Climateurope2

Addressing Mediterranean Water Challenges: The Role of Climate Services

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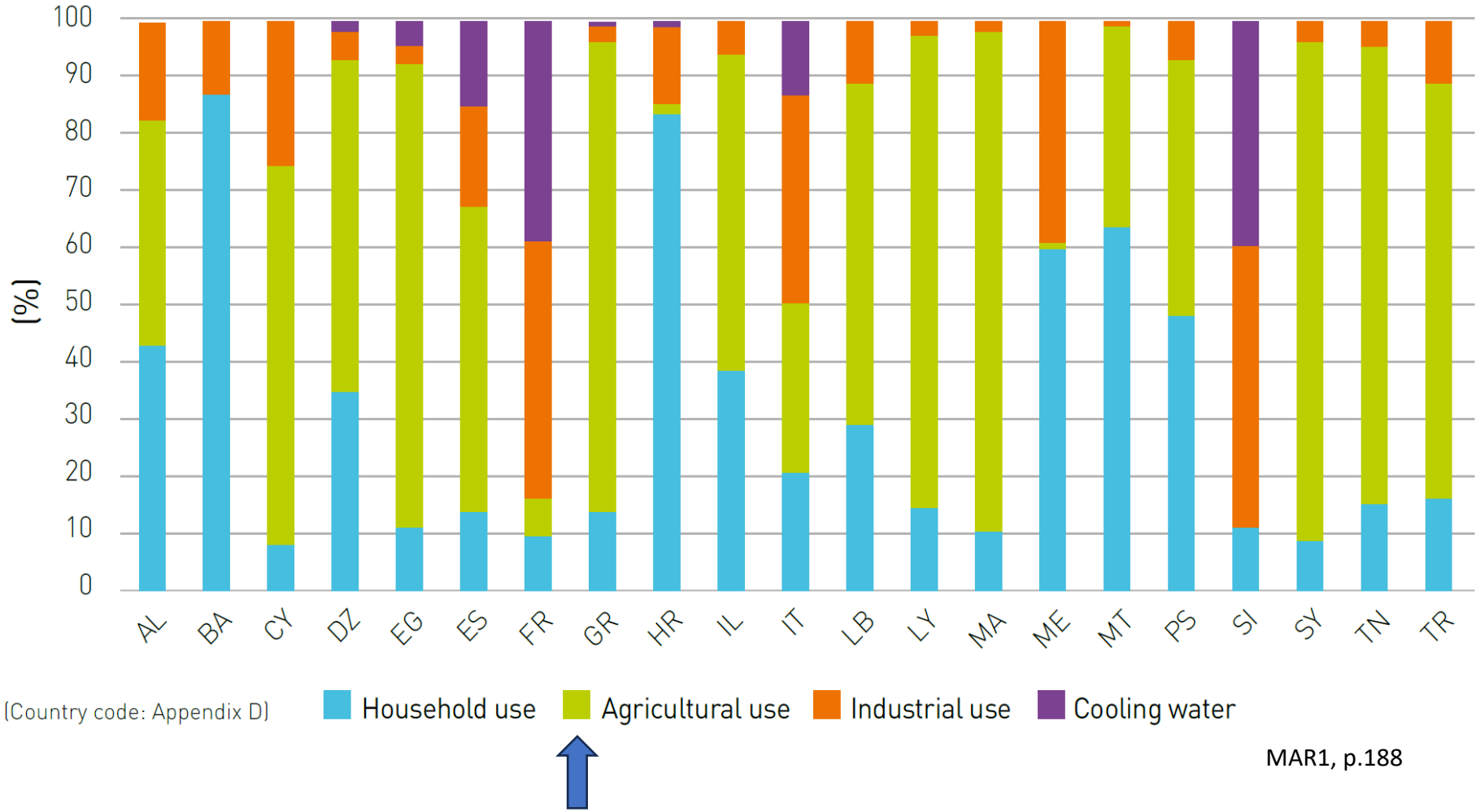
Mediterranean waters. Facts and figures

- The **total renewable freshwater resources** of the countries belonging to the Mediterranean Basin are estimated to between 1,212 $km^3\ yr^{-1}$ and 1,452 $km^3\ yr^{-1}$, distributed unevenly
- **Northern Mediterranean countries hold approx. 72 to 74% of the resources**, while the eastern Mediterranean (including Turkey) and the southern Mediterranean countries (including Egypt and the Nile) share the remaining approx. 26 to 28%
- Especially in southern and eastern Mediterranean countries **non-renewable "fossil" groundwater resources** account for almost 66% of the total groundwater
- The dependency among countries concerning freshwater resources is common. **In the southern and eastern Mediterranean, more than 60% of the surface water is transboundary**
- The **northern** Mediterranean has **36%** of the population and **72% to 74%** of the renewable freshwater, the **east 24%** and **19.5% to 21%** and the **south 40%** and **5% to 8.5%**, respectively
- **180 million people** in the southern and eastern Mediterranean suffer from **water scarcity** (<1,000 $m^3\ capita^{-1}\ yr^{-1}$) and **80 million** people from **extreme water shortage** (<500 $m^3\ capita^{-1}\ yr^{-1}$)

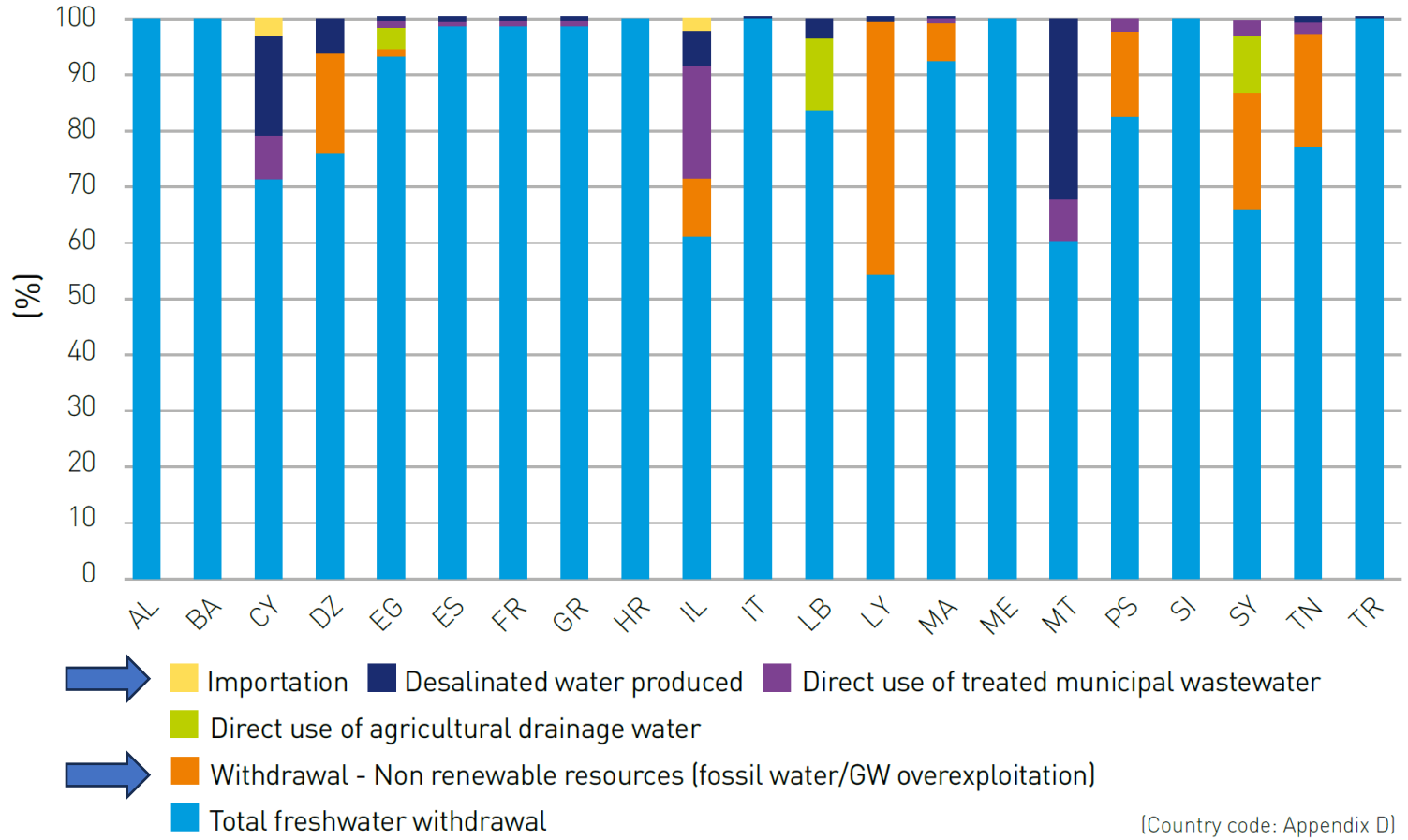
MAR1

Water demand per sectoral use as percentage of total water demand



MAR1, p.188

Sources of water supply as percentage of total water supply



MAR1, p.189

Evolution of the biogeochemical cycle of water

- In the Mediterranean region around **90% of the annual rainfall** can be lost through **evapotranspiration**
- In the Maghreb under RCP4.5, **potential evapotranspiration (PET) is projected to increase** (+6% to +11%) for 2036–2065 period and (+7% to +14%) for 2066–2095 period compared to historical period (1976–2005)
- Overall, **soil moisture is expected to decrease** by the end of this century. Under RCP2.6 and RCP 6.0 scenarios, the European Mediterranean region is expected to exhibit increase in area affected by soil moisture **drought** by 14.1% and 16.3%, respectively.
- The median **reduction in annual runoff** is projected to almost double from about 9% (likely range 4.5–15.5%) at 1.5°C to 17% (likely range 8–25%) at 2°C
- **Flood risk, associated with extreme rainfall events, are likely to increase** due to **climate** change, but also due to **non-climatic factors**, such as increasingly sealed surfaces in urban areas and ill-conceived storm water management systems
- In the Mediterranean, **water availability could be reduced by 2-15% for 2°C warming**, among the largest decreases in the world

MAR1

Water challenges and CCA

- Important challenges to groundwater quality in coastal areas will probably arise from **salt-water intrusion** driven by enhanced extraction of coastal groundwater aquifers and sea-level rise, as well as from increasing water pollution in the southern and eastern Mediterranean
- Under a global warming of **4°C vulnerability** in the Mediterranean is expected to increase, regardless of the level of **adaptation potential**.
- Robust design, construction and operation of **infrastructures** can alleviate climate driven hazards and can be a **no-regret measure for climate change adaptation**.
- The main difference between **IWRM and CCA** is the focus on current and historic issues of IWRM compared to the (long-term) future focus of adaptation, but IWRM is increasingly considering a CCA perspective.
- Many decisions relating to water, including adaptation, are sensitive to **uncertainty** and imply a particularly high risk of "**maladaptation**". Uncertainty should encourage a dual approach: **"no regret" actions and adaptation**.

Solutions

- Supply side adaptation measures:
  - Desalination
  - Wastewater treatment and reuse
  - Artificial recharge of groundwater
  - Inter-basin transfers
  - Dams
  - Virtual water trade
- Demand-side adaptation measures
  - Efficient water use in households and economic sectors
  - Agricultural management for water conservation
  - Reduction of water losses

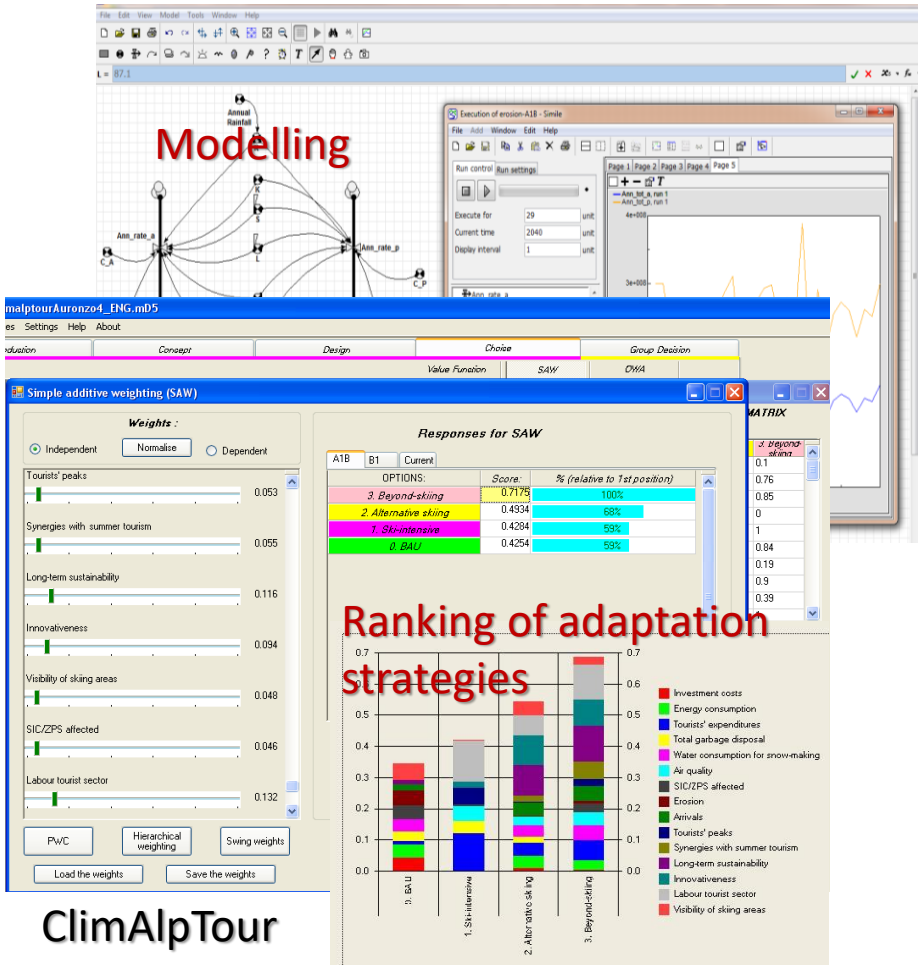
MAR1

Main messages about climate services

- The main challenges for the Mediterranean are to fill data and knowledge gaps across countries, and to foster the development of high-level climate services, including **early warning systems**. More research is needed for short- and medium-term projections, as well as large scale programs at the Mediterranean scale to address pressing challenges.
- Successful **adaptation strategies** are based on combining different approaches, i.e. on farming practices (e.g., varieties, rotational patterns, crop diversity, agroforestry) and management (e.g., diversification of income, modifying irrigation practices). **Sectoral co-designed climate services** may help reduce risks linked to unfavourable climate conditions and extremes.
- Despite some initiatives, the **level of climate services** offered by the scientific communities in most Mediterranean countries remains **insufficient**, even if such services can be decisive in providing vital information on short-to intermediate-term climate trends to planners and decision makers involved in **agricultural and water policies**.
- The use of sectorial climate services in **food production** at different spatio-temporal scales will be a key adaptation measure to **reduce the risks and alleviate the impacts of extreme events**.

MAR1

About climate services…



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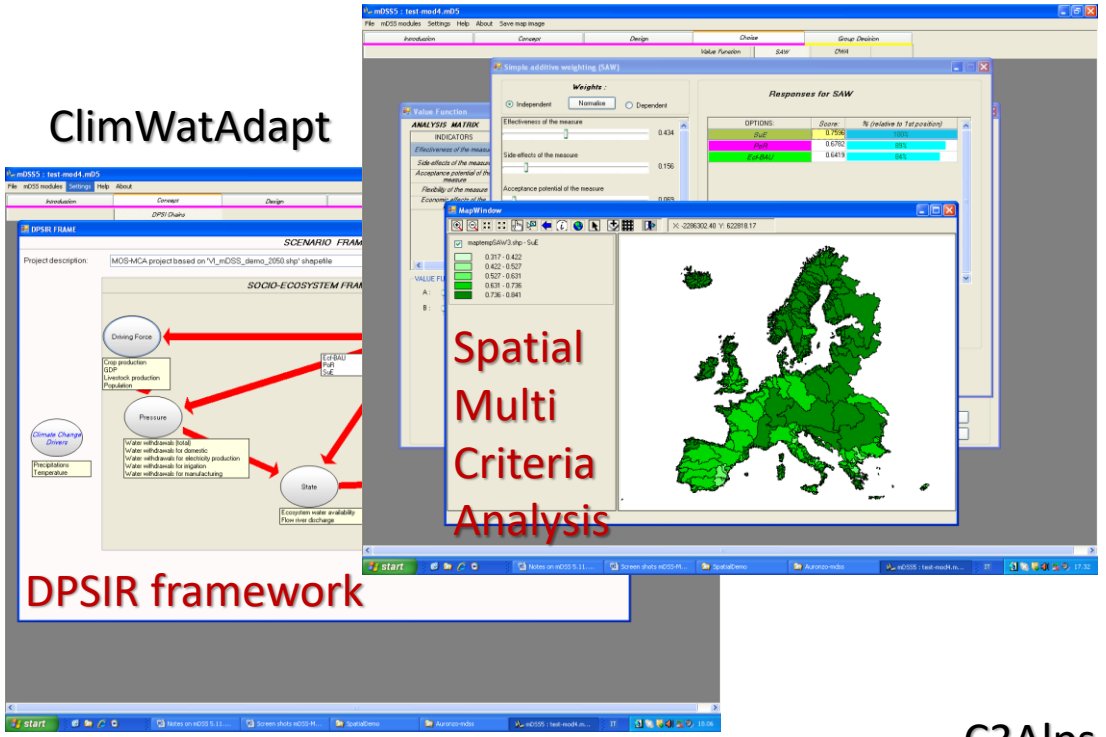
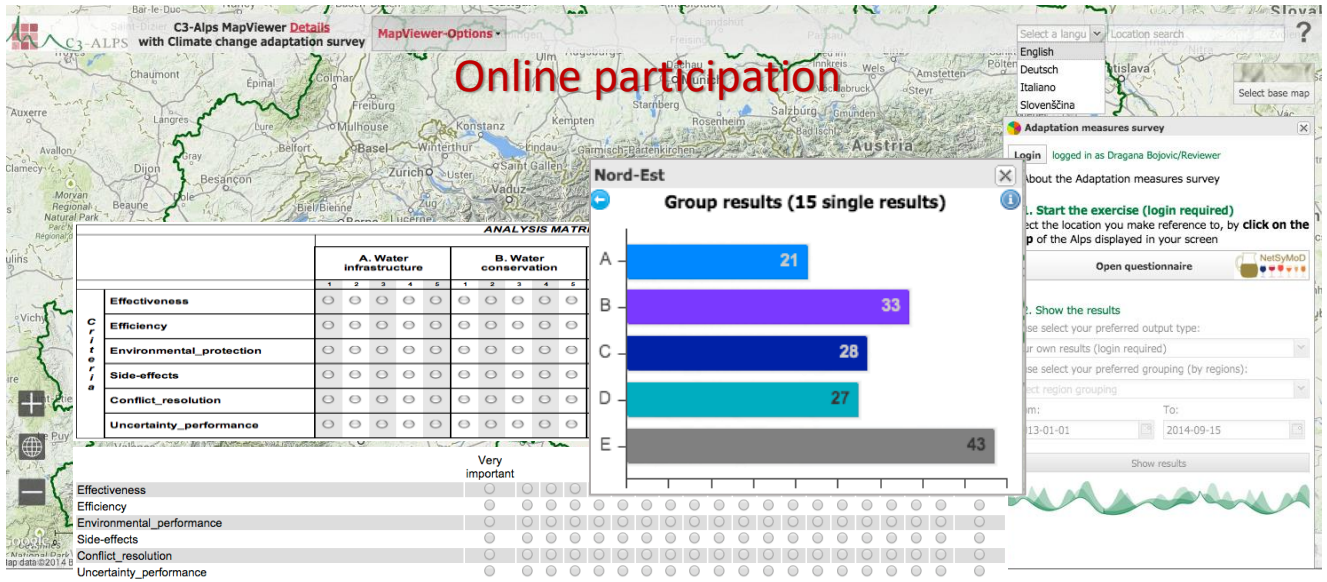


C3Alps



The mDSS 20-year experience

- **Legislation and regulations** are important drivers ⇨ objectives and constraints; roles of social actors; needs for innovative [DSS] tools implementation of new [DSS] procedures.

↳**Success criterion for DSS** ⇨ incremental improvement of policy implementation and management strategies.

↳**Key DSS role** ⇨ to provide an ICT environment facilitating transfer of scientific knowledge.

- **Prerequisites for successful DSS applications** ⇨ methodologically sound DM framework, flexibility, simplicity, and effective communication are.
- The **mDSS experience**:

↳mDSS has **lost functionalities** in the integration with simulation models and spatial data, while maintaining the DPSIR interface for facilitating problem exploration and public participation and the MCA capability.

↳mDSS has **gained flexibility** of use and the effective communication through a rather simple interface, but the need to develop ad hoc modelling approaches and case-specific indicators for each new implementation have limited its use only to experienced scholars.

Future DSS developments

- They should:
- **target existing and consolidated institutional and governance frameworks** to facilitate the adoption of innovative approaches by relevant authorities;
- **provide a platform** to facilitate networking, cooperation, and the exchange of experiences, including tools, models, and data, in order to develop an open community of practice of DSS developers and users;
- **invest in training and capacity-building activities**, to facilitate dissemination, improve competences of professional facilitators, and build trust and ownership of targeted end users;
- **develop harmonised procedures** to take advantage of transnational data infrastructures;
- and, in general: **learn from past successes and failures**.

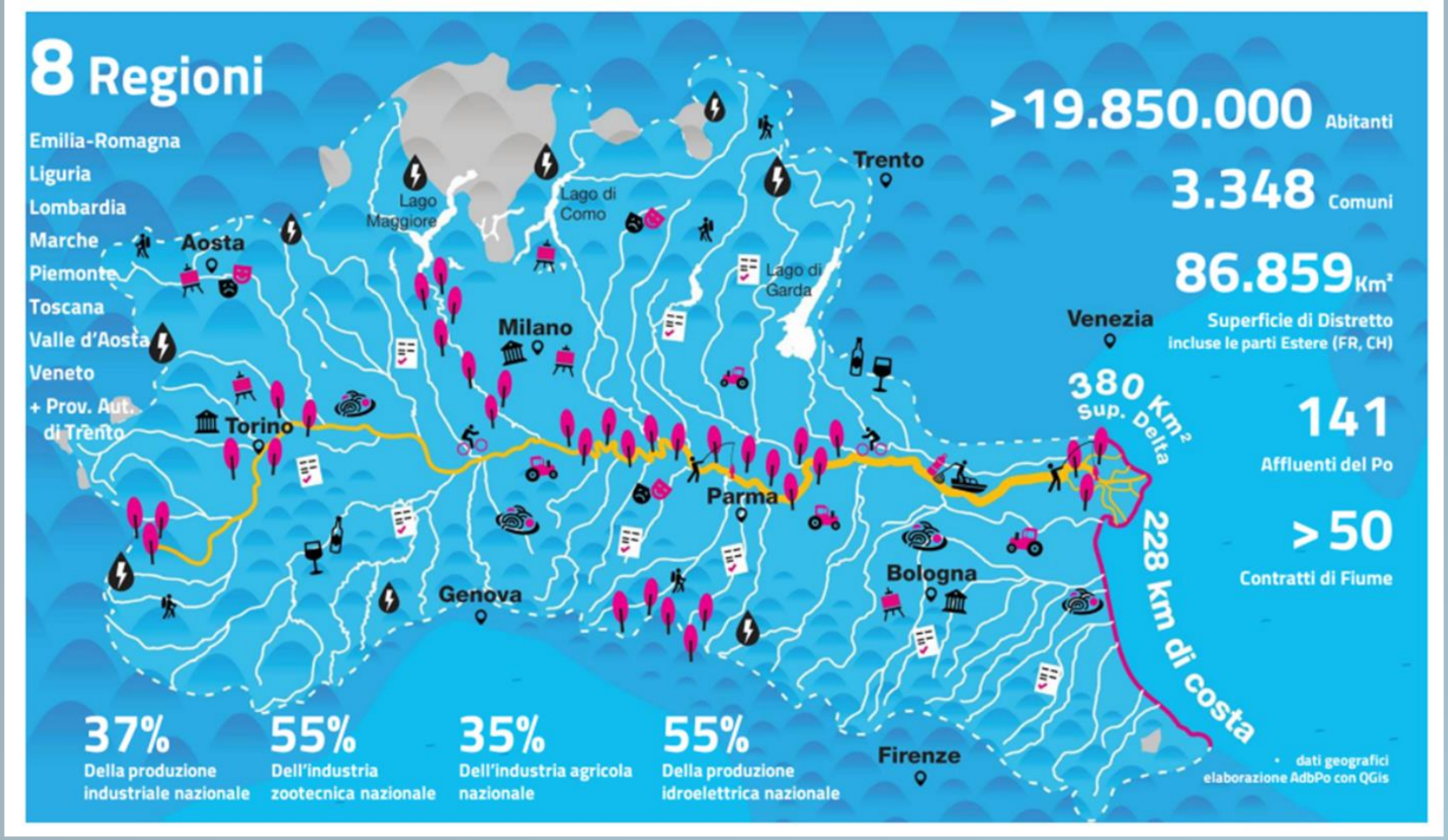
«Risk management and water use in a changing climate: the case of the Po River District»

Autorità di Bacino Distrettuale del Fiume Po

Francesco Tornatore

Resource Usage Planning and Management Sector

The numbers of the District



The Po River Basin District is a strategic area in economic, social and political terms.
The district includes 8 regions, almost 20 million inhabitants, 37% of national farms, 55% of livestock industry and 35% of farms. In addition, 55% of hydropower is produced.
About 50% of Italy's GDP is produced in the district.

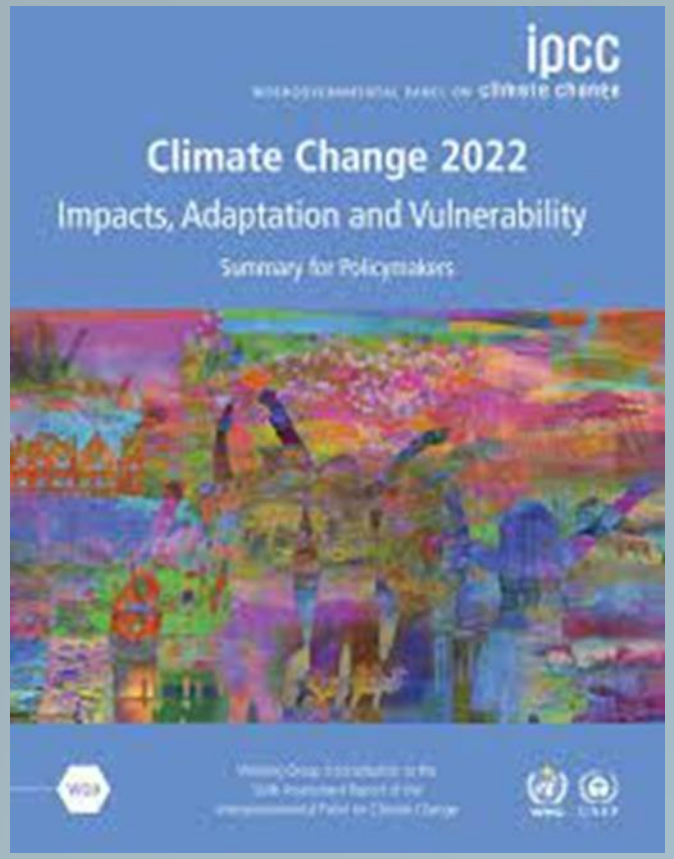
Water availability in the District

The average annual precipitation on the Po River Basin District, in the period 1991-2020, was about 990 mm.
Considering the whole the District, the average annual inflow volume was about **86 billion m³**.
Of these, about **48 billion m³** are conveyed to the sea by the Po river, while the remaining **38 billion m³** represent the sum of the evaporated volumes, infiltrated volumes and volumes used by plant activity.

Afflusso meteorico Distretto Po (fiumi: Po, Reno, Savio e Lamone)					
Anno minimo 2017		**Media** (anno prossimo al valore medio: 2016)		**Anno massimo** 2014	
Precipitazione mm	**Volume** miliardi di m³	**Precipitazione** mm	**Volume** miliardi di m³	**Precipitazione** mm	**Volume** miliardi di m³
735	**64**	**995**	**86**	**1.389**	**121**

Deflusso idrologico Distretto Po (fiumi: Po, Reno, Savio e Lamone)					
Anno minimo 2007		**Media** (anno prossimo al valore medio: 2011)		**Anno massimo** 2014	
Portata m³/s	**Volume** miliardi di m³	**Portata** m³/s	**Volume** miliardi di m³	**Portata** m³/s	**Volume** miliardi di m³
856	**27**	**1.552**	**48**	**2.315**	**73**

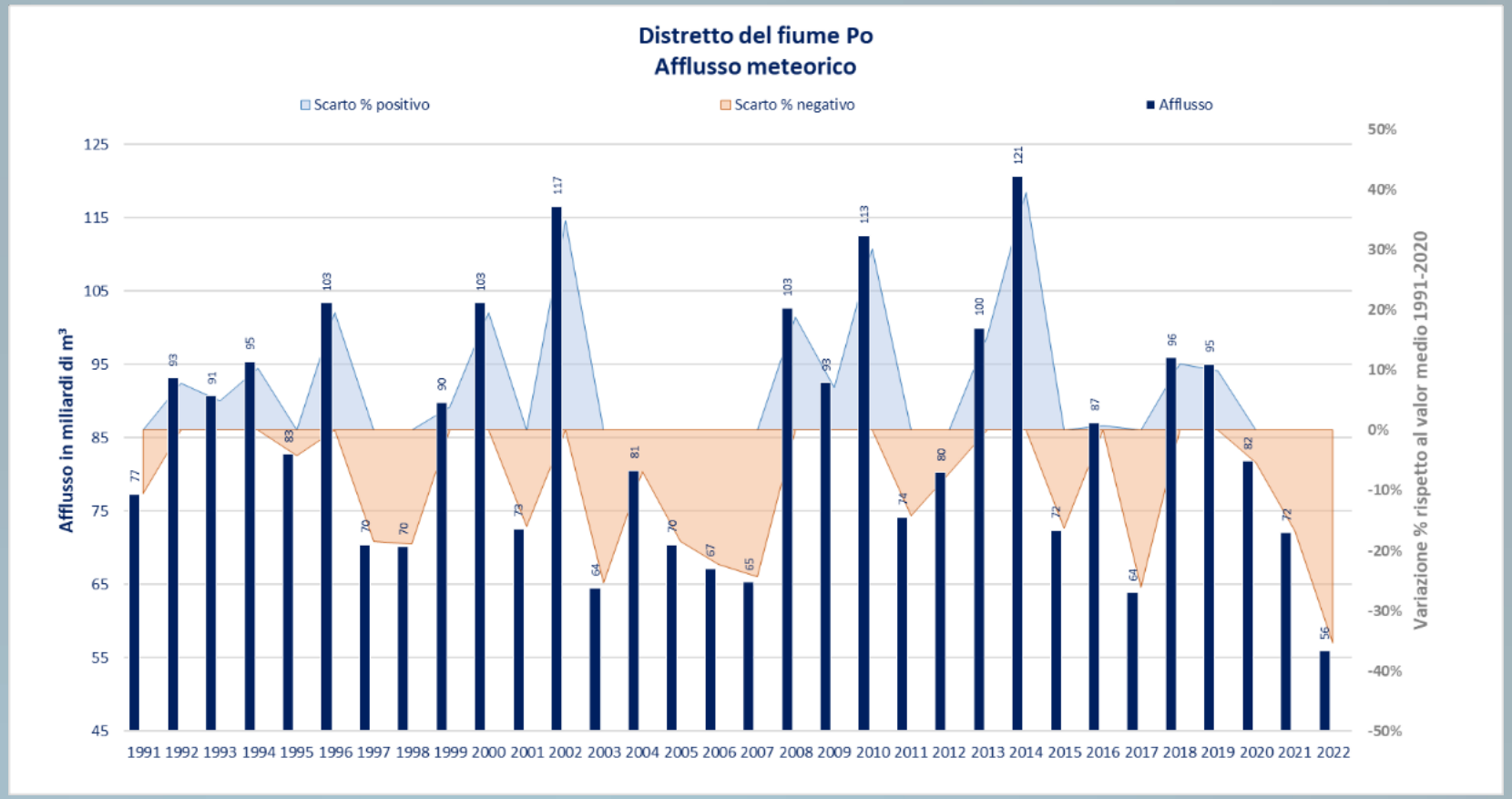
The District and climate change



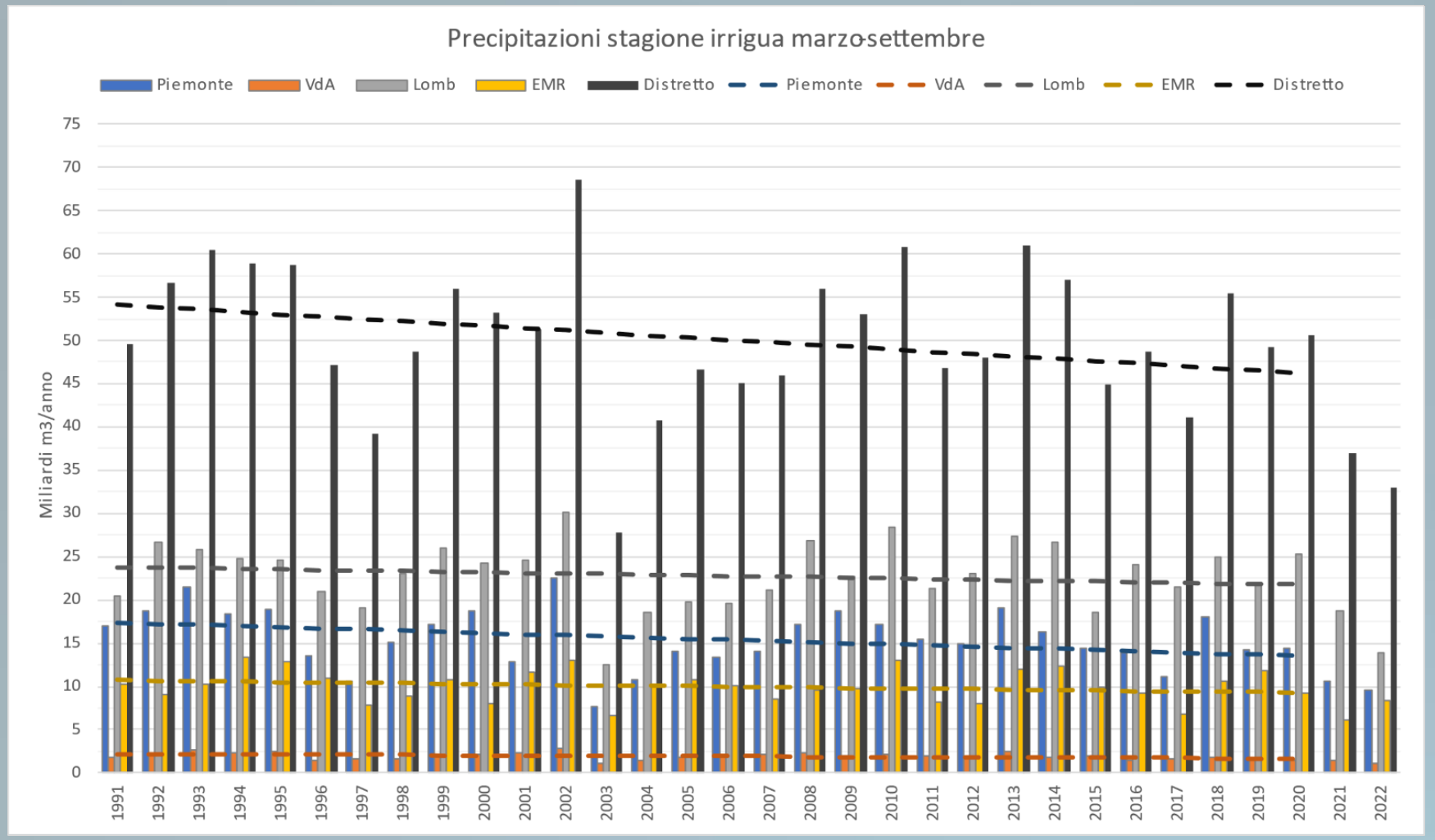
According to global and regional climate forecasting models, the District is located in the climate transition zone between the Mediterranean and Northern Europe, where uncertainty about the future climate is higher than in other European areas.

The distribution of inflows in the District

The Po River District has always been characterized by a marked inter-annual meteorological and hydrological variability, but since 2000 there have been seven years in which the hydro-climatic balance (i.e. the difference between precipitation and evapotranspiration) has been negative with an increase in the intensity of individual rainfall events but an overall reduction in the number of total events.

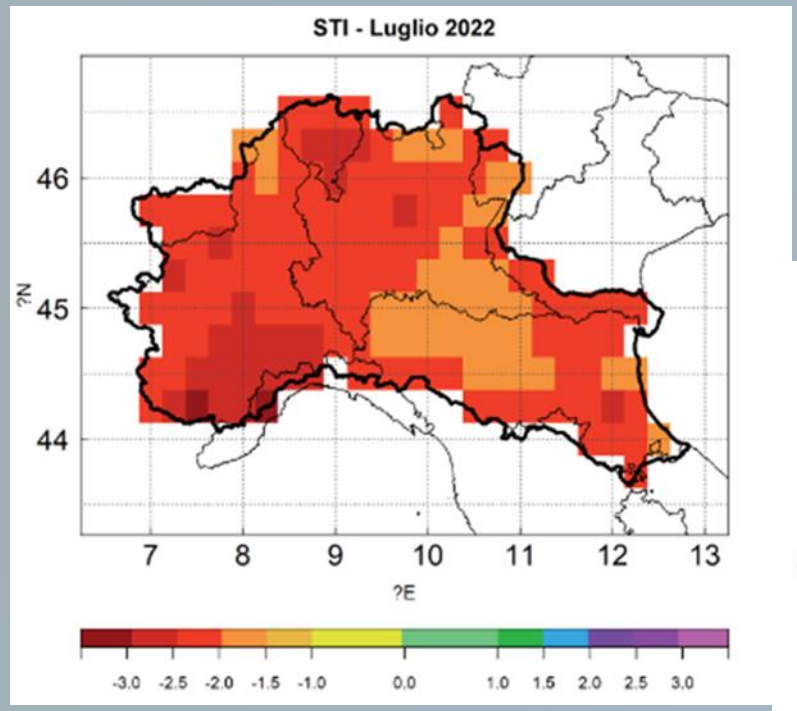


The distribution of inflows in the District

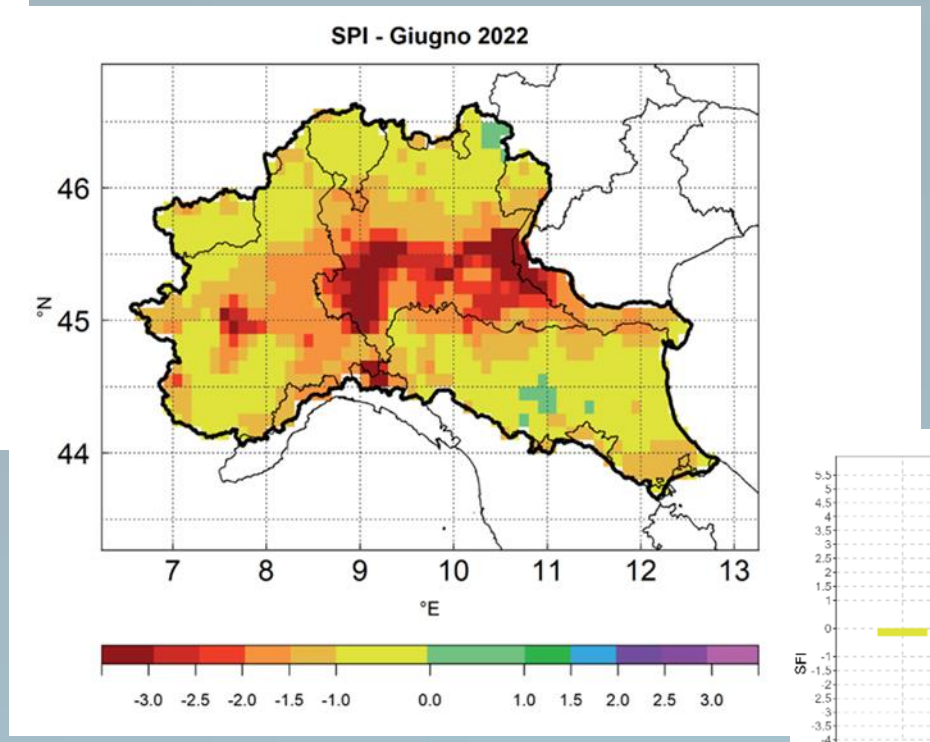


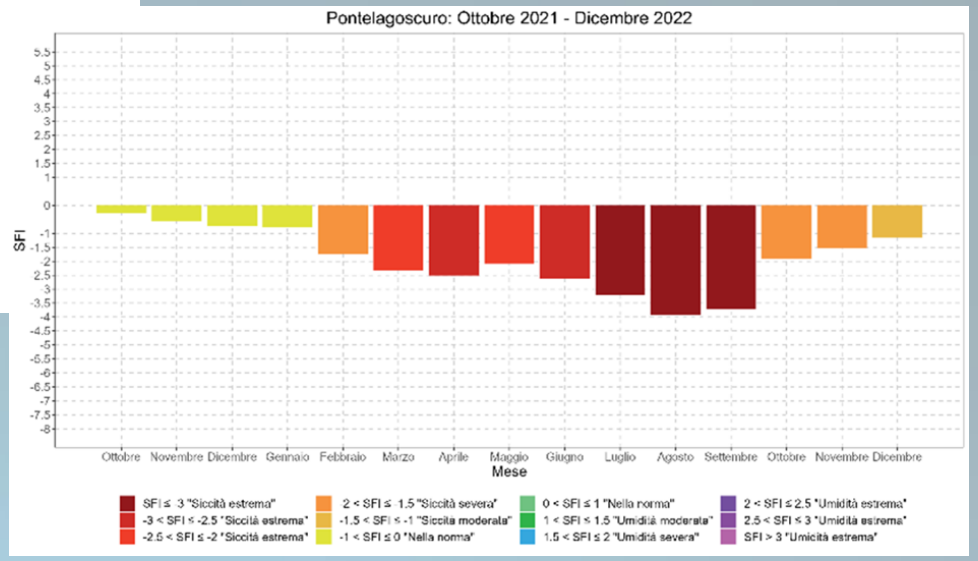
In the period 1991-2022, no statistically significant changes are observed annually in the overall volume of rainfall; but if we refer only to the irrigation season (April – September) then the downward trend in rainfall is much more evident.

Variation in precipitation regime and the 2022 water crisis

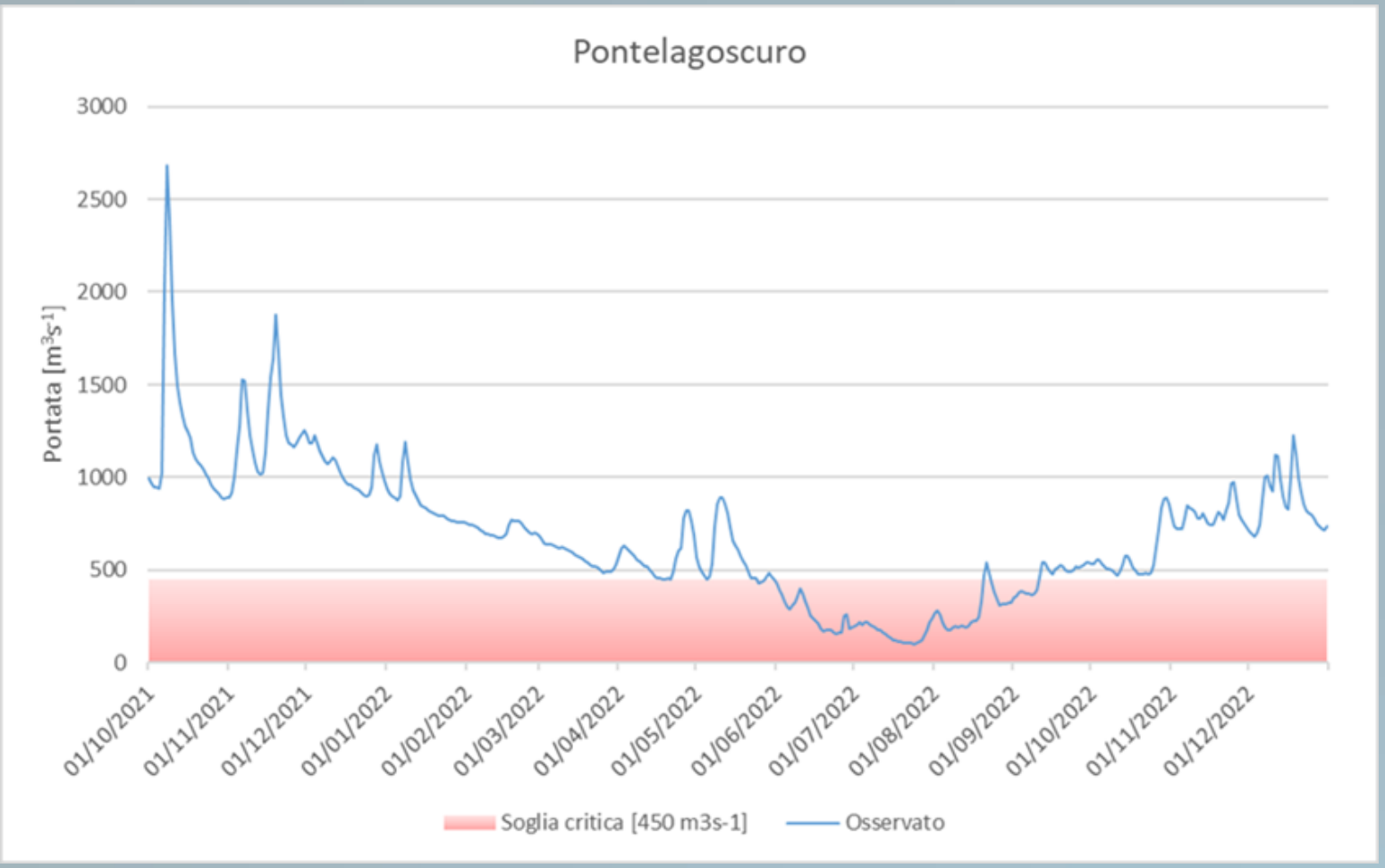


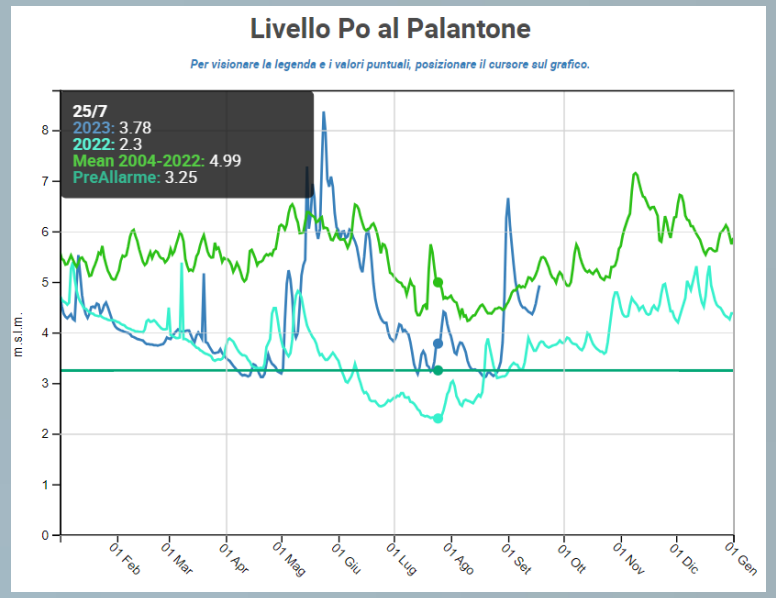
In 2022, the annual inflow of the District was the lowest ever: only 56 billion m³. All the meteorological and climatic indicators recorded exceptional values compared to the reference averages.

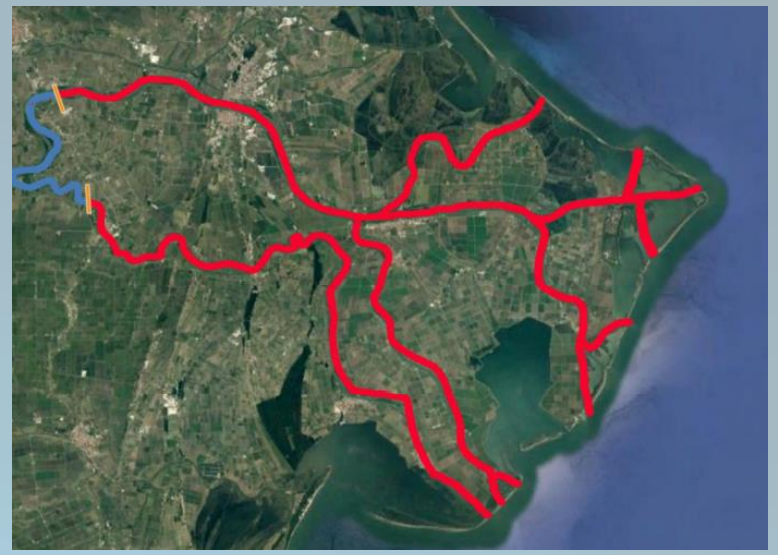




Drought or scarcity?







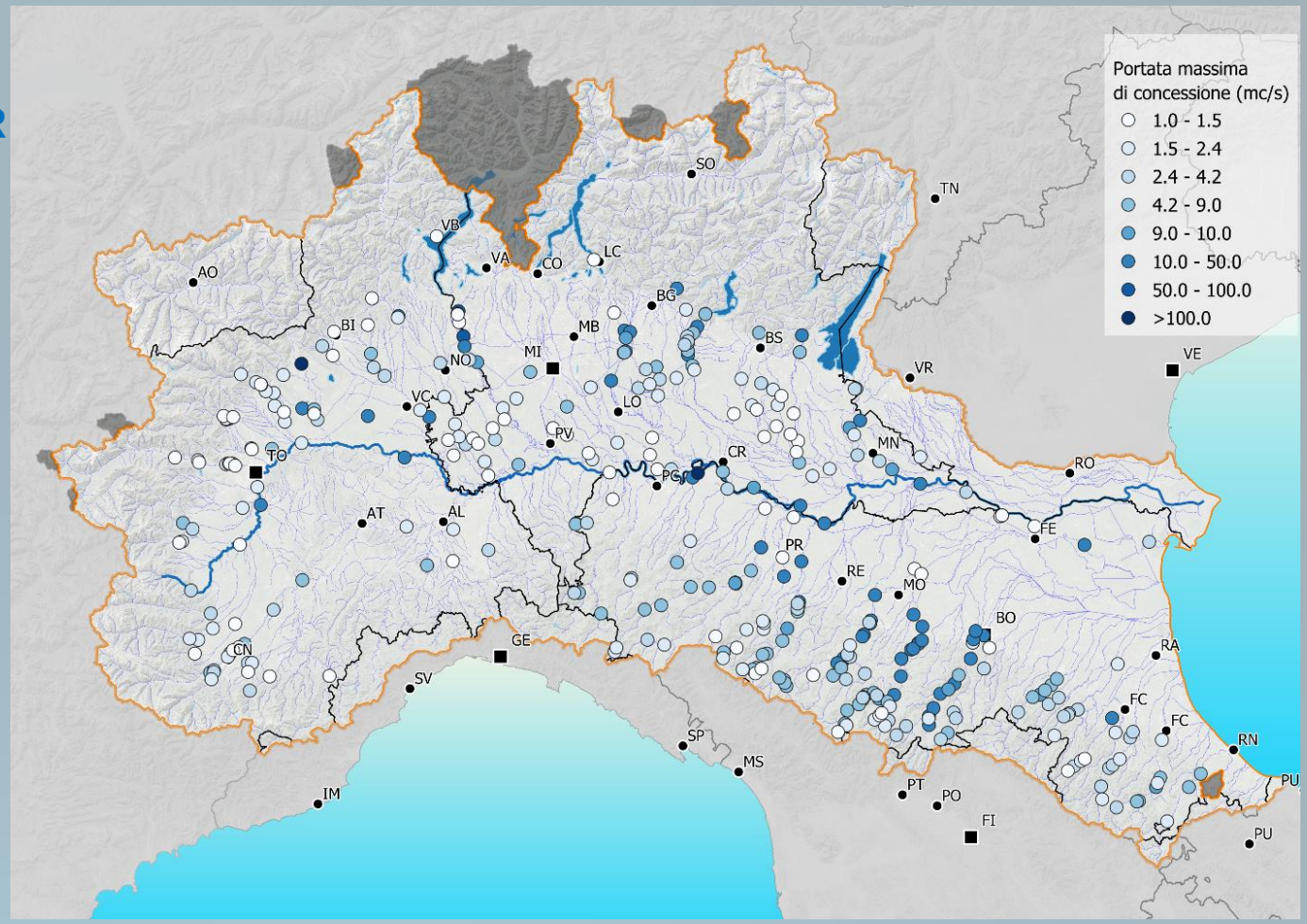
The flow rates of the Po river from the beginning of June to the end of September were constantly below 450 m^3/s and this led to an extensive salt intrusion that undermined the irrigation throughout the Delta area.

Resource uses in the District

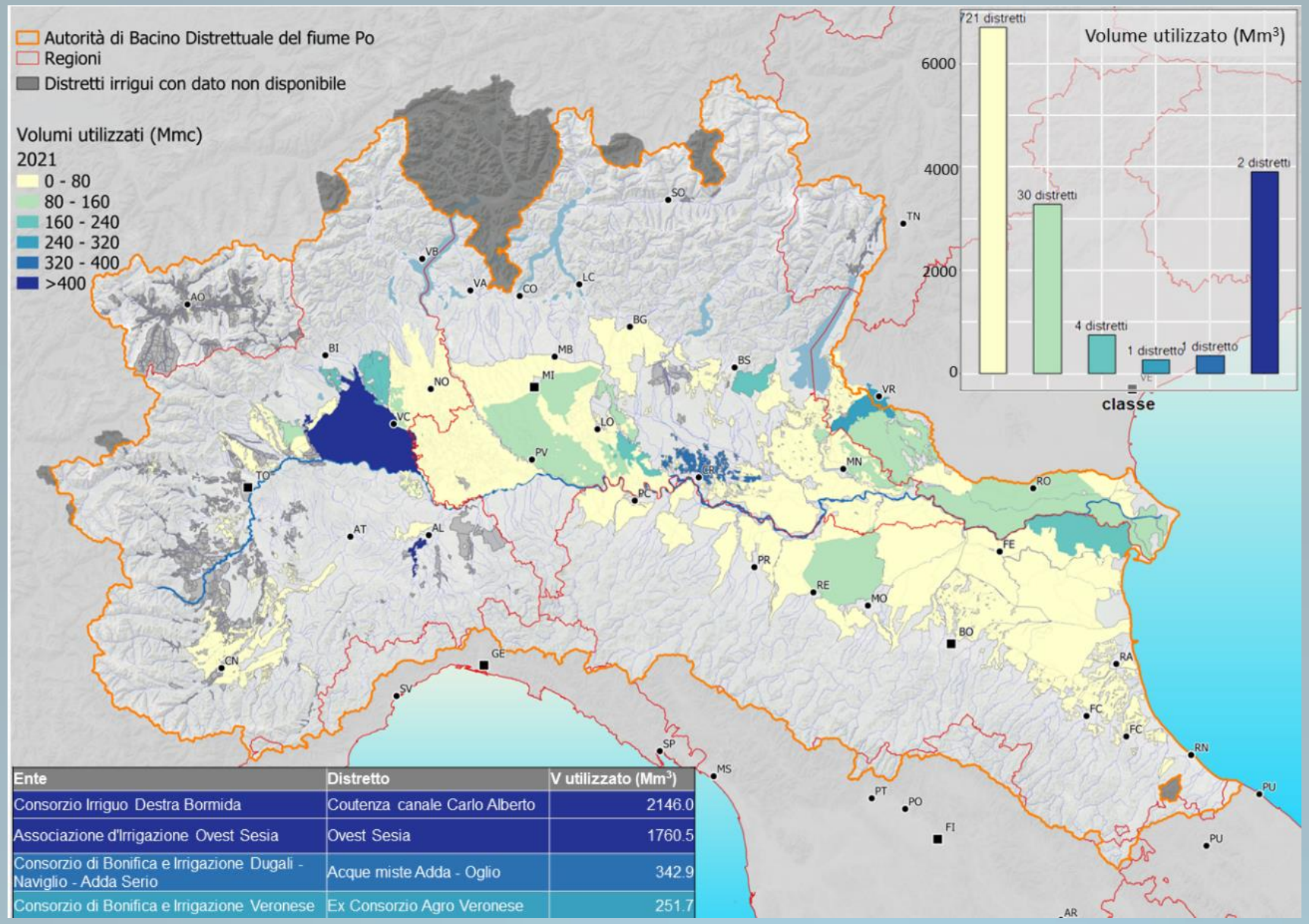
23 BILLION (AVERAGE) OF WATER WITHDRAWN FOR DIFFERENT USES

- 15 BILLION IRRIGATION USE
- 3 BILLION CIVIL USE
- 2 BILLION INDUSTRIAL USE
- 3 BILLION NON-DISSIPATIVE USES (Energy production, navigation, etc.)

Volume granted for derivations > 1 m3/s (billion m³/year)					
Regione	Piemonte	Lombardia	Emilia-Romagna	Veneto	**Totale**
Complessivo	7,76	11,46	1,60	0,03	**20,9**
Irriguo	7,12	10,92	1,43	0,03	**19,5**



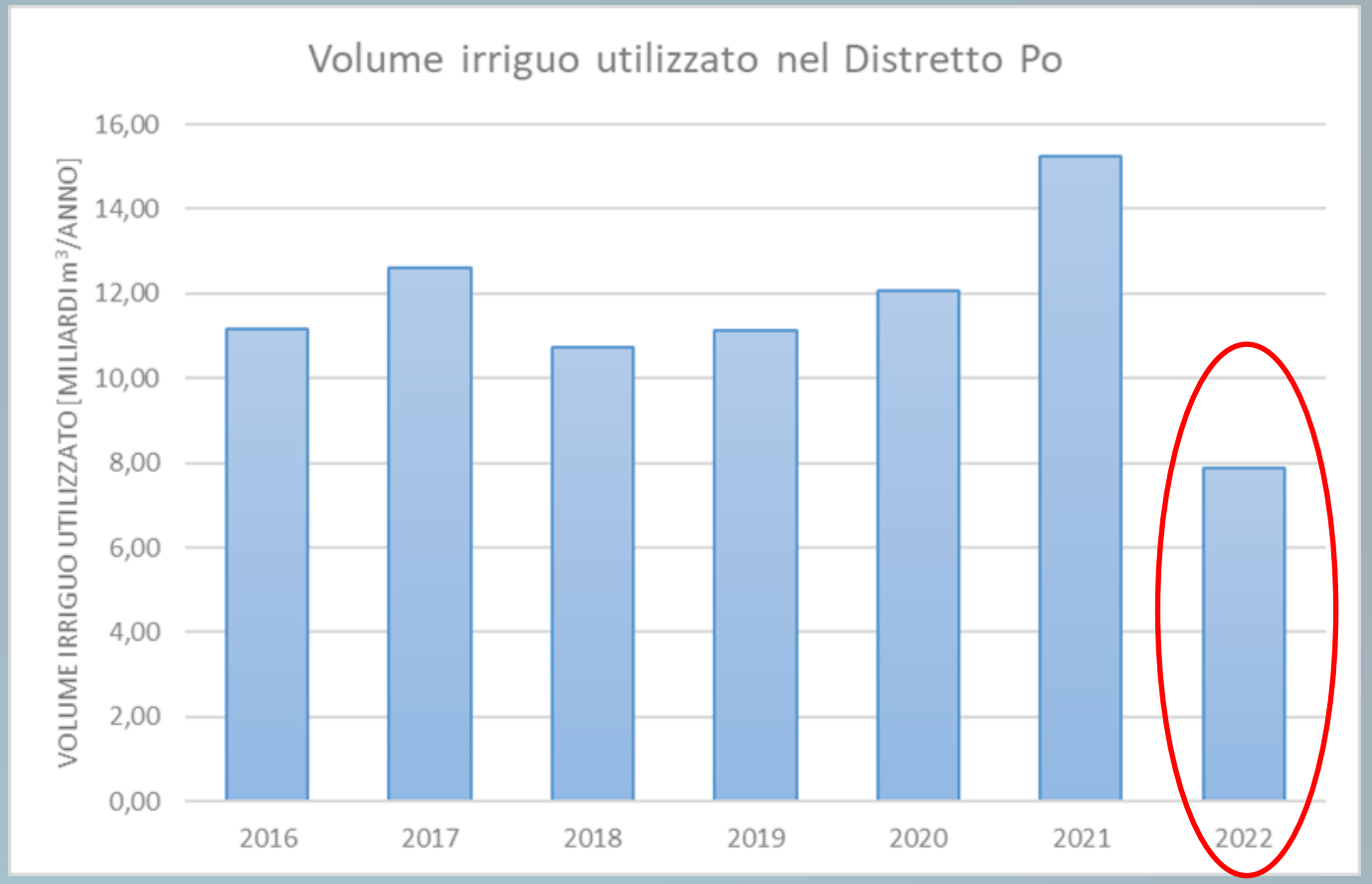
Resource uses in the District: irrigation use



Ente	Distretto	V utilizzato (Mm³)
Consorzio Irriguo Destra Bormida	Coutenza canale Carlo Alberto	2146.0
Associazione d'Irrigazione Ovest Sesia	Ovest Sesia	1760.5
Consorzio di Bonifica e Irrigazione Dugali - Naviglio - Adda Serio	Acque miste Adda - Oglio	342.9
Consorzio di Bonifica e Irrigazione Veronese	Ex Consorzio Agro Veronese	251.7

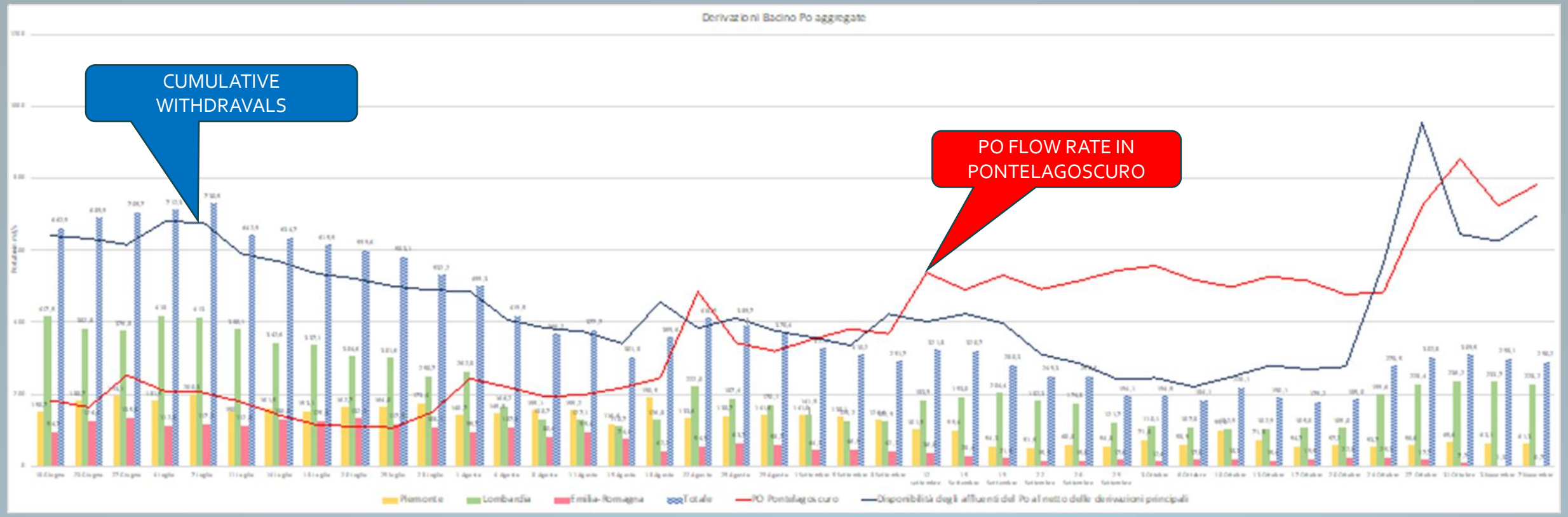
Resource uses in the District: irrigation use

Regione	SAU (ha)	Principali colture
Valle d'Aosta	58.856	Prati e pascolo
Piemonte	960.445	Seminativi
Lombardia	958.378	Seminativi, colture cerealicole, legumi, ortaggi, colture industriali
Veneto	781.630	Seminativi, colture cerealicole, legumi, ortaggi e colture industriali
Emilia-Romagna	1.081.217	Seminativi, colture cerealicole, legumi, ortaggi, colture industriali



Drought or scarcity?

During the 2022 irrigation season, despite the full-blown drought, the cumulative volume of diversions was always higher than the flow rate of the Po in Pontelagoscuro until 22 August, with a delta that exceeded 500 m³/s on 7 July when, compared to a total derived flow rate of just over 730 m³/s, the flow rate measured in the riverbed was just under 200 m³/s (**on 24 July the lowest flow ever measured in Pontelagoscuro was recorded, equal to 114 m³/s**)



Variation in precipitation regime and the Romagna flood in May 2023

Recent flooding events: May 2023

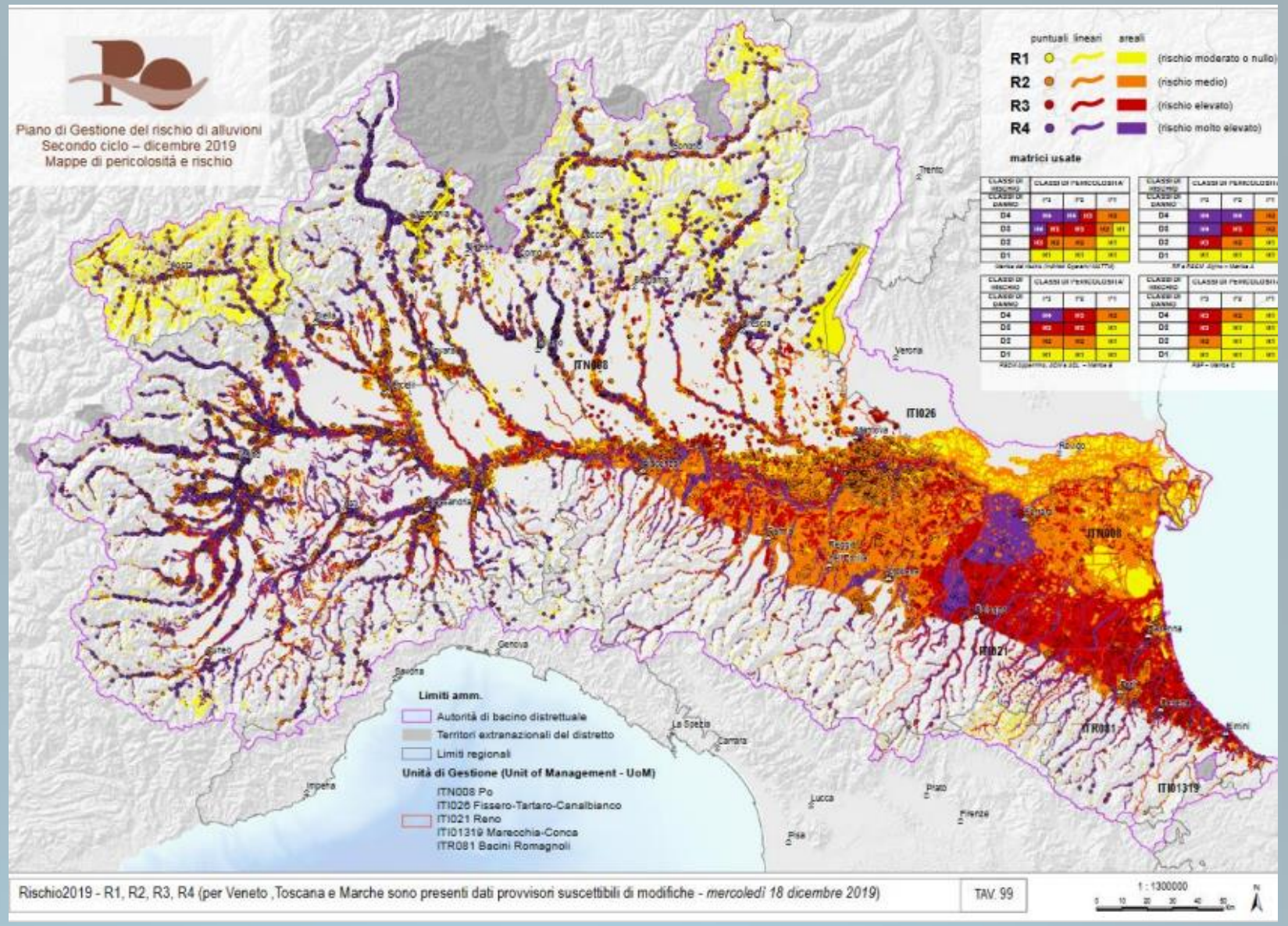
The rainfall events of 1-3 May and 16-17 May together accounted for 50% of the average annual precipitation in the Emilia-Romagna region.

The rainfall event affected the entire hydrographic network, both natural and artificial, causing the flooding of 19 rivers.

There was widespread flooding throughout the area between Bologna and Rimini, embankment breaks and widespread slope instability throughout the hilly-mountain area that affected buildings and infrastructures

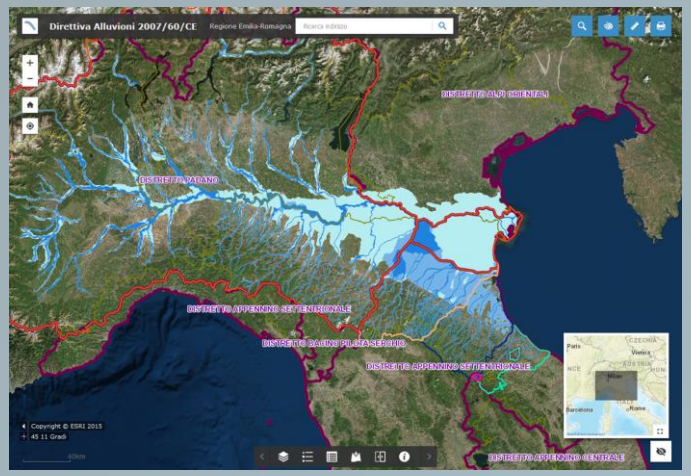
Variation in precipitation regime and ground effects

Risk maps
(Legislative Decree 49/2010)

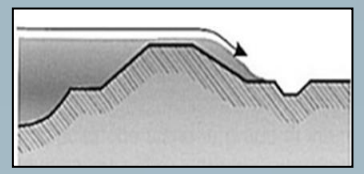


Variation in precipitation regime and ground effects

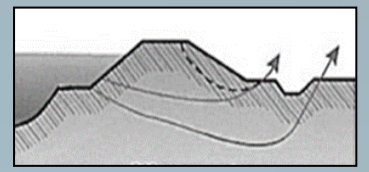
The areas at significant potential risk largely concern the dammed rivers: 1.100 km of embankments along the Po river, 1.500 km of embankments along the tributaries and 1.500 km of embankments along Romagna rivers.



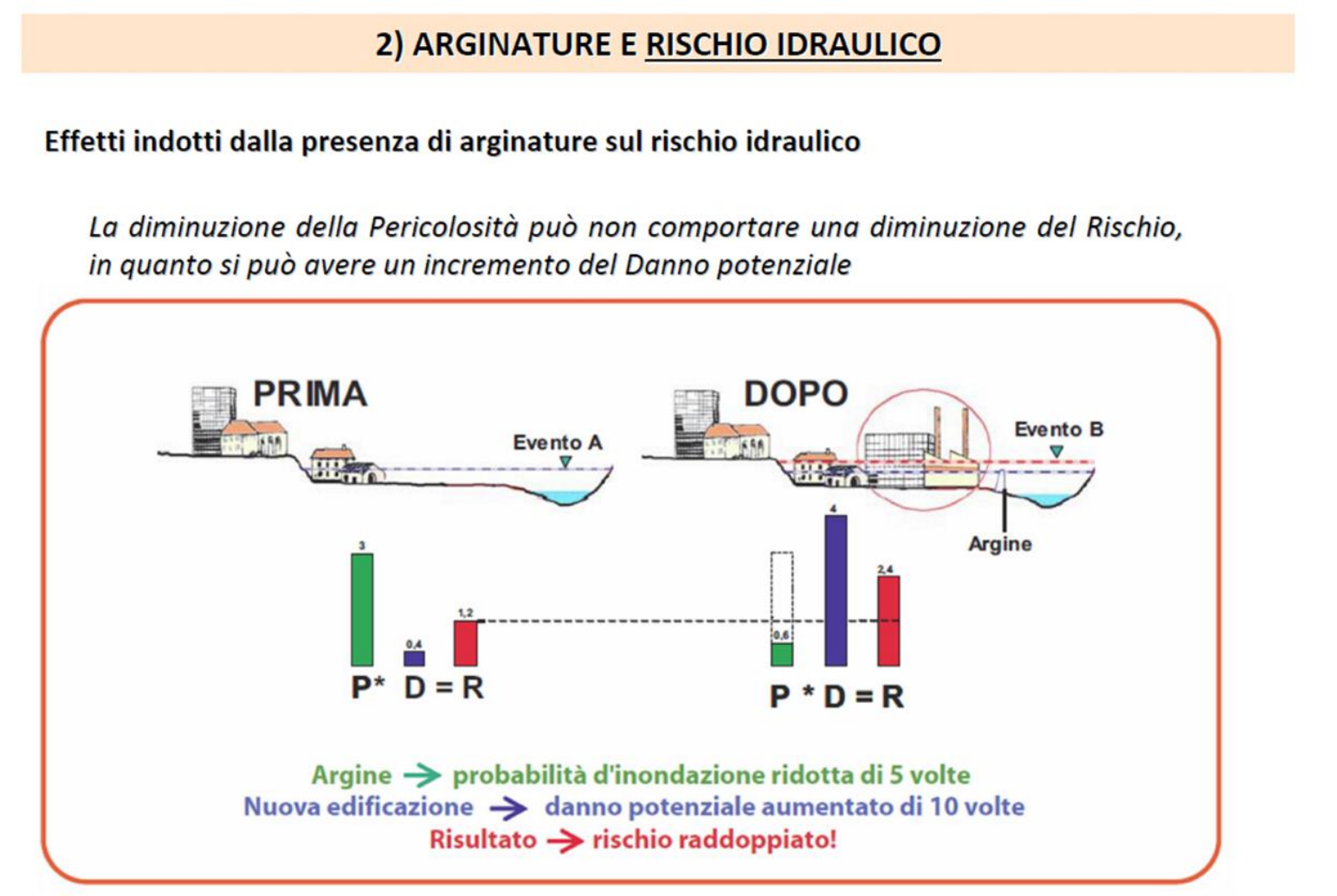
Sormonto dell'argine



Sifonamento



Variation in precipitation regime and ground effects



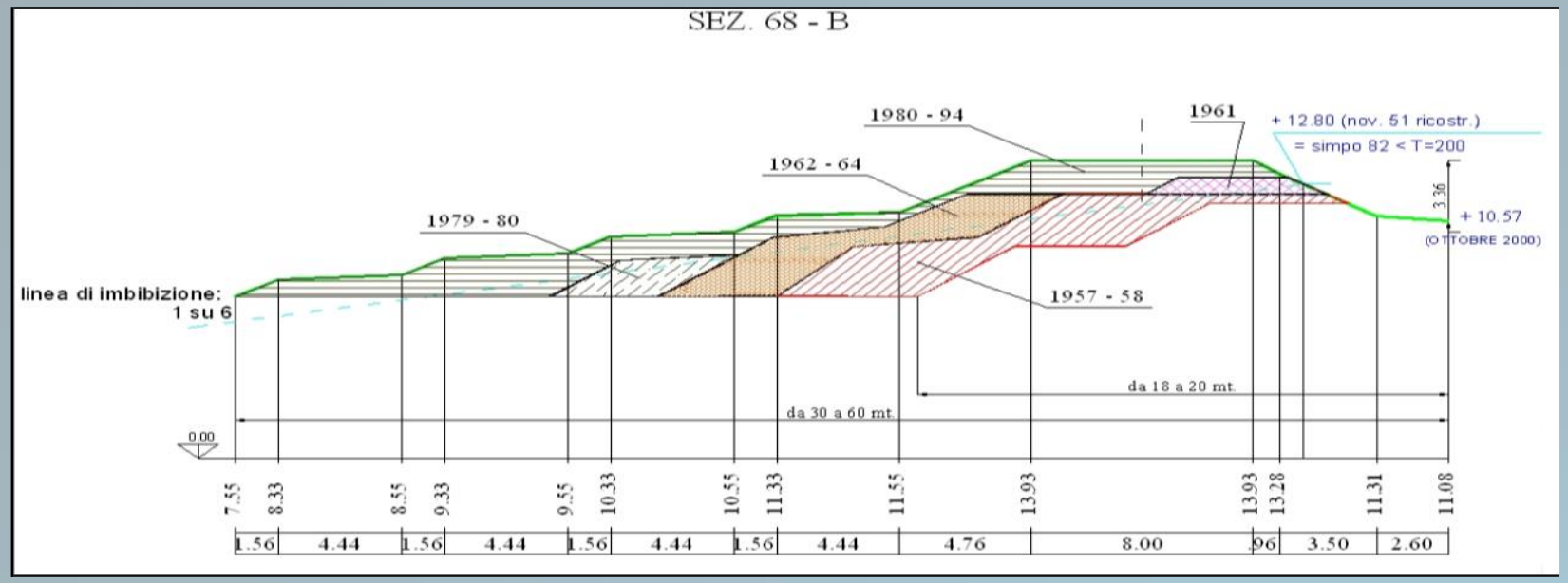
The construction of the embankments has two effects: it increases flood levels and increases the risk due to new builindgs.
This means that as a result of the construction of an embankment, the overall risk increases instead of decreasing.

Variation in precipitation regime and ground effects

"... la grandezza delle piene, come la intensità delle piogge e tutti in generale i fenomeni naturali che sfuggono ad ogni umano controllo <u>non ammettono limiti superiori sicuramente individuabili</u> ……la tattica difensiva tradizionale non considera l'evento eccezionale che supera le previsioni ..."

"... <u>le arginature da sole</u> non possono costituire la soluzione definitiva e sicura del problema della difesa dalle inondazioni"

(Prof. ing. Giulio De Marchi – II giornata della Scienza, Milano 1952)



«…. the magnitude of the floods, as well as the intensity of the rains and all natural phenomena that escape any human control, do not admit upper limits that are certainly identificable…… Traditional defensive tactics do not consider the exceptional event that exceeds the forecasts…. Embankments alone cannot be the definitive and safe solution to the problem of floods protection»

(Giulio De Marchi - Chairman of the Parliamentary Commission set up after the Polesine flood event of 1951)

What actions should be taken?

Complete, update, improve and innovate the knowledge frameworks of basin planning (PAI, PGRA, PdgPo and PBI)

To create a permanent system of relationships between experts, researchers, planners and decision-makers

Improve the capacity to disseminate knowledge on the topics covered by planning tools and awareness of the effects of climate change on flood risk and water resources management in order to increase collective awareness, resilience

Develop innovative and strategic designs, also taking into account the effects of climate change and seeking to integrate the objectives of the Water and Floods Directives, including by strengthening the design fund

Promote structured three-year planning capable of reconciling spending objectives with medium- to long-term strategies of basin planning

Ensure proportionate programming between:

1 strategic structural interventions at district level,

2 maintenance of defensive systems, sediment management and riparian vegetation,

3 relocation and vulnerability mitigation measures,

4 monitoring of the evolution of the natural system and post-construction effects.

Strengthen the implementation phase of the interventions, also through special dedicated and temporary structures in corporate form and in public-private partnership

CLIMAX PO

LIFE CLIMAX PO

CLIMate Adaptation for the PO river basin district

Programma: LIFE SIP
Area di studio: Distretto del fiume Po
Durata: 9 anni
Budget: 17,890,937 €
Partner: 21 + 4 associati

Autorità di Bacino Distrettuale del Fiume Po

LIFE CLIMAX PO: obiettivi

Promuovere l'**adattamento** ai cambiamenti climatici attraverso una gestione "**climaticamente intelligente**" delle risorse idriche a livello di distretto idrografico, implementando le misure della SNAC, adattate alle caratteristiche locali e alle peculiarità climatiche presenti nel distretto

SO1: Governance dell'adattamento a livello distrettuale

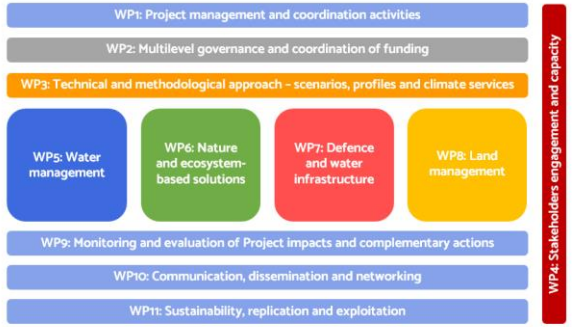
SO2: Produzione condivisa di conoscenze sul clima

SO3: Costruire capacità e consapevolezza

SO4: Migliorare la sicurezza idrica e la resilienza climatica

SO5: Istituzionalizzazione dell'adattamento climatico a scala distrettuale

LIFE CLIMAX PO: Work Plan



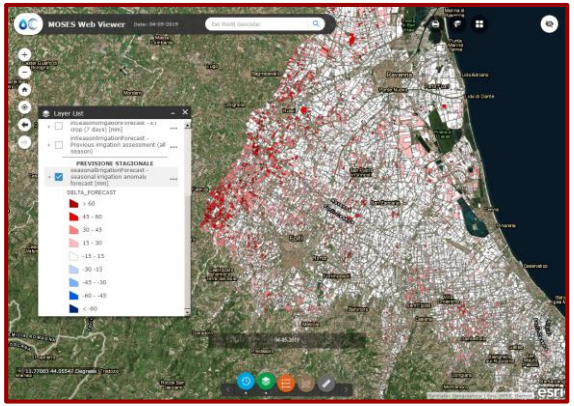
Thank for your attention

Climateurope2 FESTIVAL

March 11-13 2024, Venice

Insights from developing public regional climate services

The iCOLT climate service: crop irrigation demand forecast for Emilia-Romagna Region



Cinzia Alessandrini, Giulia Villani, Fausto Tomei, Alessandro Pirola, Valentina Pavan

Climate Observatory of ARPAE (Regional Agency for Prevention, Environment and Energy of Emilia-Romagna - Italy)

arpae emilia-romagna

osservatorio clima emilia-romagna

The iCOLT climate service

What is it? a tool for **agricultural water providing organizations**

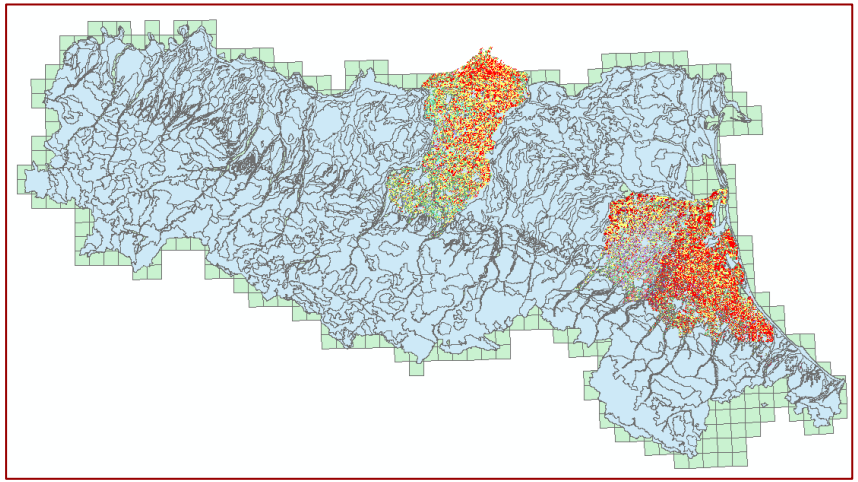
Why? to support the **decision-making process** in water procurement and allocation

How? through three **forecasts** of crop water demand:

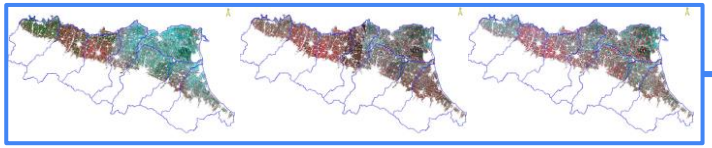
- summer (JJA) **seasonal forecasts** (+3 months) for Emilia-Romagna Region
- **sub-seasonal forecasts** (+4 weeks) and **weekly forecasts** (+7 days) for specific areas (Burana, Renana and Romagna LRB) - available during all the year

Data input

1. **crop map** obtained early in the season from classification of **satellite data**
2. regional **soil map**
3. gridded **weather observed data**
4. gridded **weather forecasts** (seasonal, subseasonal, weekly)

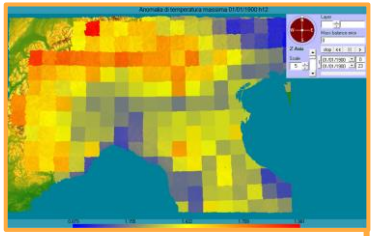


iCOLT procedure for seasonal forecasts

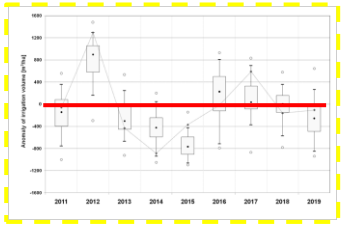


1st Window 2nd Window 3rd Window

Multitemporal satellite data analysis



Probabilistic seasonal forecasts
JJA emission



Check of the irrigation forecast

Field surveys

October-November
September

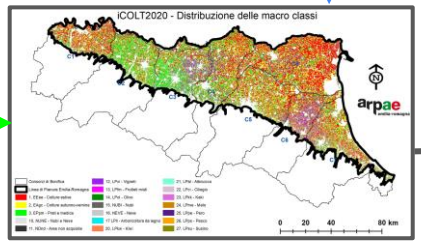
February

March-April

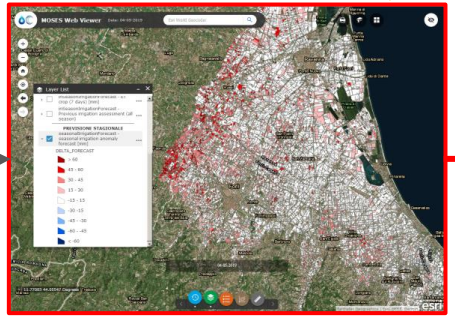
May

June

Product quality assessment



Early Crop Map

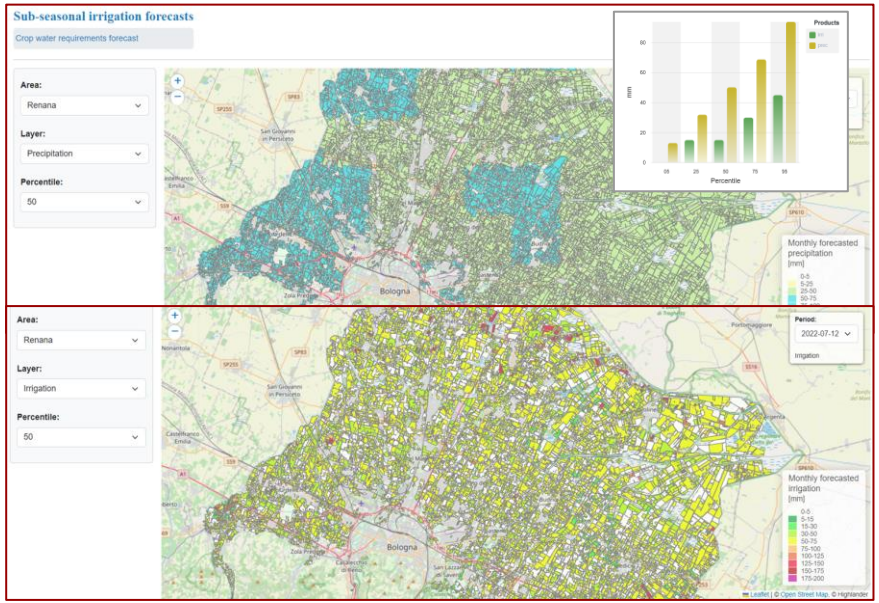


Seasonal prediction of irrigation water need

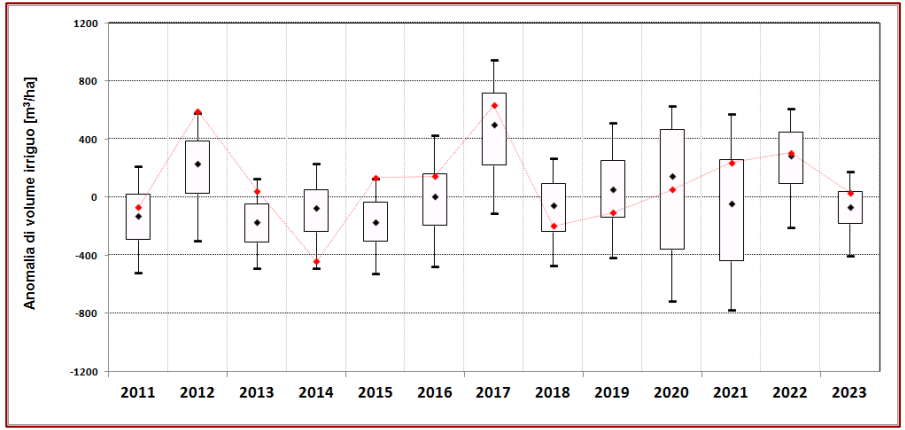
arpae emilia-romagna

osservatorio clima emilia-romagna

Outputs



subseasonal precipitation and irrigation forecast Renana LRB
https://dds.highlanderproject.eu/

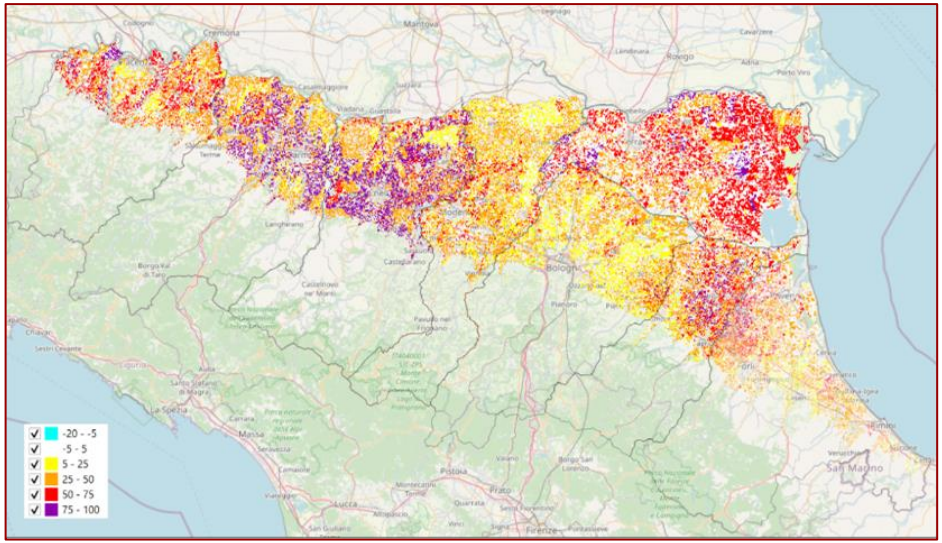


time series of the seasonal irrigation forecast on Emilia-Romagna (box plot) vs. observed irrigation (red dots)
https://sites.google.com/arpae.it/servizio-climatico-icolt

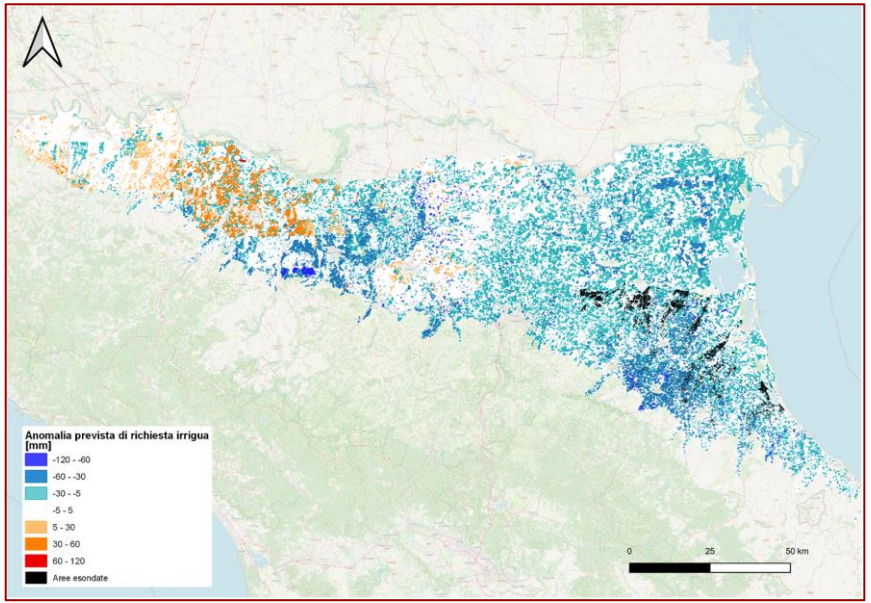
arpae emilia-romagna

osservatorio clima emilia-romagna

Outputs: crop water need anomaly [mm]



Seasonal irrigation forecast for Emilia-Romagna region (summer 2022)



Seasonal irrigation forecast for Emilia-Romagna region (summer 2023)

Final thoughts

Weaknesses

- static representation of the agricultural current crops only until May without an in-season update

Improvements

- refinement of early crop map during the irrigation season

Strengths

- documented and reliable operational chain → replicability
- low cost maintenance

Thank you for your attention

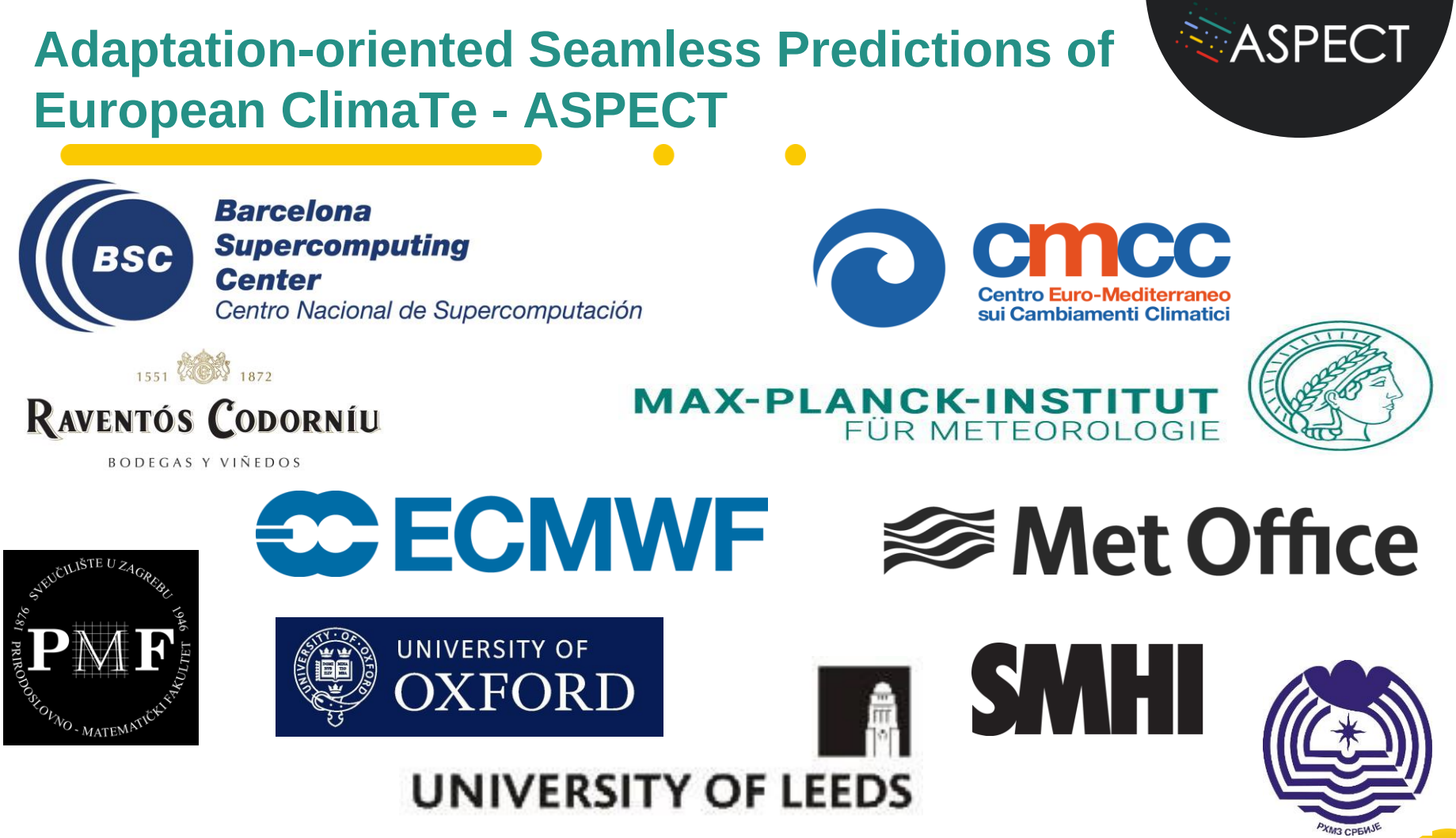
osservatorioclima@arpae.it

Seamless Climate Prediction: Enhancing Forecasting for Resilient Futures

Aleksandra Kržič
and ASPECT project partners

Funded by
the European Union

Adaptation-oriented Seamless Predictions of European ClimaTe - ASPECT



CASE STUDIES: SEAMLESS DECISION MAKING

ASPECT
FACILITATING SEAMLESS CLIMATE ADAPTATION

Climate predictions
Seasonal 1 to 12 months
Decadal Longer than 1 year

Climate change projections 20 to 30 years

	Spatial scale	Time scale		
Agriculture (grape/wine sector)	Vineyard to region	Management decisions during the growing season (Apr-Sep) to maximise the harvest	Long-term planning and investment decisions	
Finance (pensions sector)	Asset level to national scale	Near term investment decision making	Understanding climate risks from climate extremes for mandatory disclosures	Horizon scanning, estimating future pension liabilities, Net Zero ambitions
Governance (EU Mission on Climate Adaptation)	Local to regional	Advancing existing climate services (e.g. irrigation demand forecasts, forecast based impact assessment)	Enhanced climate risk assessment for strategic and operational adaptation planning	
Disaster response during extreme events	Local to national	Seasonal extremes for locating emergency response (e.g. cold waves, storms and wildfire)	Response planning to more frequent weather related disasters	Modelling future operations under climate change
Humanitarian (health & migration)	Regional to international	Predictions of how childhood health impacted by nutrition, water and infection	Supporting health of moving populations	

Timescales

Source: ESS, Barcelona Supercomputing Center

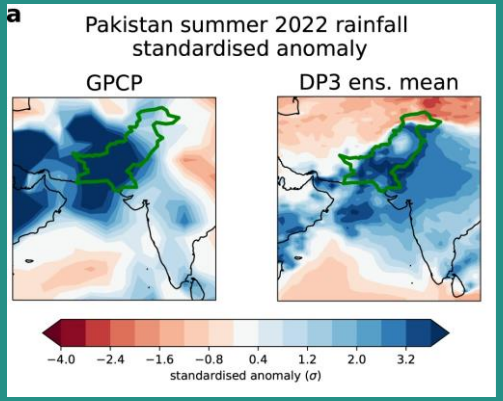
ASPECT experiments span all of the timescales in the peach coloured box
Novel experiments will be produced in ASPECT for multi-annual and multi-decadal timescales

Seamless Predictions: Predictions or forecasts made across all time ranges i.e., from months to seasons, years and to decades, which are started from a realistic initial state based on observed conditions.

Downscaling & extreme events

Downscaling

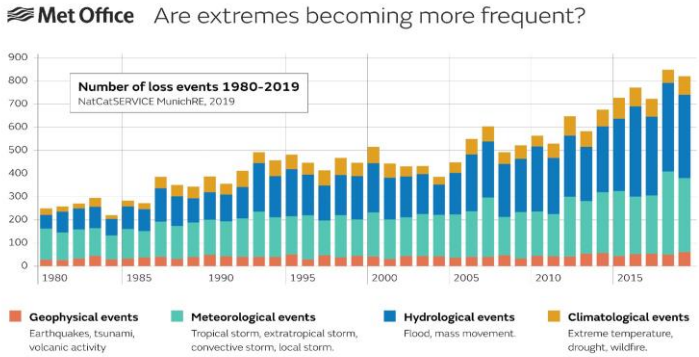
ASPECT uses advanced statistical and machine learning methods to take climate model output, which represents average conditions over an area (e.g. 60 km square), to determine what this might mean at a specific location (e.g. a vineyard).



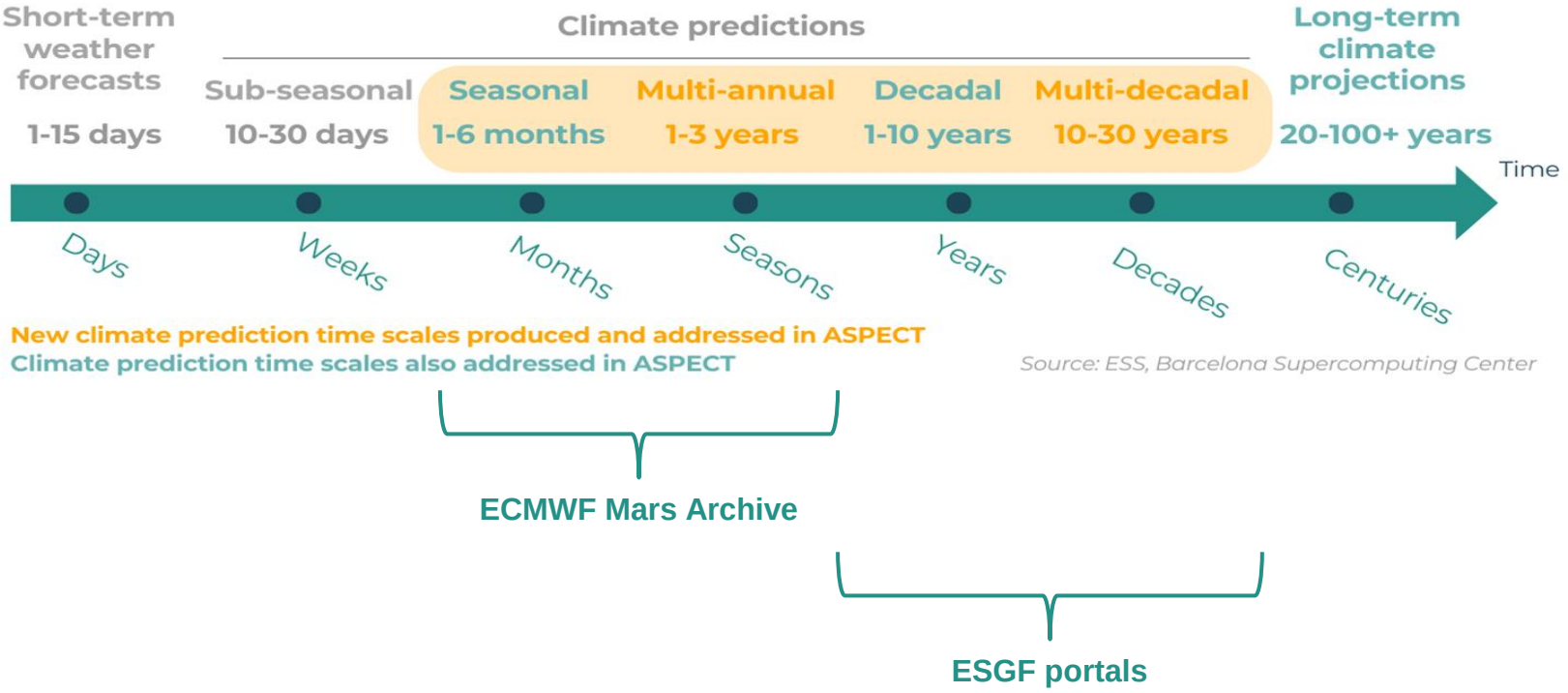
Extreme events

In the past, seasonal to decadal prediction studies rarely focused on the skill for extreme events.

Realistic simulation of extremes is **challenging** for models.

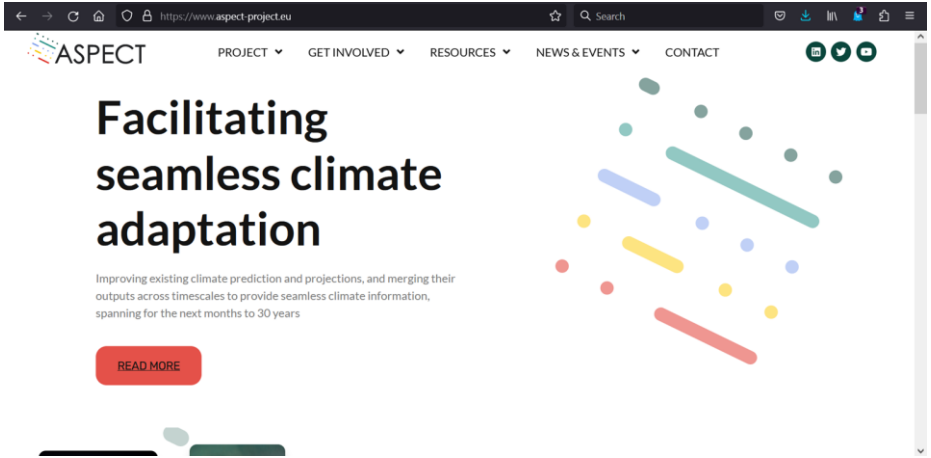


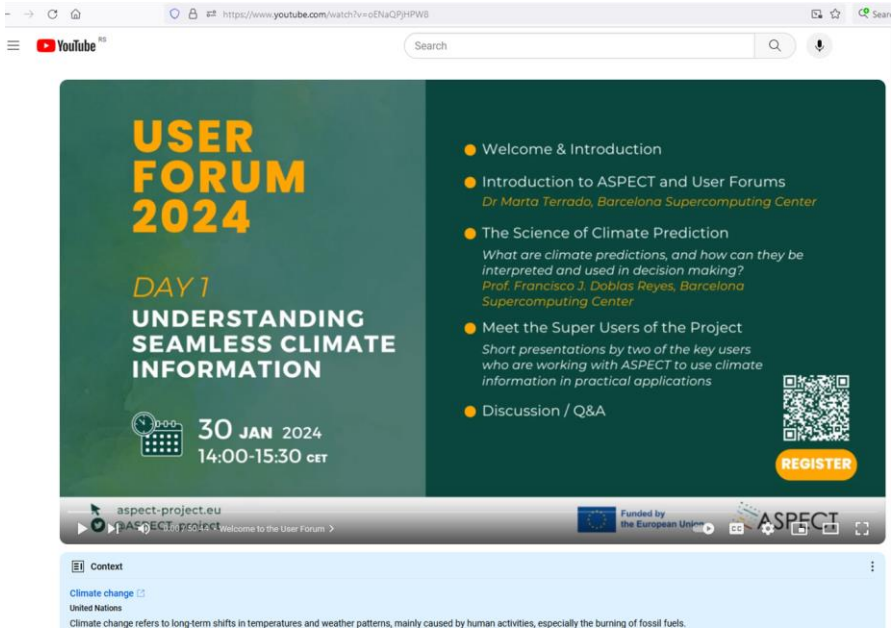
Sharing data



User demanded dataset will be published on **COPERNICUS C3S**

Get involved with us





www.aspect-project.eu

YouTube Channel @ASPECT_project

ASPECT

FACILITATING SEAMLESS CLIMATE ADAPTATION

THANK YOU!

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Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101081460. The sole responsibility for the content of this document lies with the ASPECT project and does not necessarily reflect the opinion of the European Union.

Co-funded by the European Union

LIFE CLIMAX PO Make the Change

Climateurope2 FESTIVAL
March 11-13 2024, Venice

European Project LIFE CLIMAX PO

Relatori: Paolo Leoni – Po River Basin District Authority
Email: paolo.leoni@adbpo.it

https://www.lifeclimaxpo.adbpo.it/ | climaxpo@adbpo.it

@LIFEClimaxPo | @LIFEClimaxPo | @life-climax-po | @LIFEClimaxPo | @LifeClimaxPo

Reference 18 A-PLAT (climate change adaptation platform) portal site, National Institute for Environmental Studies

Project framework

Climate change impacts

National Adaptation Strategy (NAS)

- Analysis of the most relevant impacts of climate change
- Suggestion of a set of adaptation strategies

Po River Basin District as a national special case and pilot area

- Availability of water and its uses
- Production of the 40% of the Italian gross domestic product

LIFE CLIMAX PO project

CLIMate Adaptation for the PO river basin district

EU programme: LIFE SIP
Study area: Po River basin District
Duration: 9 years
Partners: 21 + 4 associated
Budget: 17 890 937 €

LIFE CLIMAX PO objectives

to boost **adaptation** to climate change through **climate-smart water resources management** at the river basin district scale by implementing the **NAS measures** tailored-made on the local characteristics and climate peculiarities present in the **district**

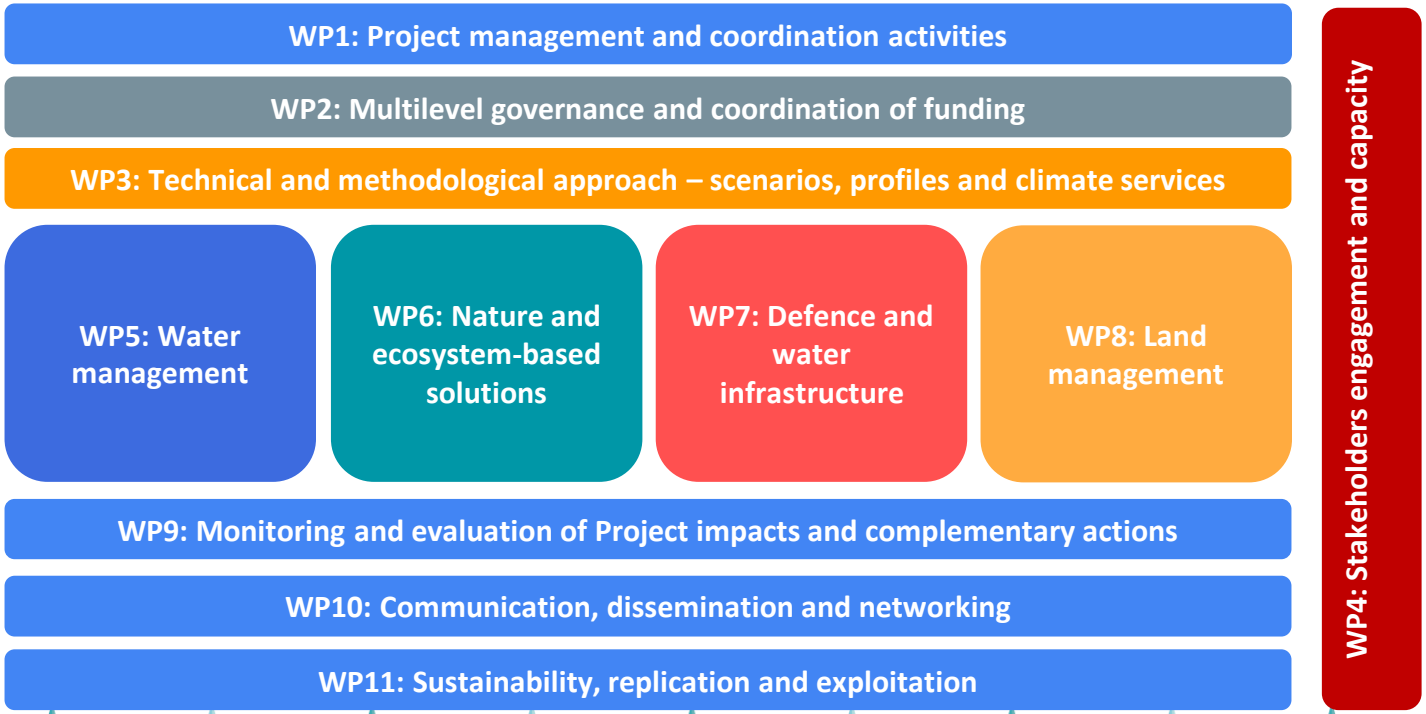
SO1: Governance of adaptation at the Po River Basin District level

SO2: Shared climate knowledge production

SO3: Building capacity and awareness

SO4: Improving water security and climate resilience

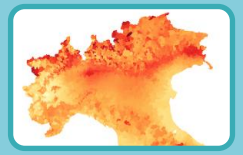
SO5: Institutionalisation of climate adaption at the Po River Basin District level


WP1: Project management and coordination activities
WP2: Multilevel governance and coordination of funding
WP3: Technical and methodological approach – scenarios, profiles and climate services
WP5: Water management
WP6: Nature and ecosystem-based solutions
WP7: Defence and water infrastructure
WP8: Land management
WP9: Monitoring and evaluation of Project impacts and complementary actions
WP10: Communication, dissemination and networking
WP11: Sustainability, replication and exploitation
WP4: Stakeholders engagement and capacity

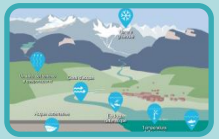
Co-funded by the European Union

LIFE CLIMAX PO Make the Change

CLIMATE CHANGE



WATER RESOURCE MANAGMENT



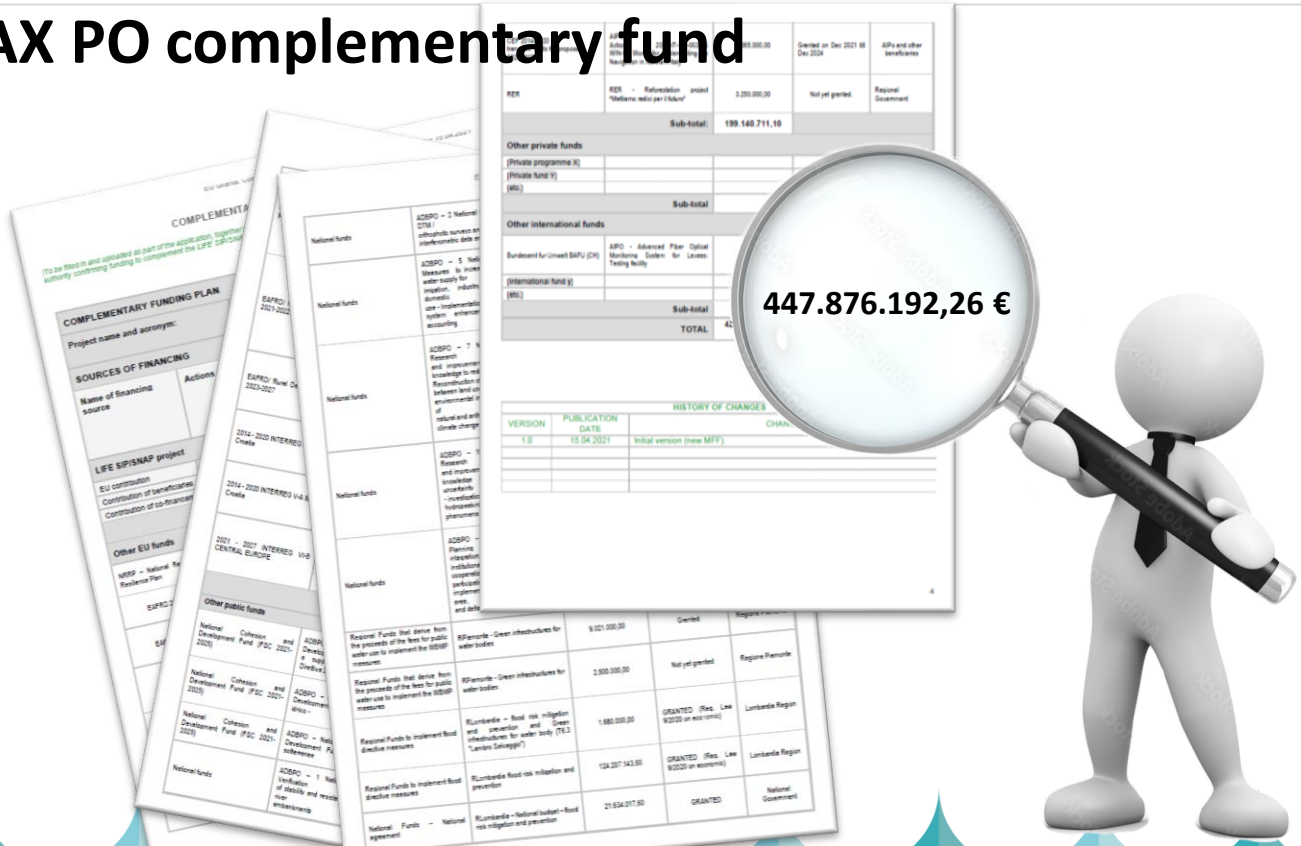
NATURE-BASED SOLUTIONS

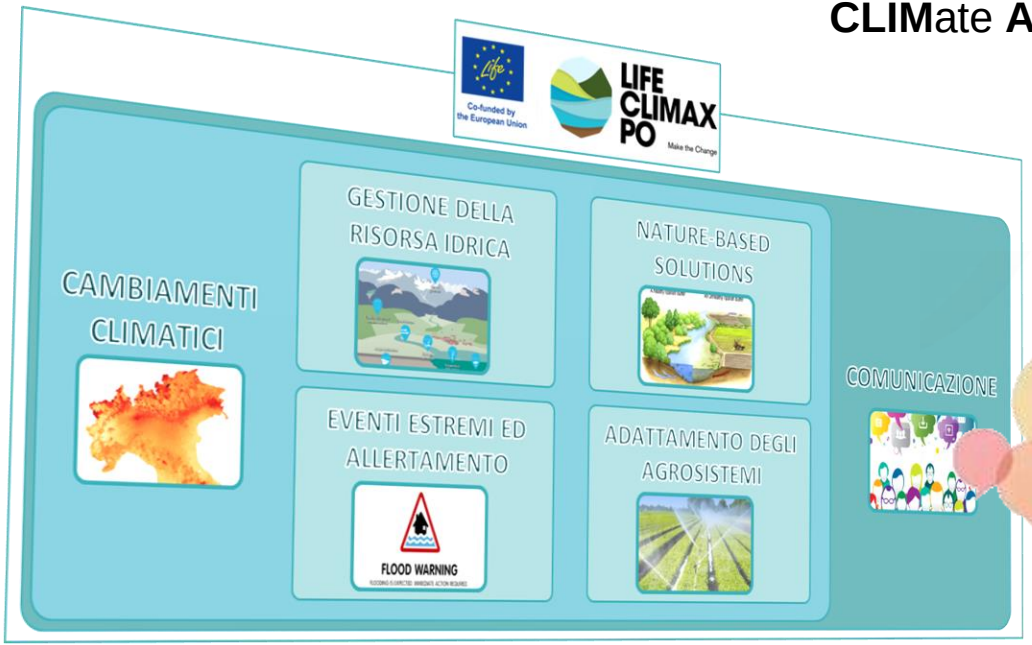
EXTREME EVENTS EARLY WARNING

ADAPTATION OF AGROSYSTEMS

COMUNICATION

LIFE CLIMAX PO complementary fund





CLIMate **A**daptation **for** the **PO** river basin district

+145 Stakeholders

(including bodies and institutions that operate abroad and in territories outside the Po River District)

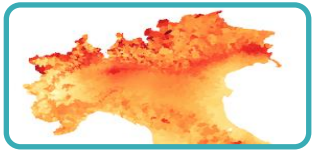
Stakeholder Boards

Consultative and informative role on the topics covered and the activities carried out by the Project

MANAGEMENT OF WATER RESOURCE

NATURE-BASED SOLUTIONS

CLIMATE CHANGES



COMMUNICATION

EXTREME EVENTS AND WARNING

ADAPTATION OF AGROSYSTEMS

"*It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change.*"

Charles Darwin