water supply

- Decreasing water availability
- Increasing competition amongst different sectors



Commercial shipping

- Interruption of navigation
- Reduction in cargo maximum capacity
- Transfer to other means of transportation

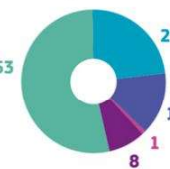


Buildings and infrastructure

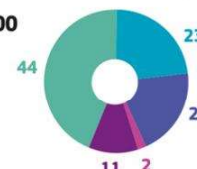
- Damages due to soil subsidence
- Aquifer over-exploitation may aggravate damage to buildings from subsidence

Share of drought losses per socioeconomic sector (%)

Present



2100



KEY SUMMARY

- Drought will be more severe and persistent in southern and western Europe, whereas it will become less intense in northern and eastern Europe.
- Mediterranean and Atlantic regions are already contributing to about 68% of present losses, and this share will become 87% at 3 °C.
- Agriculture sector is most affected now and in the future, even if its economic importance is reduced in future European economies.

For more information, including assumptions of the modelling framework used, see: JRC PESETA IV project <https://ec.europa.eu/jrc/en/peseta-iv>



The story of DMCSEE



ARSO METEO
Slovenian Environment Agency



Drought teams centred in NMHS of 13 countries in SE Europe



www.dmcsee.org



Established in 2006



Founding agencies: UNCCD, WMO



United Nations
Convention to Combat
Desertification



Hosted and coordinated by ARSO



dmcsee.org

Mission

- Development & application of drought risk-management tools and policies in SEE
- Improve drought preparedness to reduce drought impacts in SEE



Regional drought monitoring

Monthly & seasonal drought bulletins



Transnational projects

Innovative tools & knowledge transfer



Strengthening drought policies and expert capacity

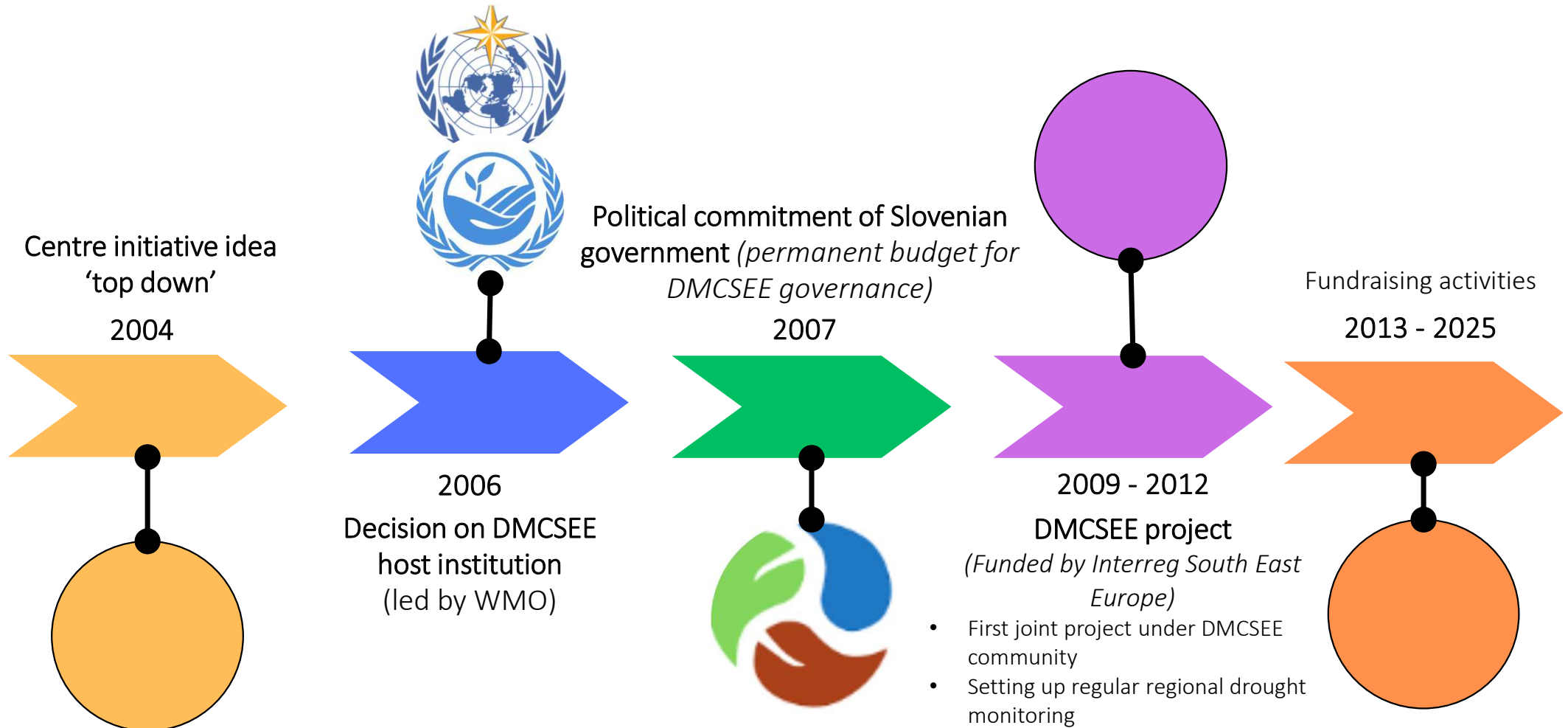
Drought policy recommendations
(national level, regional bodies);
support & organisation of trainings of national experts



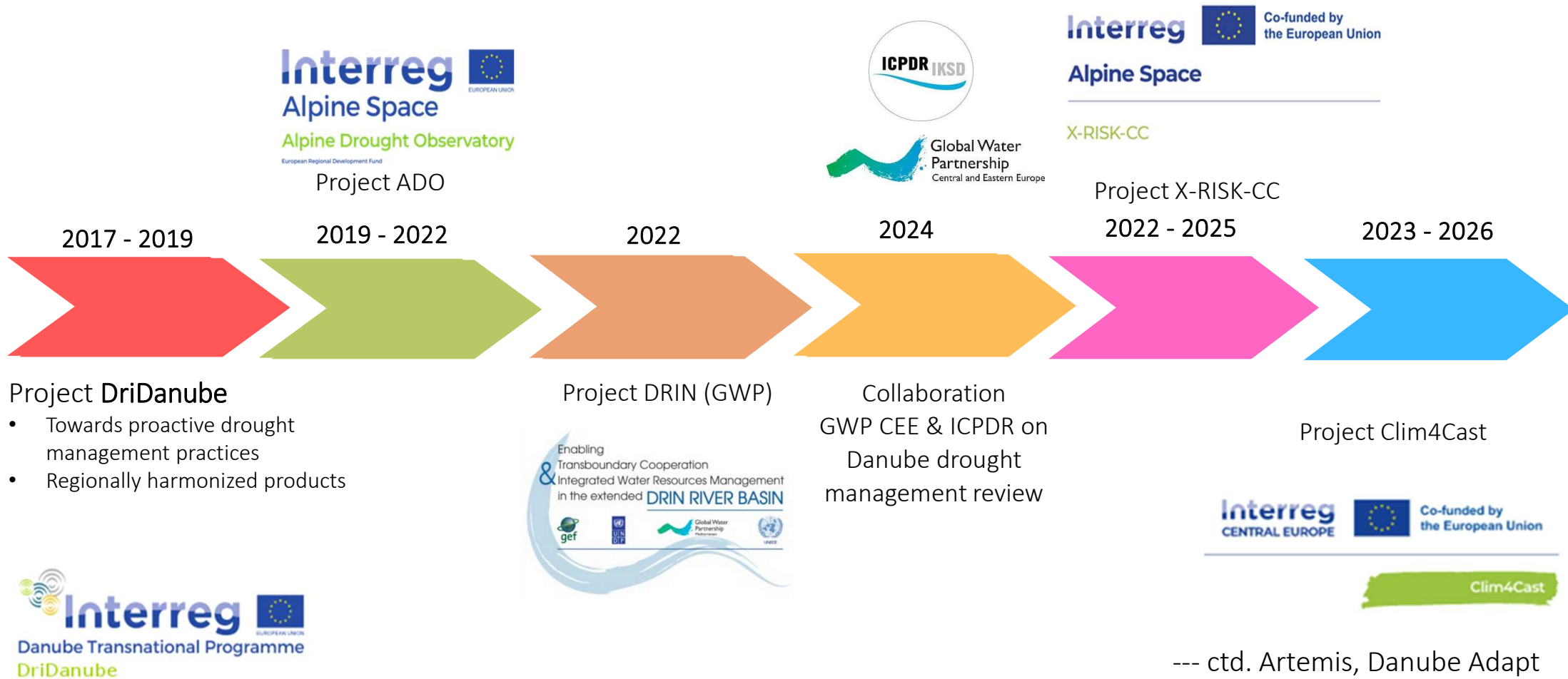
International collaboration

Joint activities & cooperation with WMO, IDMP;
Implementation of UNCCD mission

Timeline



Timeline



What we need for proactive drought management?

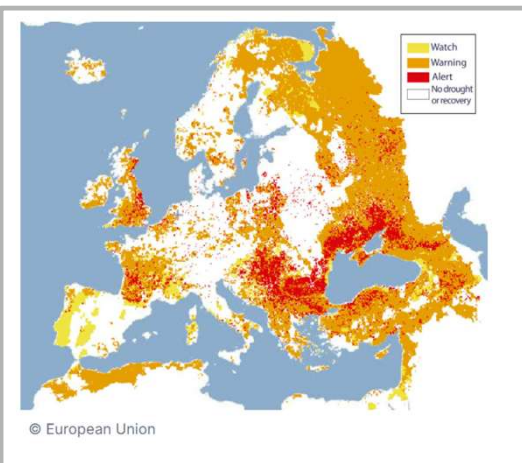


Credit: IDMP (2018)

How we monitor drought development?

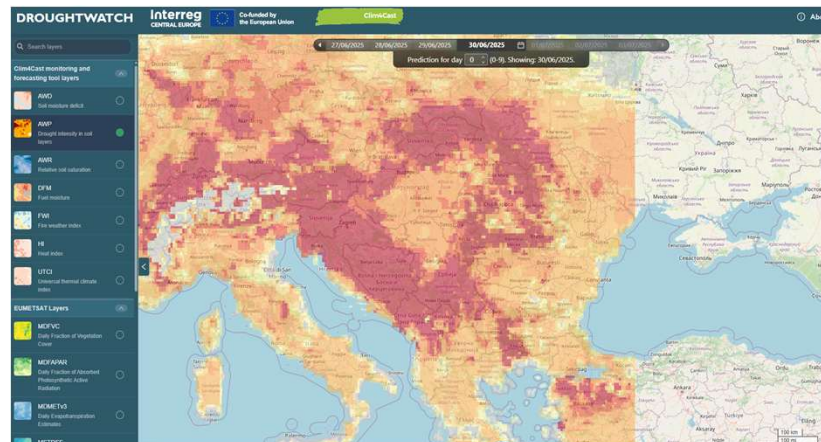
regional

Europe: European Drought Observatory (EDO) [3rd decade of June, 2025]



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

SouthEastern Europe:
DroughtWatch [June 30, 2025]



<https://droughtwatch.geocodis.com/>

national

Slovenia: Sušomer/Drought meter

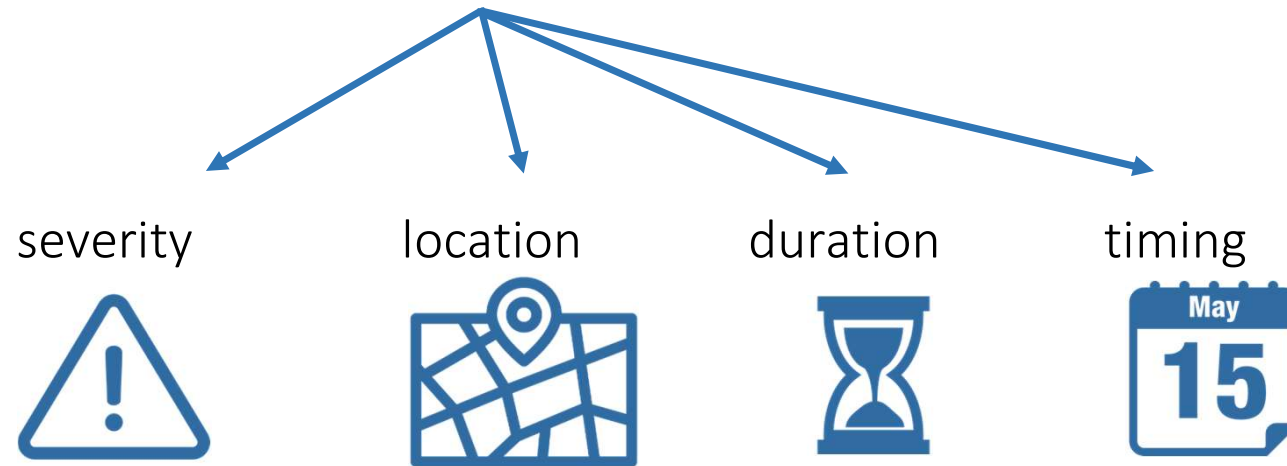


<https://www.meteo.si/uploads/probase/www/agromet/bulletin/drought/sl/>

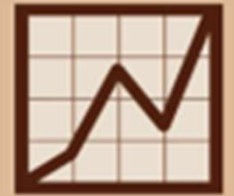
Multifacet approach

Drought characteristics detection

Droughts can be characterized in terms of their



Monitoring
Early
Warning



Drought indicators and indices provide options for identifying drought characteristics listed above. These are associated with different types of drought.

MONITORING

Drought bulletins

DMCSEE drought bulletins provide graphical and textual review of meteorological conditions across the region, vegetation development at specific locations, a summary of reported drought impacts on the living environment, and the latest outlook of water balance conditions in the topsoil layer.

Monthly bulletins:

- prepared for vegetation season months April - September (and March, if dry)
- issued 3 to 4 weeks after the observed month

Seasonal bulletins:

- review the vegetation season as a whole (including winter and autumn, if dry)
- issued approximately 2 months after the observed calendar year

[Contribute drought impacts](#)

[Leave feedback](#)

DROUGHT BULLETINS



DROUGHT MONITORING BULLETIN Month YYYY

1. Hotspot info

2. Precipitation

3. Air temperature & Surface water balance

4. Vegetation development

5. Drought impacts

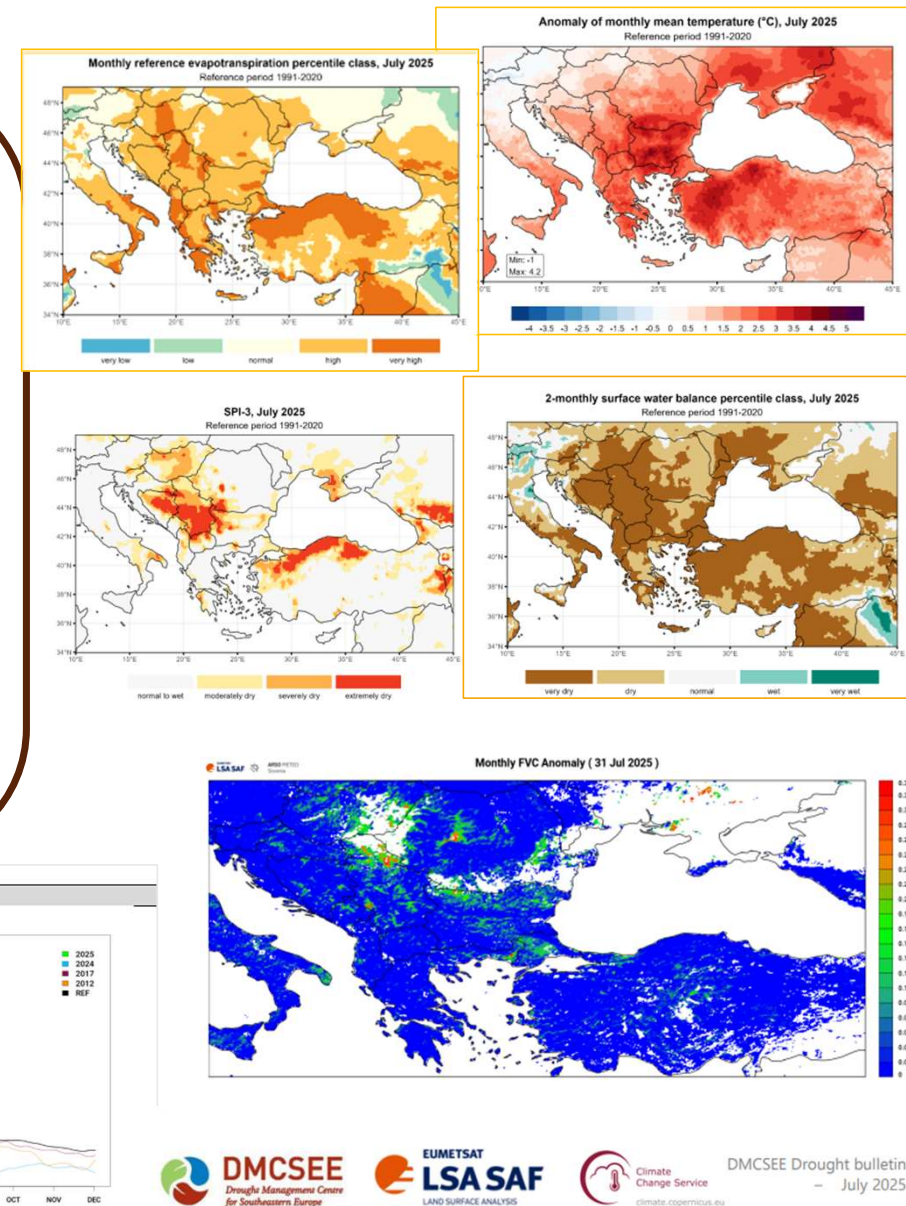
6. Outlook

Methodology

1/58

- Regional weather and vegetation conditions overview
- Maps of air temperature, precipitation, evapotranspiration, and surface water balance anomalies
- Standard deviation indices: SPI, SPEI, EDDI (updated monthly)
- Graphs/maps of vegetation development

REGIONAL DROUGHT MONITORING



- Summary of found reports on impacts of drought
- Obtained from freely available sources: online national authorities reports, press agencies, newspapers + voluntary input from DMCSEE partners
- Ground info on drought extremity: validation & complementation of drought indices; local details, ground check; textual summary per country per month (not database)

DROUGHT IMPACT COLLECTION

Grindul.

The ups and downs of ILENE ȘIPOTEANU: "I wanted to give up everything. I forgave..."

First page » News » The phenomenon affecting the Danube. Ships are at risk of getting stuck due to low water levels

The phenomenon affecting the Danube. Ships are at risk of getting stuck due to low water levels

AGENCIJA NACIONALNA DE PRESA
AGERPRES
Actualizează lumea.

Interior outer MULTIMEDIA LOG IN PAID FLOW PRESS MONITORING

home / Social / Arad: In the Nădlac area, 80% of corn production is compromised by drought and heat



Arad: In the Nădlac area, 80% of corn production is compromised by drought and heat

2024-07-23 15:35:12 13 views

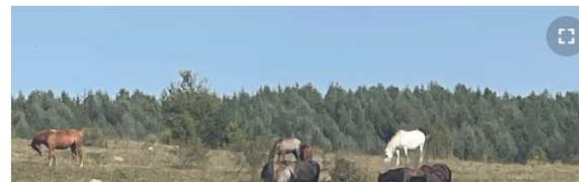
It follows Change font size:  

Approximately 80% of corn production is compromised by drought and heat, in the Nădlac area, where there are the most fertile agricultural lands in Arad county, with farmers stating that they will get somewhere around 2.5 tons per hectare, compared to 12 tons as the production is normal of the area.

GET MARRIED

Fires, droughts and water shortages in many parts of Serbia

16. August/Kolovoz, 2024.



SELF-GOVERNMENT 08 July 2024 | 14:04

The municipality of Viannos was declared in a state of emergency

The Municipality of Viannos is in a state of emergency due to water shortage.

Pension **in**

    Listening article  A A



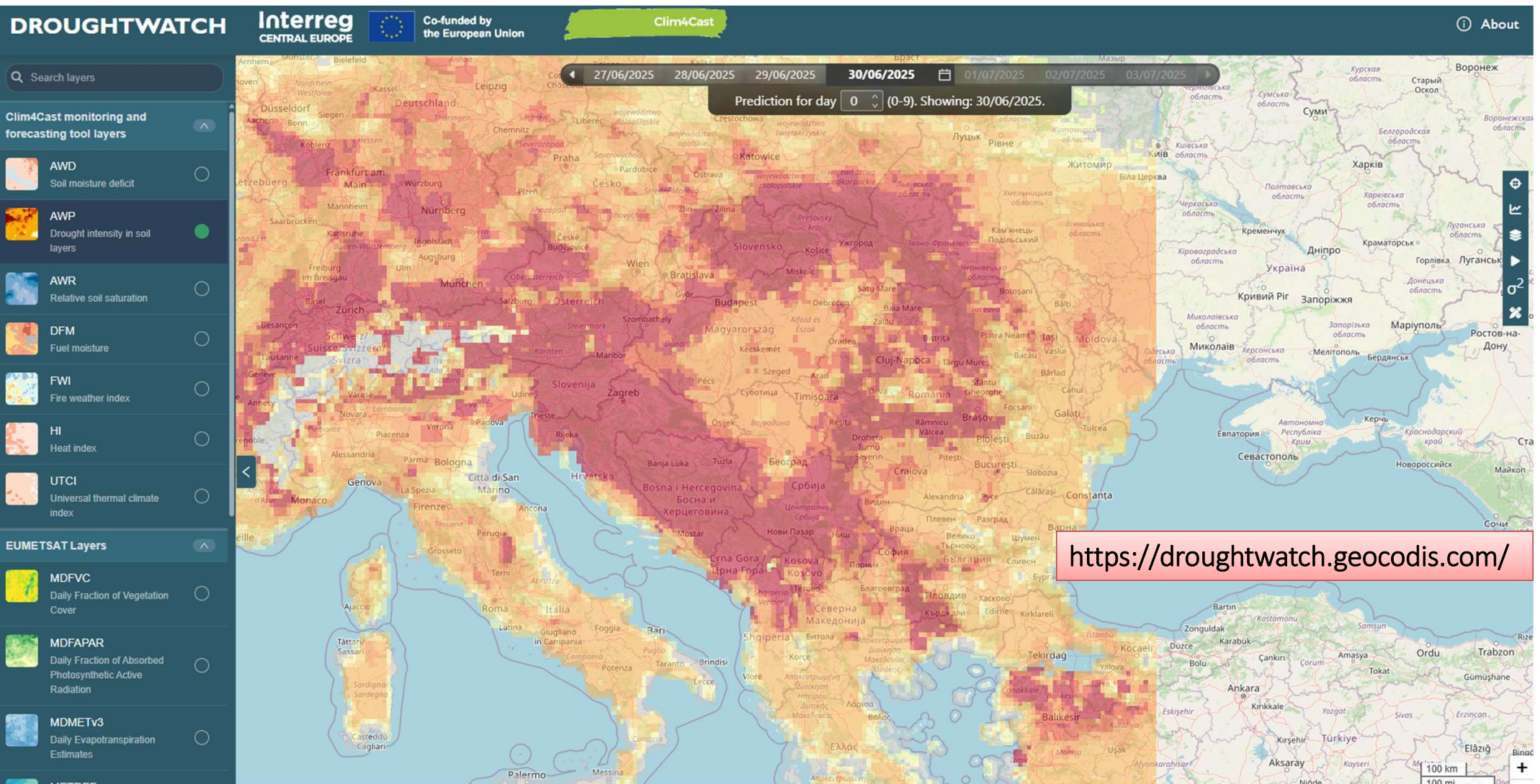
► Extension of the declaration of a Civil Protection Emergency of the Municipality of Serfos

► Decision to declare a state of emergency in Lerros due to water shortage

► Municipal unity of Corinth was declared in a state of emergency

DroughtWatch - Regional tool in development (near-real time)

- different sources – including remote sensing and forecast (June 30, 2025)





- Contact list for monthly bulletin
- Occasional drought experts meeting: recent in November 2024 and in February 2025 (ministerial conference)
- Regular updates on the DMCSEE webpage as the main communication channel.



dmcsee.org

Technical conference: Fostering regional drought resilience in South-Eastern Europe

5-6 FEBRUARY 2025, BRDO PRI KRANJU, SLOVENIA

This regional conference brought together experts and key stakeholders from DMCSEE region as well as regional and global organisations, who exchanged best practices and discussed strategies to enhance drought resilience in the region through focused and expert-driven discussions. The conference addressed key topics such as drought monitoring, drought risk and impact assessment, and drought resilience, with dedicated panels further exploring regional issues and ways forward. Invited speakers shared their perspectives on how regional and national organisations from SEE can collaboratively work towards drought resilience in an increasingly interconnected world.

Session 1: Empowering drought resilience in southeastern Europe - keynote speaker: Andreja Sušnik, Slovenian Environment Agency/DMCSEE

Session 2: Enhancing drought monitoring - keynote speaker: Danila Volpi, Joint Research Centre

Session 3: Strengthening drought impacts and risk assessments - keynote speaker: Blaž Kurnik, European Environment Agency

Session 4: Advancing proactive drought management

Conference presentations and other material are available in links below:

[Agenda >](#)
[Session 1 >](#)
[Session 2 >](#)
[Session 3 >](#)
[Session 4 >](#)

[Marketplace projects >](#)
[Sessions discussions \(PDF\) >](#)
[Key messages >](#)

Challenges of Climate Change Adaptation in South-Eastern Europe

4-6 Feb 2025
Brdo pri Kranju, Slovenia



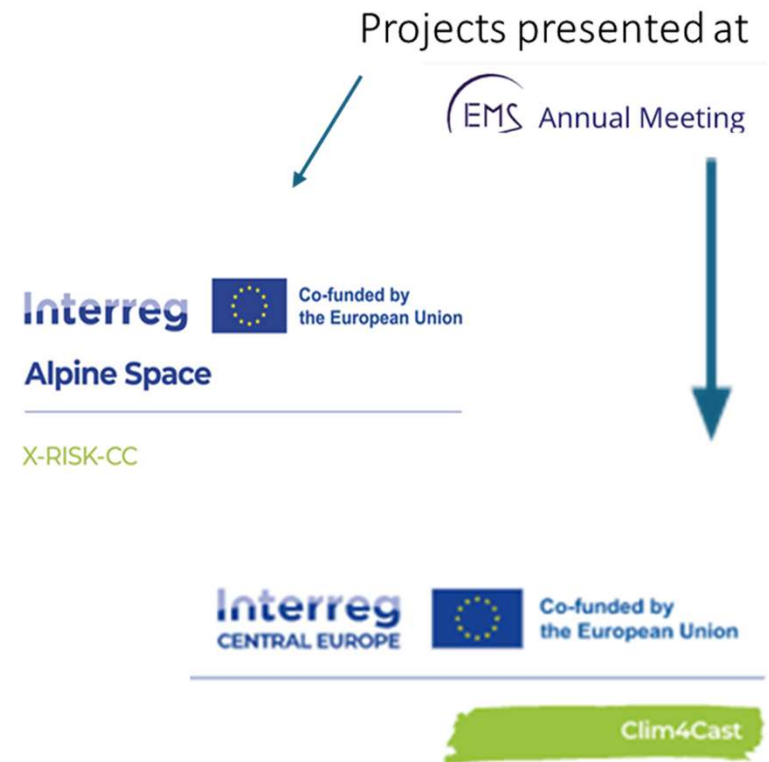
[Photo gallery \(MOPE\) →](#)

DMCSEE CONSORTIUM & COMMUNICATION

Collaboration through projects and..

- Drought Risk in the Danube Region (DriDanube) (*Danube Transnational Programme*)
- Alpine Drought Observatory (ADO) (*Interreg Alpine Space*)
- How to adapt to changing weather extremes and associated compound RISKS in the context of Climate Change (X-RISK-CC) (*Interreg Alpine Space*)
- Central European Alliance for Increasing Climate Change Resilience to Combined Consequences of Drought, Heatwave, and Fire Weather through Regionally-Tuned Forecasting (Clim4Cast) (*Interreg Central Europe*)
- Knowledge transfer on drought issues due to climate change for Armenia (*Višegrad Fund*)
- Integrated drought management system and measures to mitigate the impacts of climate change in Kosovo (*SlovakAid*)

COLLABORATION & NETWORKING



... through wider community

Integrated Drought Management Programme (WMO & Global Water Partnership) & WMO Drought Expert Team

UNCCD Drought Initiative

European Drought Observatory (Joint Research Centre)

International Drought Resilience Alliance (IDRA)

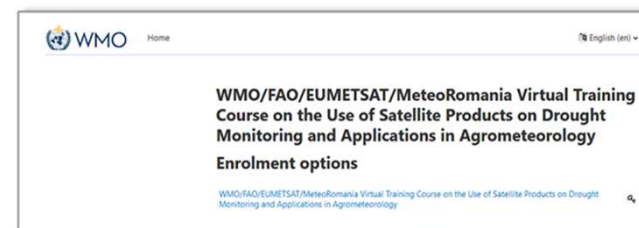
International commission for the protection of the Danube River (ICPDR)

EU Strategy for the Danube region (EUSDR)

COLLABORATION & NETWORKING

.. through capacity building

Organizing trainings, study visits for DMCSEE experts



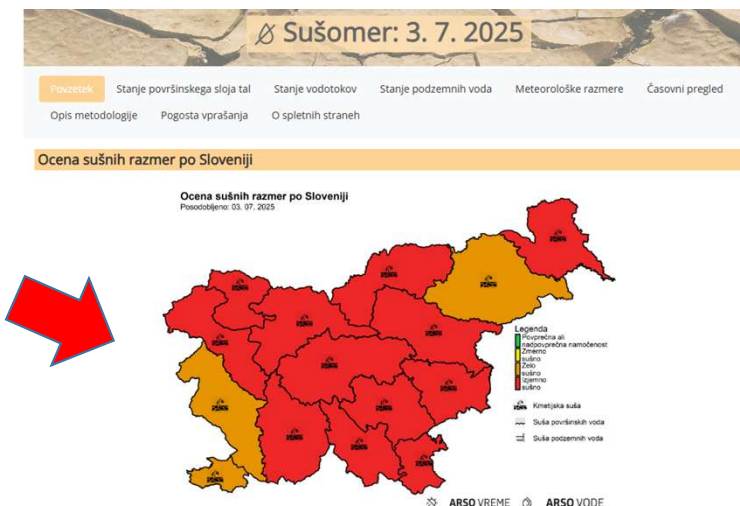
Training on Integrated drought management in Drin basin



Study visit of Armenian experts



Link:
<https://meteo.arso.gov.si/uploads/probase/www/agromet/bulletin/drought/sl>



State of drought in **15 regions** of Slovenia.

Updated **every Thursday** afternoon.

Launched in
2021

For each type of drought/part of the water cycle:

- Description of the past 7 days
- Drought level of the regions on the base of methodology
- Expected trends in the next 7 days
- Current state displayed in graphs (for chosen stations) and maps



The **structure** follows the characteristic of the drought phenomenon:

Meteorological drought as a driver

↓
Agricultural drought / in topsoil

↓
Hydrological drought in surface waters

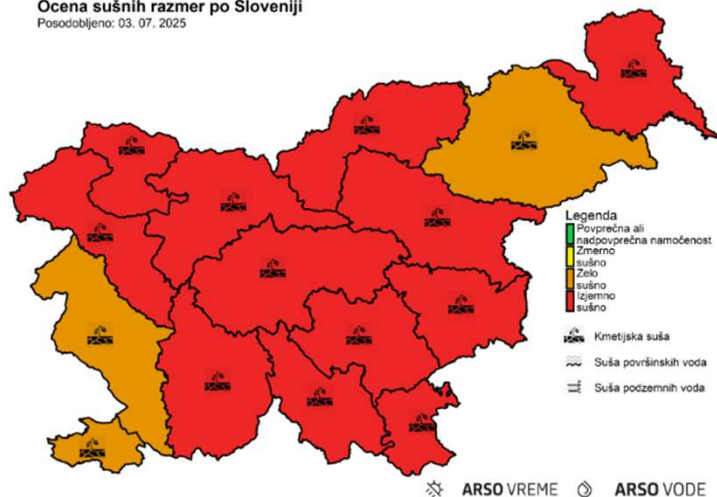
↓
Hydrological drought in ground waters

Sušomer: 3. 7. 2025

[Povzetek](#)
[Stanje površinskega sloja tal](#)
[Stanje vodotokov](#)
[Stanje podzemnih voda](#)
[Meteorološke razmere](#)
[Časovni pregled](#)
[Opis metodologije](#)
[Pogosta vprašanja](#)
[O spletnih straneh](#)

Ocena sušnih razmer po Sloveniji

Ocena sušnih razmer po Sloveniji
Posodobljeno: 03. 07. 2025



Na zbirnem zemljevidu je posamezna regija obarvana z najvišjo izmed stopenj sušnih razmer, ki so prisotna v obravnavanih delih vodnega kroga, ter s pripadajočimi ikonami (površinski sloj tal, vodotoki, podzemne vode). Morebitne manj izrazite stopnje sušnih razmer, ki so ob tem prisotne, so razvidne z zemljevidov v posameznih zavihkih.

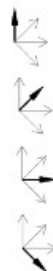
Expected trends in next 7 days:



Agricultural drought

Hydrological drought –
surface waters

Hydrological drought –
groundwater



Substantial improvement (change of 2 levels)

Improvement (change of 1 level)

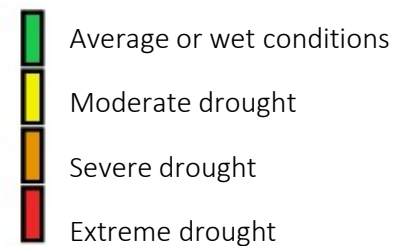
No change

Deterioration

Section Summary / joint map

- Joint map of drought situation in Slovenia
- Summary texts for each part
- Weather forecast for the next 7 days
- Colour of region = the worst detected drought level (+ corresponding icon)

Legend:



Drought monitoring methodology used in Slovenia (for Drought meter)

- Variables, statistics, indicators in use:

Icon	Type of drought	Variable used for the indicator:	Statistics applied to make an indicator:
	Agricultural drought - state of the top soil layer	<u>Surface water balance</u> (RR minus ETP using Penman-Monteith), calculated for most representative station	<u>Percentile analysis of 30-day accumulations*</u> , reference: 1991-2020
	Hydrological drought in surface waters	<u>River discharge</u> measured at few chosen stations per region	<u>Percentile analysis of 30-day moving average</u> , reference: 1991-2020
	Hydrological drought in groundwater	<u>Groundwater level</u> measured at few chosen stations per region	<u>Percentile analysis of 7-day moving average</u> , reference: 1991-2020

* Observed window was determined via study analysis on past years (dry, normal, wet)
 → Best match with past reported drought impacts (NRN)





Time overview of drought levels per region for all 3 type of droughts

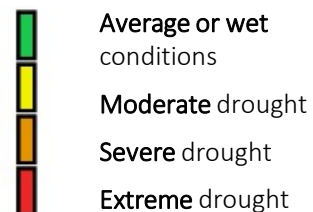
---> Agricultural drought

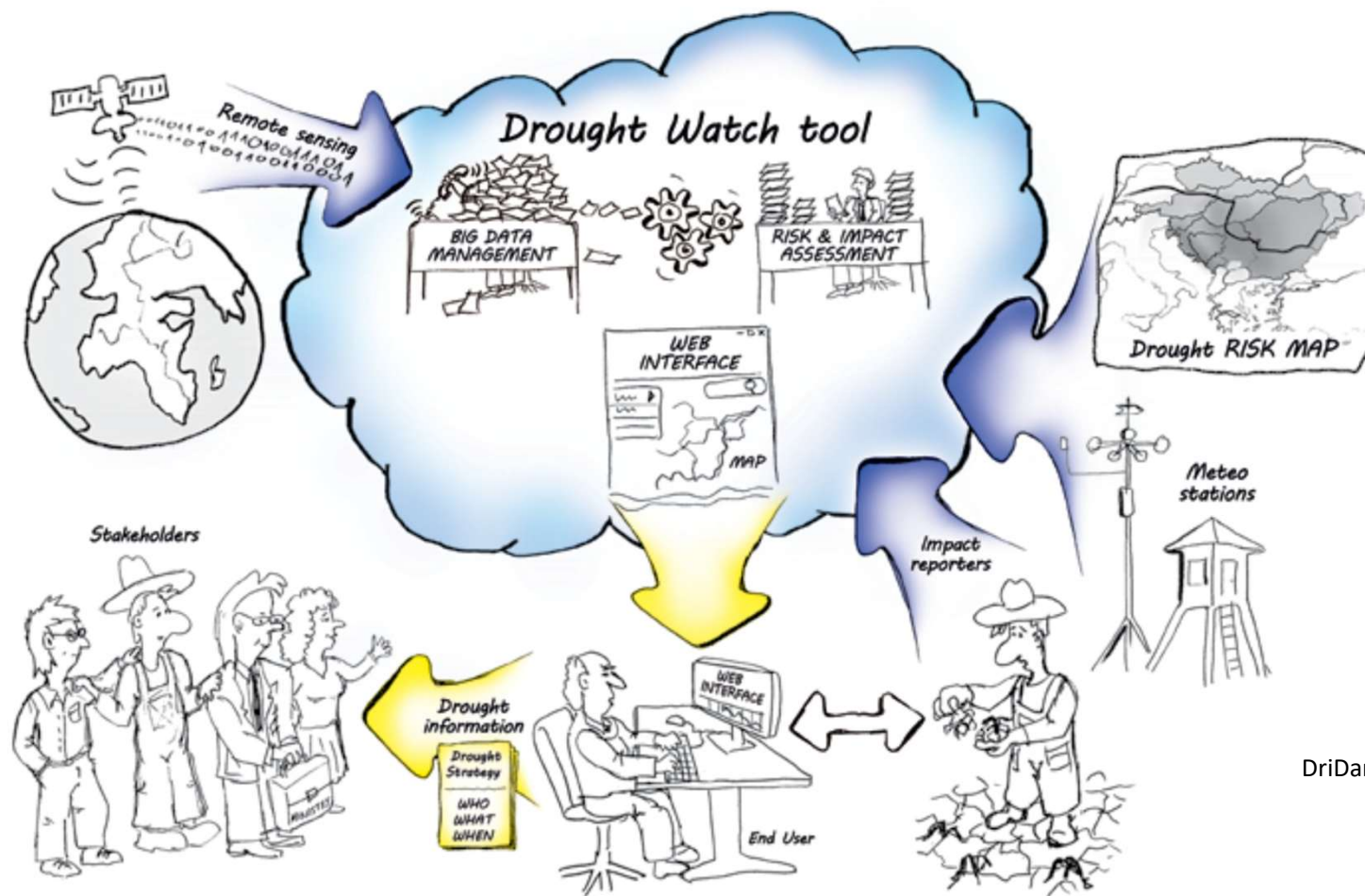
Stanje površinskega sloja tal



Št. regij po stopnjah sušnosti:

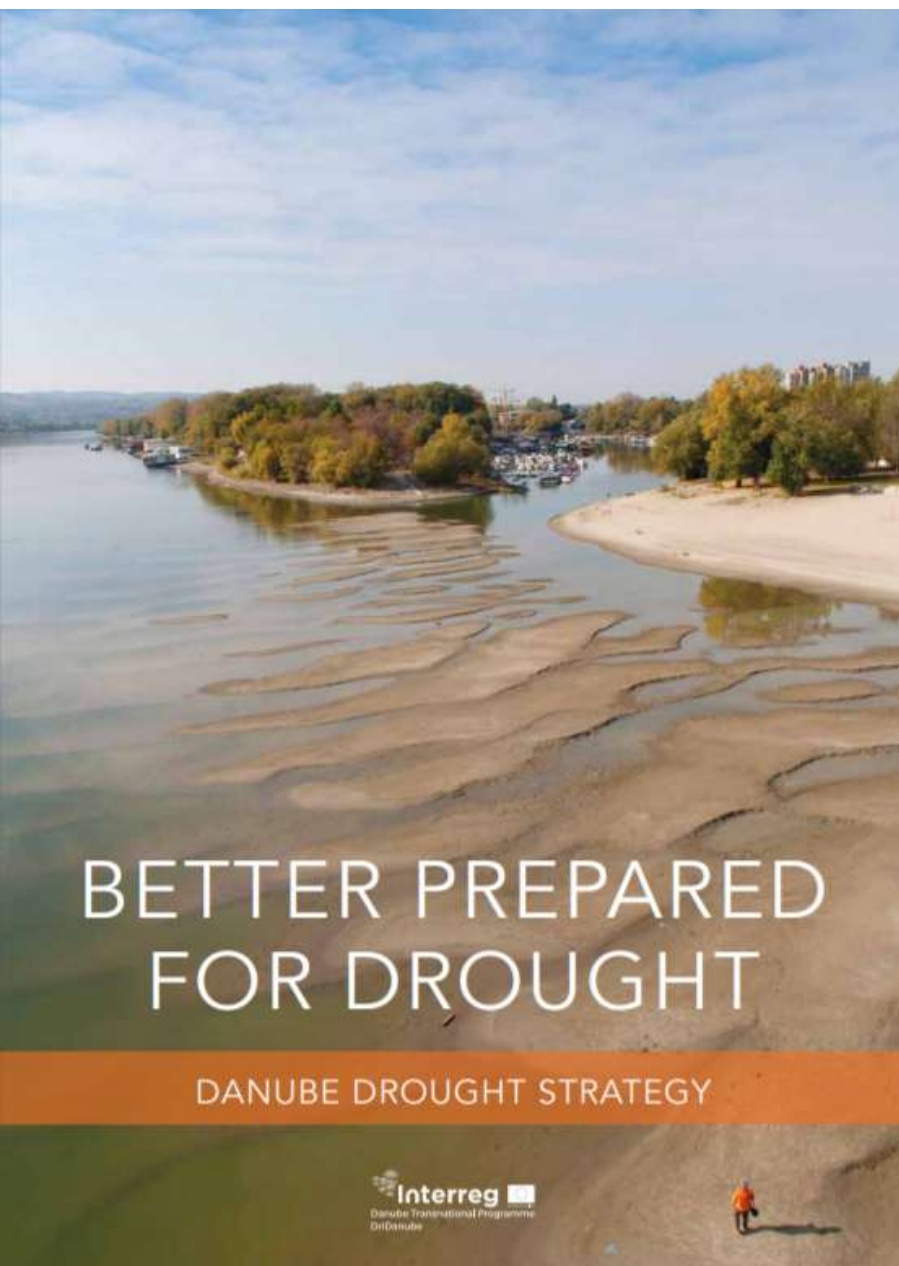
običajno	1	12	15	15	15	15	15	1			3	6	6	6	8	4	12	12	11	15	15	9	14	15	15	15	15	15	15	15	11	13	13	14	14	8	3			4	5	11	15	12	12	12	4	6
zmerno	4	3						14	6		11	8	8	8	6	10	2	3	4			6	1							4	2	2	1	1	6	10	5			8	9	4		3	3	3	6	4
zelo	10							9	15	1	1	1	1	1	1	1																		11	2	9	12	3	3	1					5	5		
izjemno																																						1	3	12								





DriDanube project, 2019

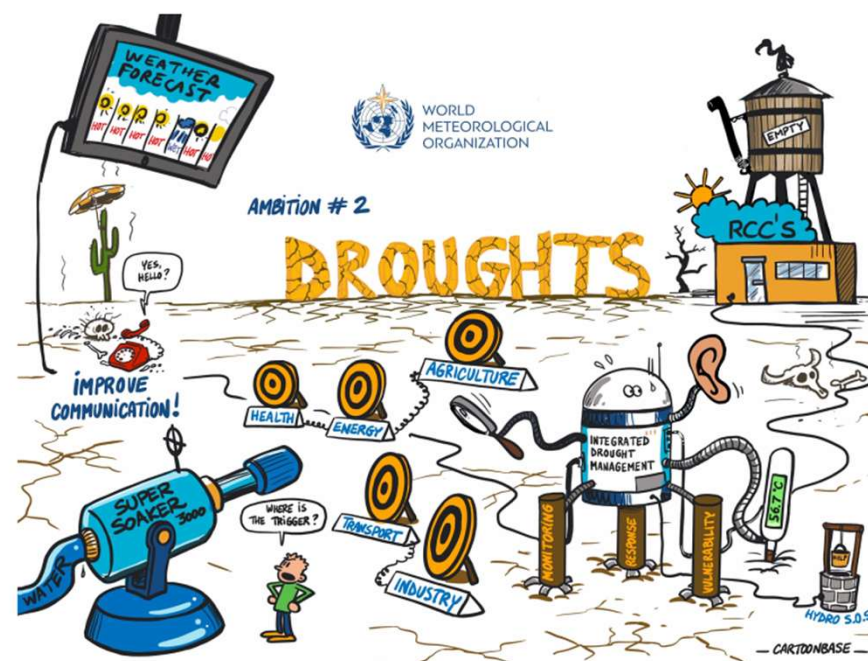
Proactive drought management comes to life through interdisciplinary cooperation among policy makers at all levels and a collaborative effort.



<https://dtp.interreg-danube.eu/approved-projects/dridanube/outputs>

The foundation for strengthening drought resilience in the SEE-Danube region

Everyone is prepared for drought



WMO Vision and Strategy on Hydrology 2023

- Continued implementation & further development of **drought monitoring**, including forecast.
- **Strengthening regional resilience**: contributing to drought resilience in DMCSEE countries through EU and UNCCD cooperation, WMO/IDMP (leading Expert Team on Drought).
- **Research & innovation needs**: remote sensing, hydrological changes, sector impacts, vulnerability assessments, adaptation strategies, and drought forecasting.
- **Knowledge sharing & networking**: promoting awareness, collaboration (COST CA23108), and building drought resilience network.

Contact: andreja.susnik@gov.si

Future plans



Search layers

Clim4Cast monitoring and
forecasting tool layers

AWD
Soil moisture deficit

AWP
Drought intensity in soil
layers

Soil layers

40cm 100cm 200cm

Temporal Resolution

daily

Extreme Severe Moderate No drought

Exceptional Significant Minor

Learn more...

AWR
Relative soil saturation

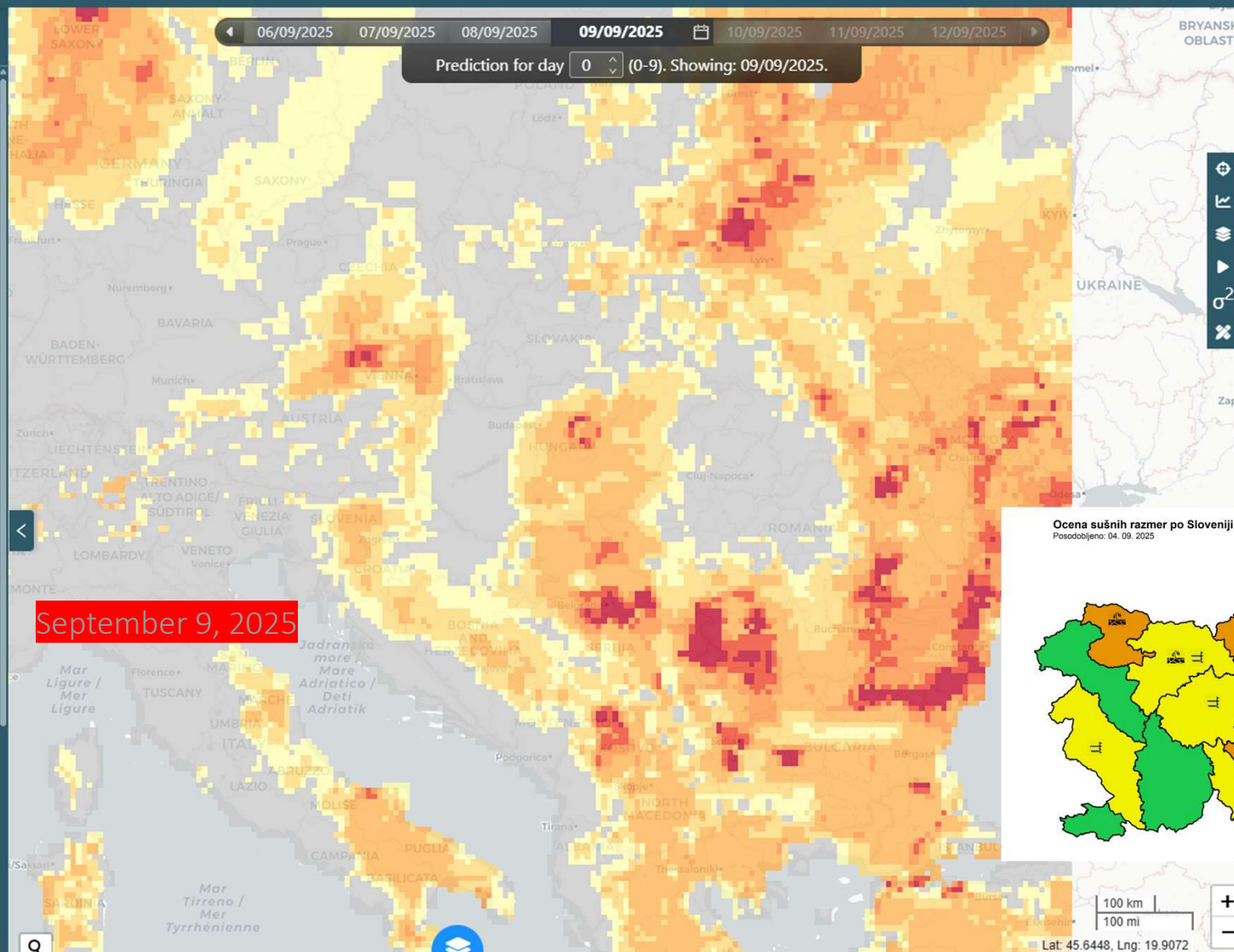
DFM
Fuel moisture

FWI
Fire weather index

HI
Heat index

UTCI
Universal thermal climate
index

EUROMETSAT LSA SAF



Ocena sušnih razmer po Sloveniji
Posodobljeno: 04. 09. 2025

