Beyond Scarcity
Water Scarcity and Drought Risk Management in the Danube Region

Danube Drought Risk Management Workshop
September 20-21, 2021

Background document
Post-workshop version

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1. Introduction

1.1. Context and objectives

This document is not a full assessment of the Drought Risk Management (DRM) situation in the Danube region. Instead, the initial *pre-workshop version* was intended at providing some general background for supporting the conversation at the **workshop "Beyond scarcity, Water scarcity and drought risk management in the Danube Region"** organized by the Danube Water Program and the Global Water Partnership Central and Eastern Europe (GWP CEE), while this *post-workshop version* additionally offers a summary of the key aspects debated in the event. This text points out some important topics and challenges and provides references of past and ongoing work, both within the region and at a global level.

Water scarcity and droughts are amongst the most tangible – and devastating – consequences of the climate crisis. They increasingly affect communities across the planet, causing tolls on societies, the economy and environmental impacts. Europe and the Danube Region are no exception. As it will be explained in this text, in the last decades, a series of widespread droughts have affected significant parts of Europe. The droughts in 2003 have affected over 100 million people, a third of the EU territory, and cost approximately € 8.7 billion in damage to the European economy. They were followed by events that have affected portions of Northern, Southern, and Western Europe in 2007, 2011, and 2012 (European Commission, 2012).

Managing drought needs to be conceptualized in the light of climate change, considering that drought is a slow onset disaster, which may cause even more severe damage than rapid events such as floods. As we will discuss throughout the document, there is no specific EU legislation especially dedicated to water scarcity and drought, so the existing policies and sectoral instruments in different water-related fields need to be used and integrated since they are partially or at least marginally related to drought and can support drought management policies.

WORKSHOP ORGANIZERS

In order to support Danube countries in their water management efforts, the **Danube Water Program**, a partnership program between the *World Bank* and the *International Association of Water Service Companies in the Danube River Catchment Area* (IAWD), has extended its scope of activities, addressing issues related to "Water Security", including water services delivery, Water Resources Management (WRM) and water-related risk mitigation in the context of socio-economic development and climate change.

Established in 1998, the **Global Water Partnership Central and Eastern Europe (GWP CEE)** works to support the countries of Central and Eastern Europe in the sustainable development and management of their water resources.

1.2. The workshop "Beyond scarcity - Water scarcity and drought risk management in the Danube Region"

The event took place online during the afternoons (Central European Summer Time) of the 20th and 21st of September 2021, and followed the agenda presented in Figure 1, aimed at covering the main objectives of the event:

1. Raising awareness about the relevance of past and potential future impacts of water scarcity and droughts in the Danube region;
2. Providing a forum for a technical exchange on good practice approaches and options to address the issue in order to make the region more resilient against such extreme events;
3. Tacking stock on challenges and potential support needs for future action.

Most of the 133 workshop subscribers were based in Danube countries and the rest of Europe, although there were active participants from Canada, India, Indonesia, Kenya, Lesotho, Mexico, Pakistan, Sudan, Thailand, Trinidad & Tobago, Uganda and the United States.

In the audience, there was a very balanced mix of Public Authority officials, International Organizations & NGO officials, Private Sector staff, Water & Environmental Agencies officials, staff of Financing Institutions and Academia, with around a 15% of the participants in each of those categories, but there were also staff members from Hydrometeorological Agencies, Water Service Companies and Water Sector Associations.

Monday, September 20th	
13:30	*Start of Day 1 – Welcome and introduction*
13:30 – 14:45	Session 1: Setting the scene
14:45 – 15:00	*Break*
15:00 – 16:15	Session 2: Relevance of water scarcity and droughts in the Danube region
16:15 – 17:00	Session 3: Working group discussion
17:00	*End of Day 1*
Tuesday, September 21st	
13:30	Start of Day 2
13:30-14:30	Session 4: Feedback from working groups
14:30-15:45	Session 5: Pathways, policy and regulatory approaches to improve resilience against water scarcity and droughts
15:45-16:00	*Break*
16:00-16:30	Session 6: Wrap-up and closing
16:30	*End of Day 2*

Figure 1*:* Workshop agenda

Before the event started, an interactive *Poll Everywhere* survey was launched, showing that most of the participants attended because they were already working on drought-related topics and covers their area of interest. A 72% of the participants expressed that they perceive drought and water scarcity as a significant or highly relevant issue in their countries and regions, with another 21% stating it is at least moderately relevant. The strongest consensus was found with regard to their knowledge that their context are somewhat prepared to deal with water scarcity and drought but with significant gaps to cover (55%, against another 21% stating that their country was only moderately prepared).

1.3. Drought Risk Management (DRM), setting the scene

Despite the widespread use of the term, there is not enough clarity about some drought-related concepts. Clarifying them is important to refine the needs in relation to strategies.
According to the European Directorate-General for Environment[1], droughts can be considered as a temporary decrease of the average water availability due to e.g. rainfall deficiency.
In contrast, aridity refers to permanent and usual conditions of water scarcity. It is therefore a characterizing feature of certain climates.
Last, water scarcity is the existence of less available water supply than the society demands. This stress or imbalance may be caused by the existence of a prolonged drought period, which reduces the supply circumstantially, but may be recurrently instigated by inappropriate water management.

[1] https://ec.europa.eu/environment/water/quantity/scarcity_en.htm

BOX 1: Some drought- related terms used in this report

- **Drought:** Period of abnormally dry weather sufficiently prolonged for the lack of precipitation to cause a serious hydrological imbalance. Sources: WMO, 1992, European Directorate-General for Environment website.
- **Proactive approach to drought management:** A proactive approach to drought risk management (DRM) includes appropriate measures being designed in advance, with related planning tools and stakeholder participation. The proactive approach is based on both short-term and long-term measures and includes monitoring systems for a timely warning of drought conditions, the identification of the most vulnerable part of the population and tailored measures to mitigate drought risk and improve preparedness. The proactive approach entails the planning of necessary measures to prevent or minimize drought impacts in advance. This approach is reflected in the three pillars of integrated drought management. Source: Vogt et al., 2018
- **Reactive approach to drought management:** A reactive approach to drought management is based on crisis management: it includes measures and actions after a drought event has started and is perceived. This approach is taken in emergency situations and often results in inefficient technical and economic solutions, because actions are taken with little time to evaluate best options and stakeholder participation is very limited. This approach has often been uncoordinated and untimely. In addition, crisis management places little attention on trying to reduce drought impacts caused by future drought events. Source: Vogt et al., 2018
- **Vulnerability:** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. It is often understood as the opposite to **Resilience**. Source: United Nations Framework for Climate Change (UNFCCC), 2014
- **Water scarcity:** An imbalance between supply and demand of freshwater in a specified domain (country, region, catchment, river basin, etc.) as a result of a high rate of demand compared with available supply, under prevailing institutional arrangements and infrastructural conditions. Sources: Food and Agriculture Organization of the United Nations (FAO), 2012; European Directorate-General for Environment website.
- **Water shortage:** A shortage of water supply of an acceptable quality; low levels of water supply, at a given place and a given time, relative to design supply levels. The shortage may arise from climatic factors, or other causes. Source: Food and Agriculture Organization of the United Nations (FAO), 2012

Source: Integrated Drought Management Programme (IDMP) Glossary Website: http://www.droughtmanagement.info/find/glossary/

1.4. Drought types

The most popular categorization of drought, but not the only one, is made in terms of the variables where the physical water deficit is measured, essentially:

- ✓ Meteorological drought
- ✓ Agricultural drought
- ✓ Hydrological drought

Each one of them is defined based on the deficit in comparison to the normal amount of water expected in rainfall, in soil and vegetation or in the water bodies (groundwater, streams, lakes, etc.) respectively.

Additionally, two more classes are incorporated by some authors and recognized in the glossaries of the Integrated Drought Management Programme (IDMP) and the US National Drought Mitigation Center (NDMC):

- ✓ Socioeconomic Drought, which occurs when the demand for water or another economic good exceeds supply as a result of the drought types mentioned above,
- ✓ Ecological Drought, which occurs when these described deficits - in rainfall, streamflow, groundwater, etc. - create multiple stresses across ecosystems.

Although these phenomena can overlap, their onsets (and ends) are deferred in time; the complete sequence of them occur only if the rainfall deficit last long enough and/or is enough intense (See Figure 2).

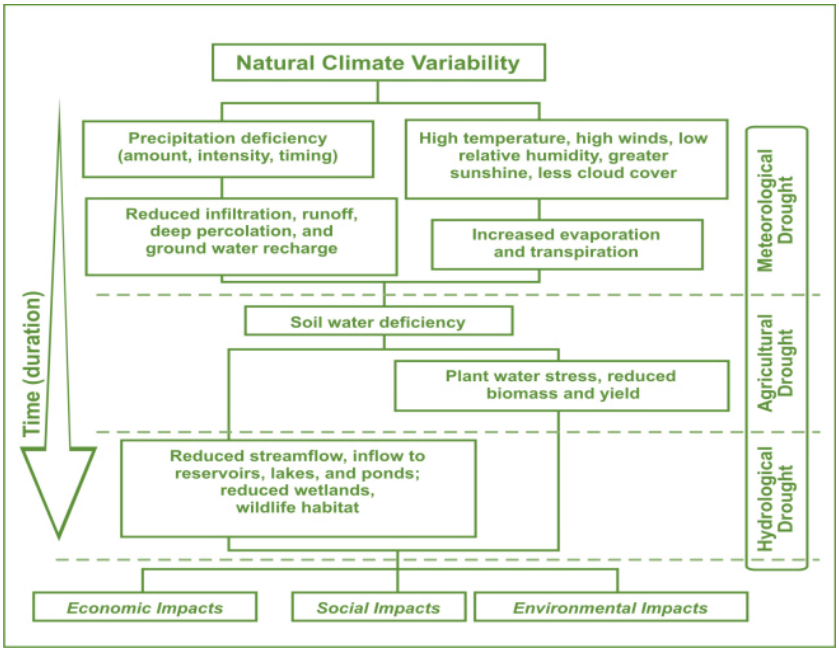


Figure 2: Sequence of drought occurrence and impacts for commonly accepted drought types. All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency. Source: US NDMC website

Drought is a complex phenomenon. In every stage of the hydro-social cycle, it causes water struggles for supply, agriculture, food, energy and environment and, as such, it is in conflict with the achievement of several of the United Nations Sustainable Development Goals.

1.5. Drought under Climate Change and the Need for Integrated Risk Management

Droughts have always existed and were triggered by variations in the regular atmospheric circulation patterns. However, climate change is increasing temperatures and modifying rainfall patterns, raising the incidence, severity and duration of droughts in many parts of the world. Carrão et al. (2018) and Spinoni et al. (2020) examined the changes in drought frequency and severity until the end of the 21st century, using the SPEI index applied to future climate models data and comparing it to historical data of reference, confirming that droughts are getting globally more and more frequent and more severe due to this warming.

Particularly also for Europe, drought is one of the main consequences of climate change, whose important effects are already felt, (IPCC, 2021) and should receive more attention.

The IPCC expects that even some of the regions of the world that are humid already, and that will get wetter on average, will experience changes in the intra-annual or inter-annual variability of precipitation, or in rainfall intensities, and that can trigger disruptions in the hydrological cycle. The IPCC assessments for Eastern and Central Europe (IPCC, 2021) point in that direction with medium confidence.

On the other hand, higher temperatures bring evapotranspiration rises, which will result in less effective rainfall, less soil moisture, less yields and potentially more agricultural and hydrological drought.

This combination of less precipitation and higher temperatures affects also snow cover and snow-melt, which implicates disruptions in the hydrological patterns and occasionally droughts too (Van Loon, 2013). It is essential to evaluate and gain further clarity of how Europe will suffer from this phenomenon.

1.6. Classification of activities to build drought resilience: the three pillars of Drought Preparedness

Currently, most approaches deployed in dealing with drought are reactive. Even if proactive risk management is proven socially optimal compared with reactive crisis management, the shift from crisis management to risk management is often happening very slowly.
With the intention of moving towards a more proactive and comprehensive perspective, the IDMP and its affiliates have adopted three pillars of drought management that form the building blocks of effective action against drought. The three pillars (see Figure 3) help structuring the work toward an integrated approach to drought management and have been reflected in many different initiatives since then:

Figure 3: Three pillars of DRM
Source: IDMP website

- Drought Hazard Characterization, Monitoring and Early Warning (pillar 1)

These actions are directed at gaining knowledge of not only the natural, but also the human processes associated with drought and, therefore, they are vital to determine current and, likely, future impacts associated with drought (and elements that need to be modified to prevent those impacts).
A drought characterization, monitoring and early warning system (DEWS) is the basis for effective proactive drought policies. DEWS produce timely information for governments, stakeholders, and citizens about climatic, agricultural and/ or hydrological drought conditions, so that mitigation and response strategies can be implemented accordingly. The most advanced monitoring efforts also track the impacts of the drought.

- Vulnerability & Impact Assessment (pillar 2)

These structured analyses are aimed at mapping and understanding the likely impacts of drought in a sector or an area, the elements and societies at risk, and the causes of such predisposition to be adversely affected.

- Mitigation, Preparedness & Response (pillar 3)

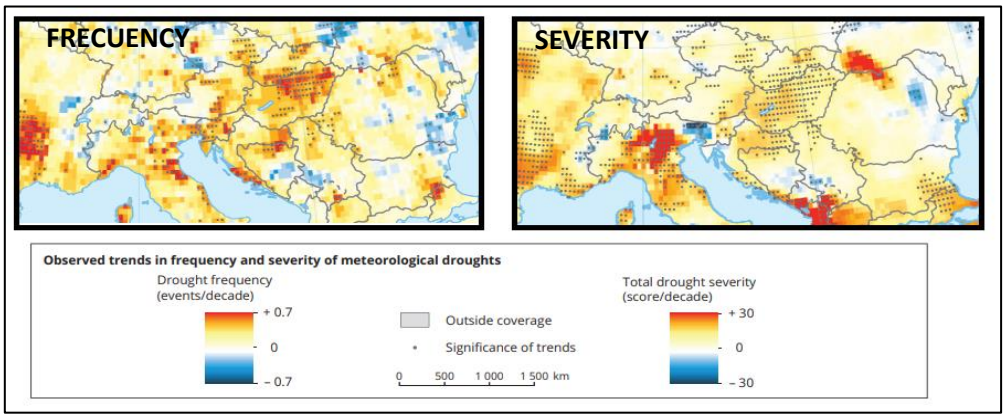
This pillar comprises the set of proactive solutions to cope with vulnerability and to boost societal and environmental drought resilience. The actions grouped here should be aimed at reducing the drought risk, preparing for it and adapting to it.
The measures can be subdivided into long-term measures, normally included in the development strategies and plans of the concerned sectors; medium-term measures, applied in a timely manner, based on triggers provided by monitoring; and short-term measures, implemented in emergency, but which should be designed with the aim of meeting basic needs while contributing to resilience (see IDMP website for more information).

2. Relevance of water scarcity and droughts in the Danube region

2.1. Drought characterization in the Danube region. Past droughts, current and future risk in a changing climate

As we can see in Figure 4, the countries in the Danube showed different trends in frequency (left) and severity (right) of meteorological droughts between 1950 and 2012 - measured with a combination of the Standardized Precipitation Index (SPI), the Standardized Precipitation Evapotranspiration Index and the Reconnaissance Drought Index - but a general drying tendency is observed, and the incidence of more droughts and more severe ones is predominant. This is because it is raining less and less than normal, but also because there is higher and higher evaporation due to the observed temperature increases.

Figure 4: Trends in frequency and severity of meteorological droughts between 1950 and 2012. Trends are based on a



combination of three different drought indices - SPI, SPEI and RDI accumulated over 12-month periods. Dots: trends significant at ≥ 95%.

SOURCE: Adapted from European Environmental Agency website: https://www.eea.europa.eu/data-and-maps/figures/observed-trends-in-frequency-and

With regard to agricultural drought, as summer soil moisture reflects the meteorological circumstances to a large extent, the observed trends in the values of this variable follow similar spatial patterns, for the same study period (see Figure 5).

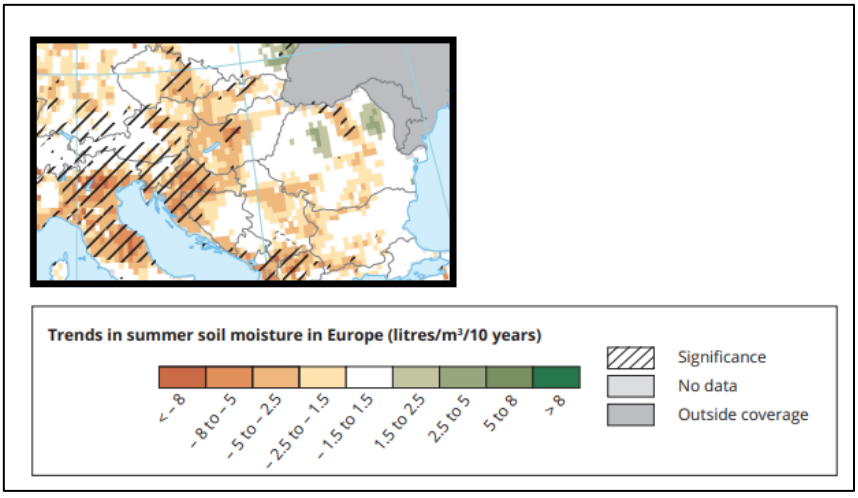


Figure 5: Trends in summer soil moisture

Source: Adapted from European Environmental Agency website: https://www.eea.europa.eu/data-and-maps/figures/trends-in-summer-soil-moisture-1

As expected, there is also a below-normal snow accumulation (or "snow drought"), caused by higher temperatures or less precipitation (Huning and AghaKouchak, 2020) which alters the typical hydrological regime of the rivers and weakens ecosystems reliant on snow-melt. In central Europe, winter run-off has increased and late spring run-off decreased due to early snow-melt (Blahušiaková et al., 2020). Literature points out to the fact that the droughts of the last decade in the basin are linked to the persistence of anticyclones and the distribution of high air pressure formations, which prevented Central Europe to receive enough moist air and effective frontal systems. Those conditions also favored higher than normal evaporation rates (ICPDR, 2016).

Apart from this intensification of the phenomenon during the recent history, drought risk can increase under ongoing climatic changes, socioeconomic decisions and water use. Figure 6 shows changes in the frequency of meteorological droughts (SPI index) for two future periods (2041-2070, left and 2071-2100, right) and for two emissions scenarios (RCP4.5, top and RCP8.5, bottom) in the Danube region. The high-emissions RCP8.5 scenario shows more contrast, but the trends are similar in both: while the upper half of the basin is expected to experience less droughts than in the present for the period 2041-2070, the lower half is expected to have more, and these same trends will get stronger during the interval 2071-2100. These patterns match with the projected annual mean precipitation trends in the Danube basin 2021–2050 and 2071-2100 presented in the Danube Climate Adaptation Strategy (ICPDR, 2018) (see Figure 7).

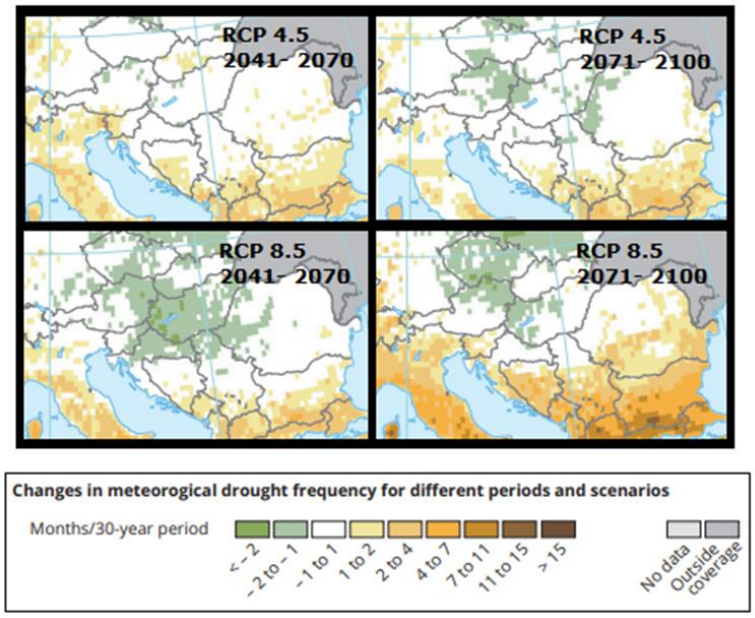


Figure 6: Changes in meteorological drought frequency for different periods and scenarios. Drought frequency is defined in this case as the number of months in a 30 year period with the Standardised Precipitation Index accumulated over a 6 month period (SPI-6) having a value below -2
Source: Adapted from European Environmental Agency website: https://www.eea.europa.eu/data-and-maps/figures/changes-in-meteorological-drought-frequency

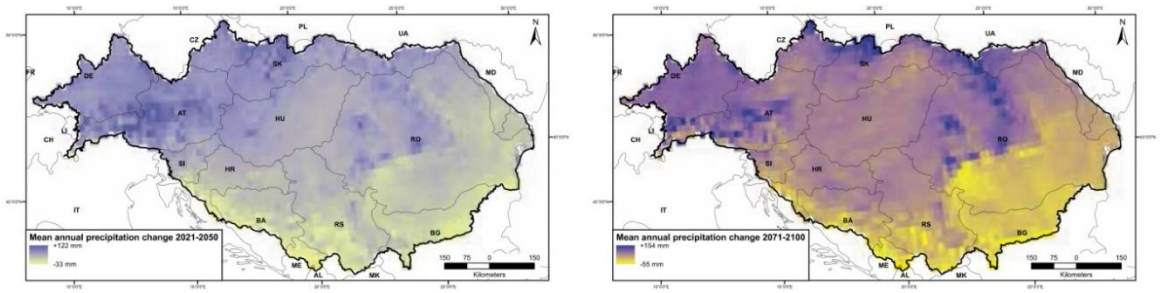


***Figure 7**: Estimated annual mean precipitation trends in the Danube region 2021–2050 and 2071-2100*
Source: ICPDR (2018)

Figure 8 depicts summer soil moisture changes between 1961-1990 and 2021-2050 using the Palmer Drought Index applied to the data of 12 Regional Climate Models; with red indicating drier and blue indicating wetter conditions. Although the overall trends agree with the previously mentioned scenarios measured with the SPI, soil moisture also depends on use, temperature and evaporation, so some relevant differences appear: most of the basin is expected having drier summer soils than in the historical period, with the only exception of some areas of Austria and Germany, with an overall expectation to have an evident impact e.g. on irrigation needs.

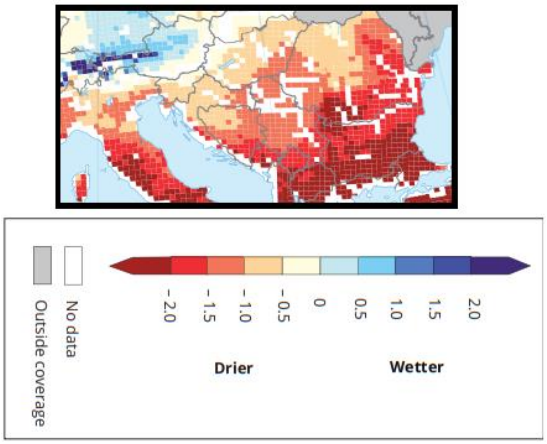


Figure 8: Changes are presented as mean multi-model change between 1961-1990 and 2021-2050 using 12 Regional Climate Models (RCMs); with red indicating drier and blue indicating wetter conditions.
SOURCE: Adapted from European Environmental Agency website: https://www.eea.europa.eu/data-and-maps/figures/changes-in-summer-soil-moisture

Last, the projected changes in stream flows is shown between the end of the 21st century and the period 1961-1990 (see Figure 9). The column to the left shows the percentage of change that the 20-year return level minimum flow is expected to experience, while the right one refers to the occurrence of deficits. It is measured for climate change only (top row) and for a combination of climate change and water use (bottom row). These projections show that the Danube and most of its tributaries may experience more frequent deficits and their minimum discharges are likely to be lower than the historical observations, impacting all the uses of the river waters.

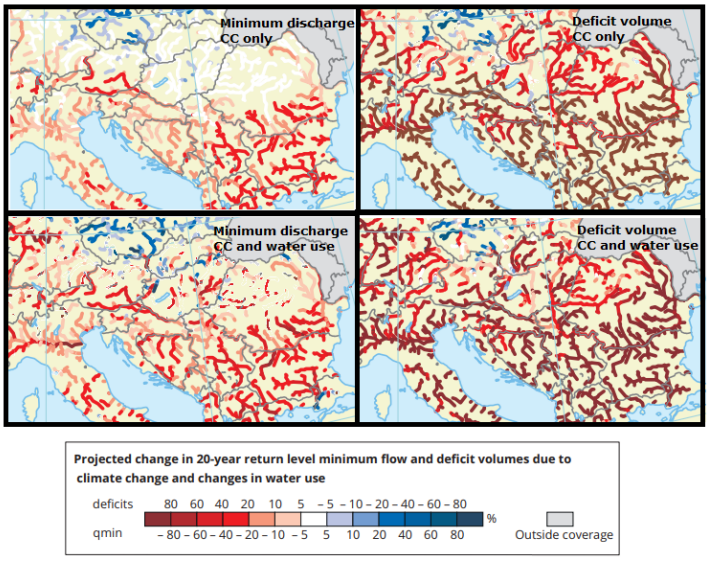


Figure 9: Differences between the end of the 21st century (SRES A1B scenario) and the control period (1961-1990) for minimum discharges (left) and change in occurrence of deficits (right) for climate change only (top row) and a combination of climate change and water use (bottom row).
Source: Adapted from European Environmental Agency website: https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-20-year

2.2. Impacts of previous droughts

As the Danube River Basin Management Plan (RBMP) points out (ICPDR, 2015 and ICPDR, 2021), drought causes economic damage in the region generally in the peak spring or summer season, when the irrigation demand is highest. While the effects of winter drought are less prominent, the scarce snow accumulation in the drought years has e.g. depressed the tourist sector (Thomas et al., 2013), constrained downstream water use and weakened ecosystems dependent on snow-melt. Melting started earlier than usual, altering the hydrological regimes (Blahušiaková et al., 2020).

Distinguishing by sectors, these are examples for the main impacts of the droughts of 2003, 2007, 2012, 2015 and 2017 (ICPDR, 2015; Slovenian Environment Agency, 2019; United Nations Office for Disaster Risk Reduction, 2021):

- Agriculture was by far the most impacted activity. These droughts led to moderate water scarcity situations, as the "The 2015 Droughts Report in the Danube River Basin" points out. In areas with periodical irrigation, water demand was substantially above the long-term average because spring precipitation was substantially below it. The most significant impact was on corn and later harvested crops like soya, sugar beet or rape seed.
- As the soil was anomalously dry and many small tributaries went warmer, dry or eutrophicated, while some others lost velocity or had their regimes altered, forests and the aquatic environment were impacted. Forest fires also increased in the summer seasons. High impacts on the ecology were reported by the Czech Republic and Moldova, while low impacts were described for Austria, Bosnia and Herzegovina, Germany, Croatia, Hungary, Serbia and the Slovak Republic.
- Drinking water supply was only marginally affected because there were plenty of emergency financial and human resources allocated for the drought response. Bosnia and Herzegovina suffered more scarcity than the rest of the basin. There were service restrictions in most of the countries, though.
- Austria, Czech Republic, Germany, Croatia, Serbia, Bosnia and Herzegovina, the Slovak Republic and Moldova reported impacts of the drought on recreational and shipping navigation in small and main rivers.
- Most of the countries in the basin reported low but noticeable impacts on hydropower production.
- As for industry, only Ukraine stated a high impact by the drought because of the lack of sufficient cooling water supply.
- In terms of water quality, most of the monitored rivers experienced an increase in temperatures, which affected fish farming in Czech Republic.

3. Drought Risk Management status in the Danube region

3.1. Drought Risk Management initiatives at the regional scale

Droughts that are more frequent and more severe will have consequences in many sectors (Blauhut et al., 2015), but the impacts will depend on the strategies followed. In the Danube region, the issue is gaining more importance and steps are taken at regional level in the framework of the International Commission for the Protection of the Danube River (ICPDR) and the European Union.

An exhaustive review of the state of the art regarding drought-related national and international initiatives that are applicable to the Danube region was performed for the Danube Drought Strategy (Slovenian Environmental Agency, 2019). Table 1 shows the level of ascription to the relevant international political activities and programs of each country within the DriDanube initiative (in order of appearance in the table: Austria, Bosnia and Herzegovina, Czech Republic, Croatia, Hungary, Montenegro, Romania, Serbia, Slovakia and Slovenia).

Although none of the listed programs at the international scale is fully focused on this hazard, all of them deal with different aspects of drought management. Most of these tools have an advisory nature, so the countries have some flexibility to transpose them to national law.

Among these policies, one of the most important instruments for water management in Europe is the **Water Framework Directive** (WFD). It provides a legislative framework with a clear focus on the river basin scale as the planning unit. In coordination with it, and following a similar approach, the European Union released subsequently a Floods Directive (2007/60/EC). Under their umbrella, river basins prepare harmonized and coordinated Flood Risk Management Plans and River Basin Management Plans (RBMPs). However, even if the European Commission developed an official Communication named “Addressing the challenge of water scarcity and droughts in the European Union” (European Commission, 2007), and a subsequent evaluation of the policy on water scarcity and droughts that followed, there is not an official regulation piece equivalent to the one available for floods or a shared vision for droughts. In these circumstances, the river basins and countries can decide how far to engage in planning efforts to prepare for this risk under their national RBMPs.

A very important policy document at the international level is the basin-wide **Danube Climate Change Adaptation Strategy**, updated in 2018 by ICPDR - International Commission for the Protection of the Danube River- in line with the 6-years river basin management planning cycle of the WFD, which will feed into the 2021 update of the RBMPs. It puts drought as a relevant issue for the future of the basin, considering “Drought management, water scarcity and Adaptation” an important field of action. The document reviews past and potential impacts, stresses the importance of the RBMPs as entry instruments for drought management and makes adaptation recommendations.

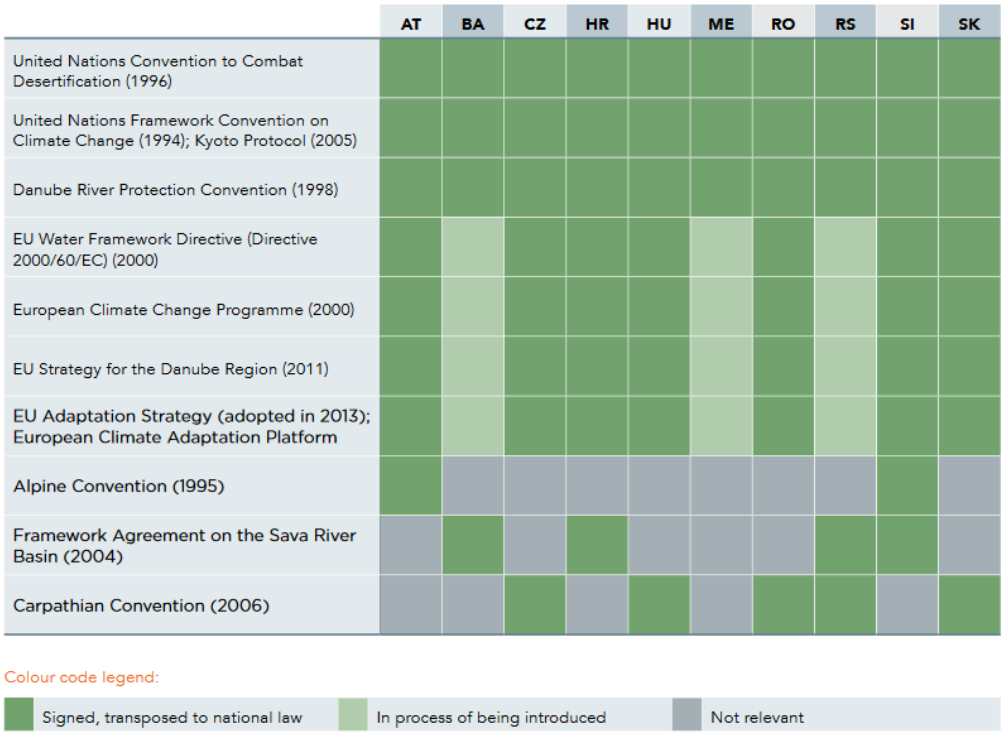


Table 1: Adherence to international political activities and programs relevant to drought of each country within the DriDanube project
SOURCE: Danube Drought Strategy (Slovenian Environmental Agency, 2019)

The **Danube River Basin District Management Plans** are aligned with this approach and are also developed by ICPDR at a basin-wide scale. In the 2015 plan still in force, drought was not considered as a significant water management issue (SWMI), unlike hydromorphological alterations or pollution problems, a situation that did not change until the release of the Decision by the Heads of Delegations at the 22nd ICPDR Ordinary Meeting in Vienna, in December 2019[2]. This recent classification of drought as a SWMI leads to the need of addressing its management in the international basin-wide RBMP which is due by December 2021.

In line with the basin-wide planning exercises, it is worth mentioning the upcoming ICPDR **Water Balance model for the Danube basin** project. The members have agreed in late 2020 to develop a Danube Water Balance model in a way that a Danube Water Management model can be established in a consecutive phase. It will be a robust Water Balance model, to be set up imminently, assessing adequately extreme hazards and climate change effects on the basin hydrology, also wholly considering groundwater and ecosystems. Data needs and data availability have been assessed and there is agreement on suitable models and a roadmap towards its assembly.

Moreover, to support such Drought Management dialogue in the basin, there are several regional projects and initiatives that have a long track record of analyzing the issue, with different geographical scopes and perspectives:

- The **EU Strategy for the Danube Region (EUSDR) Environmental Risks Priority Area (PA5)[3].** The Strategy has an action plan with a series of Priority Areas (PA) (European Commission, 2020). In particular, PA5, is managed by Hungary and Romania and its main target is to help addressing the challenges of water scarcity and droughts though the Danube River Basin Management Plan. In the past few years EUSDR PA5 contributed to the report on the impacts of droughts in the Danube Basin in 2015 (ICPDR, 2016) and to the elaboration of the ICPDR Climate Change Adaptation Strategy Update 2018 (ICPDR, 2018).

[2] https://www.icpdr.org/main/publications/danube-watch-3-2019-significant-water-management-issues-lets-go-swmi
[3] https://environmentalrisks.danube-region.eu/

- The **Integrated Drought Management Programme in Central and Eastern Europe**[4] (IDMP CEE). It was launched by the Global Water Partnership (GWP) and World Meteorological Organization (WMO). IDMP in CEE region is coordinated by GWP CEE and supports the Governments of Bulgaria, Czechia, Hungary, Lithuania, Poland, Republic of Moldova, Romania, Slovakia, Slovenia and Ukraine in the development of drought management policies and plans. It is organized to provide both policy advice and practical solutions in DRM. Some of the main achievements of the IDMP CEE are:
  - Concise overview of the situation regarding drought management in CEE
  - Guidance document for preparation of the Drought Management Plan in connection with the EU Water Framework Directive and global directions
  - Communication links between the experts and policy makers active in drought management at the country level
  - Increased capacity of the key actors to implement the entire process of preparing a Drought Management Plan in their own countries (case of the Slovak National Drought Plan)
  - Collection of existing drought monitoring indices, methods, and approaches from the CEE region, and the establishment of a link and integration of data into the European database and monitoring service (European Drought Observatory)
  - Demonstration of new, innovative approaches in drought management linked to; big emphasize on the Natural Small Water Retention Measures.
- The **Drought Management Centre for Southeastern Europe**[5] (DMCSEE), by UNCCD national and the WMO, focuses its work on monitoring and assessing drought and evaluating risks and vulnerability.
- The Interreg **DriDanube Project**[6]. The main objective of DriDanube project (2017- 2019) was to increase the capacity of the Danube region to manage drought related risks and was developed in coordination with the previously mentioned initiatives and partners. The project developed a series of activities and products, throughout the three pillars of DRM, that aim to create a unified vision in the basin:
  - DriDanube project partners developed a *Danube Drought Strategy*, which aims to build the capacity of the Danube region to overcome common deficiencies in coping with drought. Its main outcome is the development of a methodology to enhance drought management specific for the Danube region that will be described in the following chapter.
  - The *Drought Watch*[7]: An open interactive web application that offers an insight into the development of drought conditions across the entire Danube region, for a variety of end-users. It is very comprehensive and includes near-real-time and remote sensing-based drought hazard monitoring, citizen science impacts monitoring (see National Reporting Networks, below) and responses monitoring. It produces drought risk maps for different drought varieties.
  - The *National Reporting Networks* (NRNs): They consists of engaged farmers and technicians on the field with knowledge in agriculture and forestry, who weekly report their observations on the state of soil, vegetation or even loss of yield. In fact, the information on drought impacts available in the Drought Watch is collected through the NRNs.
  - *Unified drought risk assessment*: A series of informative drought risk maps with information on vulnerability and hazard were created with a harmonized approach for 10 Danube countries.

[4] https://www.droughtmanagement.info/idmp-activities/idmp_cee/
[5] http://www.dmcsee.org/
[6] http://www.interreg-danube.eu/approved-projects/dridanube
[7] www.droughtwatch.eu

- The **Interreg Project Alpine Drought Observatory**[8] (2019-2022), which aims to create an online drought monitoring platform and develop policy implementation guidelines for proactive drought management in the Alpine Space region, to increase the understanding of drought impacts in the Alps, enhance the current drought monitoring and forecasting capabilities and improve the current drought management practices and drought preparedness. The overall objective is to provide a platform for the monitoring and forecasting of drought with specialized products for the Alpine Space region.
- The **European Drought Centre**[9] (EDC) is a virtual knowledge center with the aim to structure drought related activities in Europe. The EDC promotes collaboration and capacity building between scientists and the user community to work towards a better understanding of the drought phenomenon, and thereby increase preparedness and resilience of society to drought.
- The **European Drought Observatory** [10](EDO) by the EU Joint Research Centre (JRC) works as a scientific backup and is focused on offering drought-relevant information such as maps of indicators derived from different data sources (e.g., precipitation measurements, satellite measurements, modelled soil moisture content).

3.2. Drought Risk Management initiatives at the national level and implementation challenges

Effective cooperation at basin-wide scale requires appropriate policies, capacities and suitable coordinated approaches at the national and sub-national level. Since the drought risk situation and risk perception differs among countries of the Danube region, also the level of attention the topic has received varied in the national level RBMPs.
Despite of the mentioned variation, there are many inspiring country initiatives and examples from which to build from, and some examples of the most broadly disseminated are captured in Table 2. Some of these good practice approaches were further explained in the workshop (see Box 2).

PILLAR 1- Monitoring & Early Warning examples		
ACTIVITY	**COUNTRIES**	**MORE INFO**
Drought monitoring system for Austrian agriculture *AgroDroughtAustria*, with crop vulnerability assessment and agriculture indicators	Austria	https://warndienst.lko.at/startseite+2500++1061492 https://meteo.boku.ac.at/report/BOKU-Met_Report_25_online.pdf
Meteorological and Agricultural Drought Monitoring, based on the Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), Crop Moisture Index (CMI). Dissemination via online user-friendly platform	Slovakia	https://www.shmu.sk/en/?page=1
High-resolution drought monitoring scheme with Soil Moisture, Vegetation Condition and Observed impacts	Czech Republic	https://www.intersucho.cz/ https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.6557
Drought monitoring system based on ground data and with adjusted indicators	Hungary	See Box 2 https://www.gwp.org/globalassets/global/gwp-cee_files/idmp-cee/idmp-drought-monitoring-hungary.pdf https://www.met.hu/en/idojaras/
PILLAR 2- Vulnerability & Impact Assessment examples		
ACTIVITY	**COUNTRIES**	**MORE INFO**
Application of Drought Vulnerability Index (DVI), back in 2011	Bulgaria, Serbia	https://lawsdocbox.com/120315696-Immigration/Drought-risk-assessment-based-on-impacts-archive.html
Archive of local/regional/national drought periods and impacts based on historical records	Slovenia, Hungary, Bulgaria, Croatia, Serbia	http://www.dmcsee.org/uploads/file/308_wp411_archiveoflocalregionalnational.pdf

[8] https://www.alpine-space.eu/projects/ado/en/about
[9] http://europeandroughtcentre.com/
[10] https://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000

			http://www.dmcsee.org/uploads/file/309_wp421_droughtvulnerabilityestimates.pdf
Drought Vulnerability Assessment following the recommended procedure in the framework of Drought Management Centre for Southeastern Europe		Croatia	https://hrcak.srce.hr/120753
Assessment of susceptibility to drought		Romania	https://www.gwp.org/globalassets/global/gwp-cee_files/idmp-cee/idmp-act.5.4-report-1.1.pdf
2021 Assessment of the drought-related vulnerability of the Hungarian NUTS-3 units		Hungary	https://link.springer.com/article/10.1007/s11027-021-09943-8
PILLAR 3- Planning, Preparedness, Mitigation & Response examples			
ACTIVITY		**COUNTRIES**	**MORE INFO**
Policy and planning	Program of Measures for the Elaboration of the National Strategy for Mitigating the Effects of Drought on Short-, Medium- and Long-term	Romania	http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/38/f04628e5708b3aefd6724efe63d1204b3017b321.pdf http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/38/f04628e5708b3aefd6724efe63d1204b3017b321.pdf
	National Strategy for Mitigating the Effects of Drought and Combating Land Degradation and Desertification on Short-, Medium-and Long-term	Romania	
	Integration of drought planning into Main River basins RBMP, with summary of specific measures for mitigation	Czech Republic, Austria, Hungary, Croatia	
	Preparation of Drought Management National Action Plan	Slovakia	See Box 2 https://www.gwp.org/en/GWP-CEE/WE-ACT/news/2017/slovak-national-action-plan-to-combat-drough/
Preparedness and Mitigation	Enhancement of groundwater recharge: bank filtration for drinking water supply	Hungary	https://www.hydrology.nl/images/docs/iah/publications/4_Management_of_Aquifer_Recharge_and_Subsurface_Storage.pdf
	Maximizing natural groundwater storage with Induced Bank Filtration	Serbia, Slovenia, Slovakia	https://www.taylorfrancis.com/books/edit/10.1201/9781003078838/management-aquifer-recharge-sustainability-peter-dillon?refId=793f5ea8-9516-49ca-83a1-0034afb151ec
	Converting cropland to grazing land	Slovenia	https://qcat.wocat.net/en/wocat/technologies/view/permalink/2823/
	Natural Small Water Retention Measures (NSWRM)	Slovakia, Hungary, Slovenia, Romania, Croatia, Czech Republic	http://nwrm.eu/list-of-all-case-studies
	RECARE: Preventing and Remediating degradation of soils in Europe through Land Care	Slovakia, Romania	http://www.recare-hub.eu/case-studies
Drought response	Weather Risk Insurance based on weather variables correlating with yield individually defined	Germany	https://wetterheld.com/home/
		Austria	https://noe.lko.at/verbesserung-f%C3%BCr-d%C3%BCrreindex-versicherung-2018+2500+2646626
	Comprehensive set of response measures: • Drinking water supply support (humans, livestock, wildlife) • Insurance compensation • Public aid to compensate loss of revenue • Tax relief (reduction or delay of payment deadline) • Fire control programmes Implement set-aside regulations	Serbia	http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/38/3cb4570428a27fe181416ac87502dd2163222b64.pdf
	Adaptation of farming techniques in paprika crops	Hungary	https://www.reuters.com/article/us-hungary-climate-water-paprika-idUSKBN24B26G

Table 2: Country initiatives for each of the three DRM pillars
Source: Authors

BOX 2: National Action examples featured in the workshop

Case Study; Slovakia, National Drought Action Plan

In the last few years, the country has taken several steps towards a more proactive drought management, after the effects of the last droughts. These activities are overseen by a ne National Drought Action Plan.

The plan is based in three principles:

1. It is aimed at strengthening prevention, with a specific focus on forests, agriculture and urban settlements. It has also a particular emphasis on water harvesting, Nature Based Solutions and on increasing the natural retention capacity of the landscape.
2. It develops management and operation measures in several sectors. Moreover, it relies on cobenefits, finding synergy of measures for flood protection and drought mitigation (reconstruction, maintenance of water storage constructions, etc.) and measures for nature protection (like revitalization of wetlands)
3. It focuses on research, education and public awareness

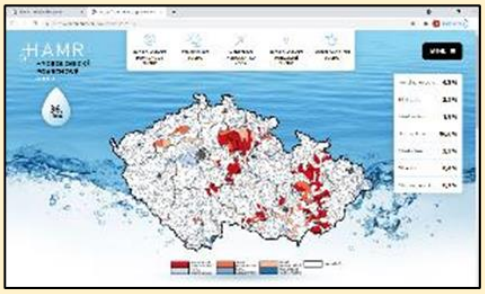
MORE INFO: https://www.gwp.org/en/GWP-CEE/WE-ACT/news/2017/slovak-national-action-plan-to-combat-drough/

Case Study: Czech Republic new integrated approach

The country is facing more water resources temporal and spatial variability challenges. For example, it is already experiencing longer summer dryness and more droughts than at the start of the historical records.

In order to avoid losses, Czech Republic is tackling several DRM pillars that were not enough advanced, among others:

- Development of multipurpose water infrastructure, based on new rainwater harvesting management frameworks,
- Modification of the Water Act to establish a Commission for DRM and to set the standards for an upcoming Plan for managing drought and water shortage,
- Dissemination of an open access DEWS



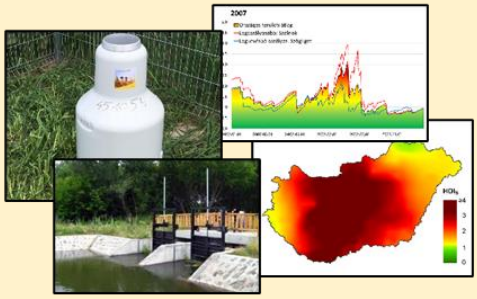
Case Study: Wasserschatz Österreichs, the Water treasure of Austria

In Austria, groundwater is highly important for the main uses, especially when irrigation needs are higher.

For this reason, the country is performing a cutting-edge, detailed groundwater availability and demand assessment in order to obtain the basic information to ensure sustainable and secure use of this resource.

The analysis uses climate change scenarios and projections of socio-economic water demand to identify the areas that will be more problematic from the point of view of availability and intensity of use, especially in dry periods, considering also ecological needs.

MORE INFO: https://info.bmlrt.gv.at/themen/wasser/nutzung-wasser/wasserschatz-oesterreichs-studie.html



Case Study: Hungary, Operational drought and water scarcity management system

Hungary is likely to face more droughts in the coming decades, and the past ones already caused significantly more damage than excess of water and floods, for which the country is more prepared.

As part of the strategy to improve this situation, a DEWS was created, based on – so far- 102 ground monitoring stations.

From the raw data obtained, which is stored in a geodatabase, the Hungarian Drought Index (HDI) is applied, adjusted from more commmon indicators to effectively include soil moisture. Based on the HDI evaluation, weekly drought and wáter shortage reports are released.

This system is starting to influence interventions and alert.

MORE INFO: http://aszalymonitoring.vizugy.hu/index.php?lang=en g

Targeted actions will help increasing awareness and improving resilience of the Danube region; strengthening capacities in the countries were some of the three pillars advanced less so far is essential.

In the framework of the DriDanube, the country partners reviewed the state of their national DRM systems. In parallel, a "Review and classification of IDMP examples of long-and short-term measures" was performed for a sample of countries. Their key findings, compiled in 2019, were put in common with the audience of the workshop and debates and Miro online whiteboard[11] sessions were facilitated. The result is the creation of an **updated list of the status of the different DRM pillars**:

- Drought monitoring, early warning (DEWS), communication and dissemination (*IDMP pillar 1*)
  - ✓ It is the most advanced pillar and all the countries have some drought monitoring in place, but not all of the systems are equally developed,
  - ✓ The varieties of drought that are monitored change from country to country and many different drought indices are used. Moreover, there is no consensus on thresholds for the different tracked drought types,
  - ✓ DEWS are followed mainly when drought has started and the warnings released are offered with some delay, which contributes to the reactive approach (occasionally when it is already late),
  - ✓ Groundwater monitoring is often not performed or not disseminated,
  - ✓ More tracking of water use is required (linked to the implementation of permits, audits, etc.),
  - ✓ The press and other public media dominate the creation of the message on drought conditions and impacts. Journalists are increasingly more prepared, thanks to several training initiatives, but it varies from country to country,
  - ✓ There are initiatives like youth campaigns and increased media coverage to raise awareness, but it needs to continue,
  - ✓ Uncertainties, DEWS results and model results are often not well interpreted or properly "translated" to the general public
- Vulnerability & Impact Assessment (*IDMP pillar 2*)
  - ✓ There are initiatives and recent pilots were implemented, some in the framework of the NRNs, but vulnerability and risk assessment is much less advanced than drought hazard characterization and DEWS use. The countries need systematic and regular collection of drought impacts to complement drought monitoring,
  - ✓ In some countries like Slovakia, the water sector assesses water uses vulnerability to provide advice, but it is not widespread,
  - ✓ One of the main obstacles is that data collection, directly on sectoral drought impacts or collection of data on aspects that could serve as proxies, is not similarly exhaustive among the different European countries, so sharing risk evaluations experiences can support the initiation of better surveys, data gathering campaigns and assessments in the least advanced ones,
  - ✓ In particular, there is neither enough emphasis on costing drought impacts on water-related sectors, nor enough evaluations of the avoided losses and economic benefits of risk-based measures. These studies help making the economic case for a proactive approach versus a crisis-management approach,
- Enabling environment: Strategic elements in national legislation, planning and institutional roles and cooperation (*Part of the IDMP pillar 3 long-term measures*)
  - ✓ Most countries in the region do not have a framework document in place (National Drought Management Plan, National Law, etc.) that would directly address the overall drought management, therefore this hazard is weakly considered in various strategic documents that have a reactive focus,

[11] https://miro.com/app/dashboard/

- ✓ Despite of that, a number of Danube countries are addressing water scarcity and drought in the context of Climate Change adaptation in their national River Basin Management Plans,
- ✓ The main terms we presented in Box 1 are often confused in these strategic documents,
- ✓ It is not mandatory to create the RBMPs under a perspective that addresses water quantity issues adequately, so drought planning is difficult. Related to that, many countries- like Slovakia in the times of developing the national framework- face the question of how to formalize DRM, if it should be supplementary to the RBMPs (see Box 2, example of Spain), if it is easier to align them to the country Climate Change Strategies or if DRM should rely on totally separate instruments.
- ✓ Coordination arrangements are in place for drought emergency, not so obviously for preparedness. National expert institutions and sectors cooperation is ad-hoc and not based on a inter-institutional scheme of data flow and responsibility flow, so it is inefficient,
- ✓ Cooperation, and drought measures in general (i.e. water allocation in drought periods), could be more based on DEWS thresholds and triggers, as it is done in other parts of the world.

- Multi-sectoral preparedness (*Part of the IDMP pillar 3 long-term measures*)
  - ✓ In general, crisis-oriented drought measures prevail,
  - ✓ Preparedness, mitigation and response measures exist in all the countries and sectors, but there are gaps motivated by the absence of an integrated strategy for drought,
  - ✓ In this same vein, sectoral agendas might not be aligned with the DRM agenda or experience different timings. For example, the participant stated that, in some cases, hydromelioration projects for the agriculture sector did not help it being more prepared for drought or were unsuccessful controlling water demand, or some forestry interventions were not considering drought- resistant species,
  - ✓ The participants of the workshop see clear opportunities to build DRM more effectively by teaming-up with other sectors like flood protection and nature conservation. As a cited example, there are incentives for conservation of terrestrial ecosystems that can be used with the intention of also providing drought resilience. It is essential to explore the cobenefits of proposed mitigation actions and prove how these would be advantageous with or without drought, in order to make them more attractive,
  - ✓ In the region, the agriculture sector has more measures in place than water resources or other sectors, especially regarding crop production (rotation, shifts to less water-demanding crops and cropping systems, soil preparation and conservation, etc.),
  - ✓ In the water sector, demand management is starting to be relevant, and rationing and restriction is gaining importance. Supply augmentation measures are also in place for most of the consulted cases,
  - ✓ Other types of actions like temporary reallocation of water (on basis of assigned use priority), banning uses, provision of emergency supplies based on other sources like groundwater are not that common, but there are some examples from which to get inspiration,
  - ✓ The countries face the need to ensure water for aquatic ecology and all the ecosystems depending on water in streams and watersheds. In this regard, it is obvious for the participants that keeping environmental flows in a changing regime poses a challenge,
- Drought response (*IDMP pillar 3, short-term measures*)
  - ✓ The response is not structured based on DEWS indices or outcomes,
  - ✓ Normally, the activation of institutions occurs when drought is severe, which contributes to the reactive approach (occasionally when it is already late),

- ✓ Many countries have legal frameworks established on post-drought procedures for economic evaluation of drought damage costs and compensation,
- ✓ At household and sectoral activity level, drought financing and insurance need more thinking and acceptance.

Moreover, the participants state that - even if there are funds available for the water sector coming from national or European sources - budget is not adequately and sustainably allocated for drought institutions and measures, because water scarcity and droughts are not yet recognized and addressed at the required level of importance the topic deserves.

BOX 3: Examples from other regions

Case Study: France, adapting conjunctive use in times of drought

- To deal with insufficient water resources during the low water periods, the French provinces define and take exceptional measures to limit or suspend the use of surface or groundwater in application of article L.211-3 II- 1 ° of the environment code.
- The thresholds leading to restriction measures (and the measures themselves) are pre-defined locally by the provinces, based on information on water levels in aquifers and streamflows.
- "Drought orders" can only be prescribed for a limited period, within a specific perimeter. The provinces are forced to allocate the water first for the priority uses (health, civil secutiry, domestic water supply and environmental flows and storages). The measures must also respect the equality between users of the different departments and the necessary upstream-downstream solidarity of the watersheds.
- The province prefect takes her/his decision (a decree) based on the recommendations by the drought committee meetings ("Comités Sécheresse" or "Comité de Suivi de la Ressource"). The DDT's (Direction Départementale des Territoires) are in charge of defining the drought allocation measures and thresholds and they in turn receive data from technical entities. For groundwater there are about 4000 piezometers that are surveyed by BRGM (French geological institute) who produces weekly reports on the status of the groundwater units in each province.
- The procedures are defined in legal decrees, which establish the mandates to draft and enforce these plans and measures. The declaration of drought levels is also a decree.
- While the decisions are taken at an administrative scale, the information on thresholds is gathered and defined by aquifer unit and/ or by basin.
- The drought response measures are embedded in the broader environmental legislation.
- Coordination among technical agencies is key here, no new agency is created for drought or groundwater monitoring or management, but a collaboration mechanism is in place.

MORE INFO: https://www.oieau.org/IMG/pdf/IOWater-WaterManagementFrance.pdf

Case Study: USA, Standardized Drought Response and Recovery for Water Utilities

- The USA Environmental Protection Agency (EPA) has developed guidance material for water utilities to design comprehensive urban drought plans (UDP) linked to their Water Utility Master Plans (WUMP) and Urban Water Supply Management Plan (UWMP). This way, the utility counts on water resource planning to ensure that adequate water supplies are available to meet existing and future water needs including during periods of droughts.
- UDPs contain a) drought resilience long-term actions and investments in water security and b) contingency actions prepared to be enforced when drought hits. UDP can be included in the suppliers´ WUMP/UWMP or developed in parallel to them. In general, this urban drought planning has the following intentions:

✓ Collect and sort basic information on urban demands and assess resource availability.
✓ Define the shortage risk statuses linked to droughts (also called scenarios of operational drought) in their own systems.
✓ Establish the conditions that could be reached within every status of risk of shortage.
✓ Establish the objectives of demand reduction and reinforcing supply.
✓ Provide guidance on the measures to apply in the different declared statuses (shortage situations) for the supply system to prevent possible greater damage.
✓ Establish responsibilities in decision making and how to manage the different possible drought situations. The issue of the scale is very relevant here: city vs basin or vs aquifer and how to manage these interlinkages.
✓ Document all of the above and keep it updated.

MORE INFO AND IMPLEMENTATION GUIDELINES: https://www.epa.gov/sites/production/files/2017-10/documents/drought_guide_final_508compliant_october2017.pdf

Case Study: Spain, Drought Management Planning

In Spain, Drought Management Planning is obligatory in the main riverbasins and it is organized under the umbrella of the WFD and connected to the RBMP. The Drought Management Plans:

- ✓ It contains water resources and drought characterisation and diagnose. It also offers a detailed historical drought inventory,
- ✓ It defines and applies an indicator system for situations of prolonged drought and occasional water scarcity. DEWS,
- ✓ It enforces measures, roles and actions to develop during the different phases of drought and water scarcity, triggered by monitoring,
- ✓ It defines how to perform drought follow-up and post-drought reports and how to assess socioeconomic and environmental impacts,
- ✓ It provides a reference framework for urban and rural supply emergency plans

MORE INFO: https://www.miteco.gob.es/es/agua/temas/observatorio-nacional-de-la-sequia/planificacion-gestion-sequias/ (In Spanish)

Source: Authors

4. Achieving optimal DRM in the Danube region

4.1. What to change? Lessons learned, gaps and opportunities

In the previous section an account is provided on challenges for DRM in the region and the different countries, based on literature review and feedback from the workshop. However, the workshop participants also reflected on the general opportunities for improvement, updating the assessments and recommendations already published for the Danube Drought Strategy (2019). A summary of the main arguments is offered below:

- ✓ Drought management is a very relevant issue in the region, and is gaining traction, but more frameworks and protocols are needed. It is key to start with the development and enforcement of a national strategic document on drought management that defines a timeline and corresponding course of institutional actions, inspired by the frameworks described in this chapter.
- ✓ It is essential to call for political will and a coordinated legal approach. Countries are encouraged to acknowledge drought among national priorities.
- ✓ Strengthen existing partnership between agencies and stakeholders and promote connections with other institutions and initiatives is key.
- ✓ Awareness, communication and education is vital for understanding and perceiving the risk, so that people and governments take adaptation action. Knowledge and good practices sharing has proven efficient in the region. It is also essential to strengthen water-related learning curriculums at all levels.
- ✓ Even if steps are taken in all sectors and in all the countries of the region, there is variation among them, which requires in depth diagnostics and action in the identified gaps.
- ✓ Allocation of budgets for drought preparedness is fundamental: programs, data, products, tools and human capacities need to be financially sustainable. In many cases, a sector at risk counts on sufficient funding, but it is not being used to become more drought resilient.
- ✓ Countries should form a drought impact inventory managed by national authorities.
- ✓ Professionals and decision makers are encouraged to introduce available tools, at least DEWS consultation and dissemination, into daily work routine.

"We must work with governments and across sectors for proactive action, before drought hits"

4.2. How to start changing the situation? Pathways, policy and regulatory approaches to improve resilience against water scarcity and droughts

Many regions and countries in the world face common deficiencies in proactively coping with drought, so some systematized methodologies have been created with the aim to help to overcome them comprehensively, which can serve as inspiration for the Danube region and the countries. These are not necessarily focused on establishing new institutions or activities, normally are more oriented towards organizing the existing capabilities and enabling cooperation by key sectors that rely on water use.

The IDMP National Drought Management Policy Guidelines (WMO and GWP, 2014) provide a template for action that countries can use in the development of a national drought management policy and drought preparedness/mitigation plans. The process is structured in **10 steps** that can be adapted by countries to reflect their institutional, infrastructure, legal, socio-economic and environmental context and to improve their capacities to address the risk in a proactive manner (see Figure 10).

Figure 10: 10 steps for Drought Policy preparation
Source: IDMP website

Based on the IDMP National Drought Management Policy Guidelines, IDMP CEE partners developed the **guidelines for preparation of the Drought Management Plans** in order to provide a better understanding of how to integrate drought management into RBMPs in CEE. The ten steps approach was adjusted to a set of seven steps that relate specifically to the environment of CEE countries.

A key objective of the IDMP CEE was to fill gaps in implementing the EU Water Framework Directive (WFD). Among its requirements, the WFD obliges EU Member States to develop River Basin Management Plans (RBMPs). Integrating measures in the RBMPs can be a way to address water scarcity and droughts, next to the development of a Drought Management Plan (DMP) as a targeted supplementary measure. IDMP CEE further found that DMP development in CEE was limited, and most countries had not produced a specific DMP.

The guidelines were also informed by 20 National Consultation Dialogues[12] in 10 countries in two years with national drought experts and responsible policy actors. The dialogues opened communication among different sectors and institutions and encouraged efforts to establish the necessary organizational structures for drought management.

However, as one of the main achievements of the DriDanube Drought Strategy, a new framework for improved drought management specific for the Danube region has been developed, adapting the 10 steps to keep the main focus on the institutions and regulations. It proposes an **Optimal Drought Management Model (ODMM)**, a concept of how DRM would optimally function to comprehensively tackle risk management issues.

The conceptualization of optimal drought management model reflects IDMP's three pillars of drought management and follows the ideas promoted in the National Drought Management Policy Guidelines – A template for Action and in the Guidelines for preparation of the Drought Management Plans. The model addresses agencies within the existing institutional scheme to jointly implement drought policies in a way as specified in protocol of actions, and therefore has 3 main elements: Drought policy framework, which represents the legislative basis for DRM, Institutional cooperation scheme through which the drought policy is enforced and a Protocol of actions (see Figure 11).

[12] https://www.gwp.org/en/GWP-CEE/WE-ACT/Projects/IDMPCEE/National-Planning/

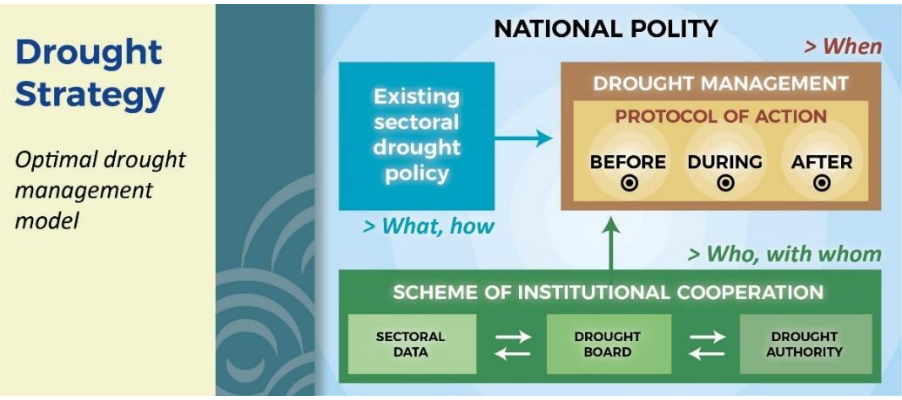


Figure 11: Main components of an Optimal Drought Management Model (ODMM)
Source: Danube Drought Strategy (Slovenian Environmental Agency, 2019)

This means that once the agencies that will integrate the cooperation scheme are identified, the already-existing legislation in a country is organized to endorse their collaboration and reaction in an optimal way, in different stages of drought risk management: from acting preventively during time of no-drought conditions, early response upon its first signals and further development, and during mitigation and evaluation process. Everybody involved has tasks and timing assigned and these rely on drought monitoring.

The development of the Strategy has been complemented with the initial assessments to understand what is missing to achieve this model in each of the DriDanube countries, concluding that all of them need an umbrella policy framework to start providing structure to a national ODMM. More information of the assessments in the "Common report on existing drought management status"[13], that is available online as an annex to the Strategy.

In addition, more information on the ODMM and the methodology for application to the countries in the region is available in the Danube Drought Strategy paper (Slovenian Environmental Agency, 2019).

Last, the **EPIC Response framework** can be a helpful tool for the Danube region to complement the structured methodologies previously described, because it works towards improving the full three pillars spectrum and explains in detail the areas that should be integrated in Drought Risk Management.

EPIC Response was developed by the World Bank and Deltares in 2021 (Browder et al., 2021) and looks at floods and droughts not as independent events, but rather as different ends of the same hydroclimatic spectrum that are inextricably linked. The logic of addressing them together is to seize key opportunities for protecting against both flood and drought hazards, such as protecting watershed, wetlands and forests. In some cases, programs corresponding to the two different hazards can share management agencies and the coordination mechanisms can have similarities, which is helpful to optimize resources. The main national or sub-national agencies involved are WRM, Disaster Risk Management, Natural Resources Management, Agriculture and Hydromet, but some other sectors are important as well. The report helps defining their roles in the management of both risks.

EPIC Response provides a template for the countries to gauge the effectiveness of their preparedness and responses programs and a framework to evaluate the level of effort that is required to improve them.

The methodology identifies twelve fundamental building blocks – the main Program Areas (see Figure 12) - and describes another 40 distinct programs that should exist and that are managed by a variety of national agencies, which must fulfil their specific mandates but also need to collaborate. Collaboration means different agencies working together on a shared agenda, with each agency contributing according to its area of expertise as an equal partner.

[13] http://www.interreg-danube.eu/uploads/media/approved_project_output/0001/38/75e83c4805db64eb7751cb32549e593da4c580f2.pdf

These different programs interact in complex ways, but generally in a downward cascading manner that ultimately determines to what extent hydro-climatic hazards result in disasters. More information and guidelines for the application of the evaluation available in the EPIC Response report[14].

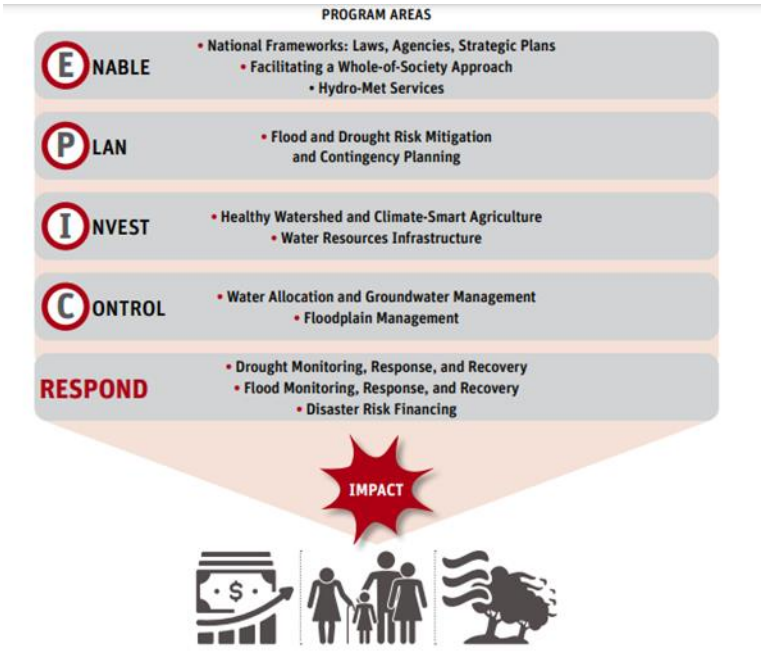


Figure 12: Main components of the EPIC Response Framework
Source: Browder et al., 2021

[14] https://openknowledge.worldbank.org/handle/10986/35754

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