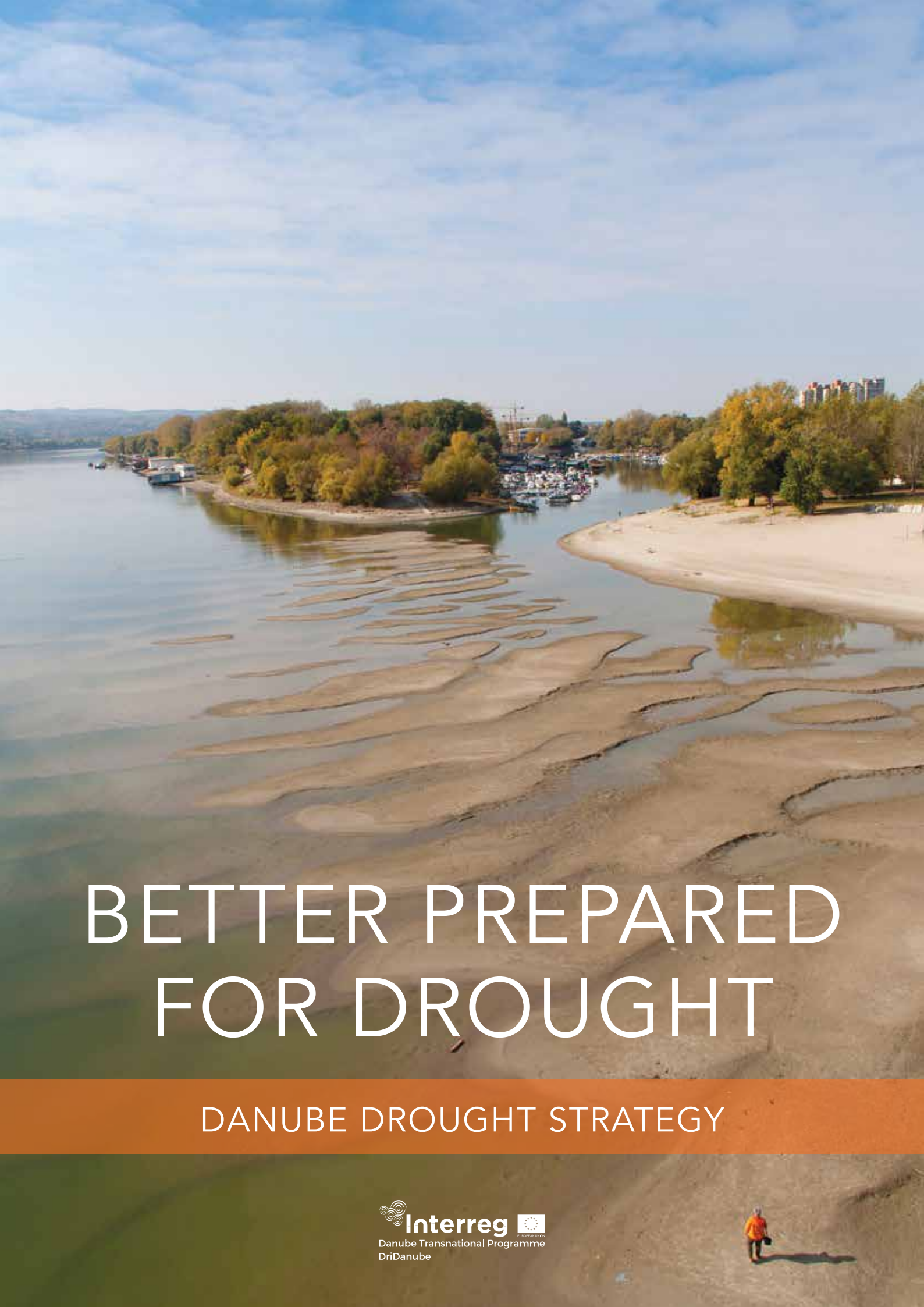

BETTER PREPARED FOR DROUGHT

DANUBE DROUGHT STRATEGY

Interreg
Danube Transnational Programme
DriDanube

BETTER PREPARED FOR DROUGHT

DANUBE DROUGHT STRATEGY

BETTER PREPARED FOR DROUGHT - DANUBE DROUGHT STRATEGY

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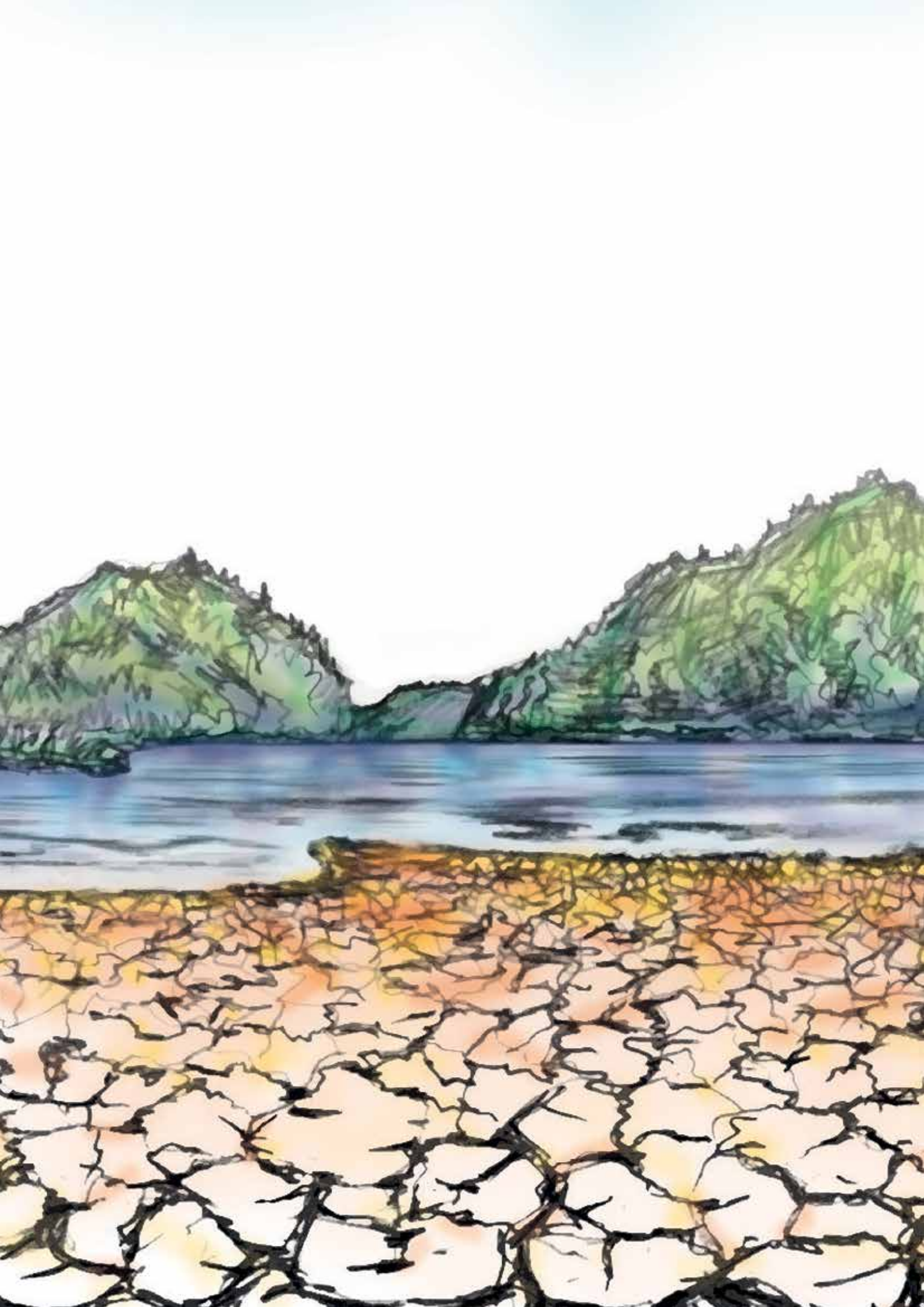


PREFACE

While many people consider droughts to be rare, they are in fact a normal and recurrent natural hazard and feature of the climate. Drought events are regional phenomena, affecting transnational water management. Unfortunately, they have a high damage potential: economic losses, ecological damages, and implications on human health. In recent years, concern has grown world-wide that droughts may be increasing in frequency and severity given the changing climatic conditions. Droughts are occurring more frequently and their impact on all sectors is more intense, affecting both economies and societies.

Given the newly recurring character of droughts in the Danube River Basin, efforts are being made by the ICPDR and its 15 contracting parties to devise strategies to decrease the vulnerability of people in the basin in the face of these growing concerns. Thus we are delighted to see a report such as this one adding to our combined knowledge on droughts; to see a report that's reaching out to the public, and striving to make them aware of the unique challenges arising when it comes to our most important and valuable resource: water.

- International Commission for the Protection of the Danube River

The EU Strategy for the Danube Region is aiming at developing the region in many areas. Improving water quality and preventing environmental risks are among the priorities identified. Droughts have negative impacts on water quantity and quality and, considering the more frequent and prolonged droughts due to climate change effects, it also presents an increasing environmental risk. According to the EU assessment in 2019, already 14 EU Member States considered droughts relevant in their river basin management plans showing that drought is becoming a significant water management issue in river basins.

EUSDR therefore supported the establishment of the DriDanube project from the beginning with a letter of recommendation and followed it during its lifetime. By creating a solid drought information basis and a strong transnational network, the project contributed to the EUSDR objectives, its achievements and concrete results are appreciated by EUSDR. DriDanube also paved the way for further activities the Danube region in areas of drought forecasting, risk assessment and management as well as water management issues like water abstraction, natural water retention measures, water balance and ecological flow, smart water use.

- European Union Strategy for the Danube Region

ABBREVIATIONS

AT – Austria

BA – Bosnia and Herzegovina

CAP – Common Agricultural Policy

CZ – The Czech Republic

DMCSEE – Drought Management Centre for Southeastern Europe

DRB – Danube River Basin

DriDanube – Drought Risk in the Danube Region

EDO – European Drought Observatory

EU – European Union

EU WFD – The European Union Water Framework Directive

EUSDR – The European Union Strategy for the Danube Region

FASRB – The Framework Agreement on the Sava River Basin

HR – Croatia

HU – Hungary

ICPDR – The International Commission for the Protection of the Danube River

IDMP – Integrated Drought Management Programme

IPCC – The Intergovernmental Panel on Climate Change

ME – Montenegro

NAP – National Action Programme in the frame of UNCCD

NGO – Non-governmental organisation

NHMS – National hydrometeorological service

NRN – National reporting network

ODMM – Optimal drought management model

RBMP – The River Basin Management Plan

RDP – Rural Development Programme

RO – Romania

RS – Serbia

SDG – Sustainable Development Goal

SI – Slovenia

SK – Slovakia

ToR – Terms of reference

UNCCD – The United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa

WMO – World Meteorological Organisation

TERMS USED IN THIS DOCUMENT

Behaviour mode – A collective (institutional) attitude or a position taken towards dealing with drought issue.

Danube region – The part of European continent that covers Danube riparian administrative units of 14 countries: Austria, Bosnia and Herzegovina, Bulgaria, Croatia, The Czech Republic, Germany, Hungary, Moldova, Montenegro, Romania, Serbia, Slovakia, Slovenia and Ukraine.

Danube countries – The 14 countries in Danube region.

DriDanube countries – The 10 Danube countries participating in DriDanube project: Austria, Bosnia and Herzegovina, Croatia, Czech Republic, Hungary, Montenegro, Romania, Serbia, Slovakia, Slovenia.

Drought – A period of abnormally dry weather long enough to cause a serious hydrological imbalance[1]; a natural phenomenon.

Drought management – A strongly inter-connected system of drought monitoring and corresponding institutional reaction.

Preparedness – A state of being prepared for a particular (future) situation.

Preventive (adj.) – Intended to stop something before it can happen, or before it becomes a problem[2].

Proactive – A behaviour mode that is focused on taking action by causing change and not only reacting to change when it happens[2]. The interference between previous learning and performance of later learning[3].

Proactive drought management (also: drought risk management) – A drought management concept that is based on the preventive and early response, in addition to emergency dealing with drought, and thus builds drought resilience.

Reactive drought management (also: drought crisis management) – A drought management concept that is based on ad-hoc dealing with consequences of drought once they are already in place, and is thus crisis-oriented.

Water scarcity – A situation when water demand exceeds the water resources exploitable under sustainable conditions[4].

1 https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf
2 According to Cambridge Dictionary.
3 According to Merriam-Webster dictionary.
4 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0414:FIN:en:PDF

Be prepared. Know the risks. Take action.

DANUBE DROUGHT STRATEGY SUMMARY FOR POLICY MAKERS

- **Drought is becoming one of the major challenges** in water management in countries of the Danube region.
- **Drought management starts already** when there are no signs of drought at all and a general belief is present that sufficient water conditions are going to last. It is during that time when we need to build drought resilience.
- **Behaviour mode to be adopted** in drought management should shift from dealing with damages caused by drought to acting preventively for potential next drought.
- **Cooperation of stakeholders, operational services and decision-making authorities** is the key to earlier and more efficient response to drought in order to minimise the extent of drought damage and losses.

Interreg
Danube Transnational Programme
DriDanube

DROUGHT IS BECOMING OUR REGULAR VISITOR

Changes in our climate are reflected in more years with above average temperatures, increased evapotranspiration and an unfavourable distribution of rainfall also across Danube countries – all of them increasing the occurrence of drought, which is becoming more frequent, more intense and no longer only associated with the summer months. In recent years such as 2003, 2007, 2012, 2015 and 2017, significant parts of the Danube River Basin were affected by drought, which had a negative impact on various water-dependent economic sectors, on vegetation and on the aquatic environment. **Severity and frequency of drought can lead to water scarcity situation, while overexploitation of available water resources to meet various water needs can exacerbate the consequences of drought.**

Damage and losses caused by drought 2017	
Austria	140 mio EUR/crop failure and fish mortality.
Bosnia and Herzegovina	126 mio/agriculture, 40 % losses in energy production (Bileća).
Croatia	125 mio EUR/agriculture, >4000 fires over 86 500 ha of the Adriatic coast; islands water supply shortages.
Czech Republic	120 mio EUR/agriculture.
Hungary	51 000 ha of agricultural land damaged.
Montenegro	50 % lower yield in viticulture, 42-50 % losses in energy production (Perućica, Piva), fish mortality.
Romania	reduction of Danube flow for 60 %, higher electricity prices, crop transportation problems.
Serbia	Substantial losses in agriculture, water shortage, dried-up lakes, disturbed energy production. >1 bn EUR/all sectors.
Slovakia	20-40 % lower crop yields, dried-up rivers, hydrological drought.
Slovenia	65 mio EUR/agriculture

Source: Consortium of DriDanube project partners.

WE COPE WITH IT UNSUCCESSFULLY

Despite extensive damages in the last decades, drought continues to be managed as a crisis situation, by implementing emergency procedures and urgent measures. However, this approach usually fails to achieve the most sustainable solutions. Existing national drought management practices revealed a number of shortcomings:

Drought monitoring:

- Regionally diverse drought monitoring in terms of the type of drought that is monitored, variety of indices used for it and consensus on used approach for early warning to public.
- Thresholds for agricultural drought and especially for hydrological drought, crucial for efficient early warning, are in most countries either not in place or agreed upon at country level.
- No systematic and regular collection of drought impacts to complement drought monitoring.
- Early warning is mostly carried out when first signs of drought impacts have already occurred.

Drought response:

- Lack of cooperation between relevant national institutions as well as across vulnerable different sectors, especially before and during drought development.
- No clear inter-institutional scheme of data, responsibility and communication flow, resulting in neutralising the institutional response before, during and after drought.
- Existing crisis-oriented drought policies support the adoption of reactive drought response that mainly deals with the treatment of drought impacts.

- In almost all countries there is no formal umbrella document on drought management.
- Despite the drought impacts on the economy and welfare of the people, drought is at the political level still not considered an issue of high priority.

THERE IS A BETTER WAY...

An alternative to crisis-oriented management of drought can be found in adopting a proactive approach, which is slowly becoming one of the main concerns of strategic regional bodies. Through focusing on the preventive and early response, it helps build country resilience to drought and better preparedness for potential next drought. **Optimal drought management model** described in Danube Drought Strategy provides an operational model for the implementation of proactive drought management at the country-level. The proposed model clearly indicates the necessary actions and respective responsible institutions in each stage of drought – as to determine ***who is doing what and when.*** This way, the model serves as a tool for strengthened institutional cooperation and support in the decision-making process. It has been developed in a way that allows its adoption by any country regardless of its internal organisation of national authorities.

... AND HELP ALONG THE WAY

Several activities are proposed within this Strategy to make the model operational and enable the beginning of proactive drought management implementation in the country. In addition, DriDanube project developed tools that support implementation of proactive drought management in the countries of Danube region:

- **Drought Watch:** an open interactive web application that offers an insight into the development of drought conditions across the entire Danube region. It was designed for national authorities and drought experts, but also for other end-users such as farmers or water managers, to help them make appropriate decisions that lead to the application of relevant short-term measures.

- **National Reporting Networks:** an operational way of drought impact assessment which helps to deliver early awareness of drought damage in place. They consists of engaged individuals on the field, mostly farmers and technicians with knowledge in agriculture and forestry, who weekly report their observations on the state of soil, vegetation or even loss of yield on their specific location, throughout the season or the year.

It is possible to detect drought in its early stages and act accordingly before it creates an emergency sitation.

https://www.youtube.com/watch?v=ASYMEKEeVN0&t=

- **Unified drought risk assessment:** informative drought risk maps, prepared with a harmonized approach for 10 Danube countries which thus enable comparative information on level of risk for occurrence of drought – to recognize the areas prone to rainfall deficit and the areas where significant drought hazard and/or considerable crop losses are expected.

WHAT CAN POLICY MAKERS DO?

Danube Drought Strategy concludes with some brief recommendations on how to enhance capability of the society to better cope with droughts on the long run:

1. **Initiate political will and call for coordinated legal approach.** Policy coherence related to drought on the regional/national level is one of the guiding principles of the Strategy implementation. For achieving the aim of the Strategy, countries are encouraged to acknowledge drought among national priorities.

2. **Encourage collaboration and partnerships.** Strengthen existing partnership between policy makers and stakeholders, and connect with other institutions and regional initiatives to gain extra knowledge and good practices.

3. **Search for resourcing.** Activities to perform fundamental maintenance of project results on the regional level will be completed with the existing resources or future budget decisions (DMCSEE, partners). At the same time, it is reasonable to expect national efforts ensuring the integration of the results, such as investing in data, products, tools and human capacities that support Strategy implementation.

4. **Develop and adopt a national strategic document on drought management.** It shall cover strategic view on drought issue, set long-term goals and a manner of achieving them, and define a matrix of drought timeline and corresponding course of institutional actions. Support for its preparation can be found in Danube Drought Strategy.

5. **Form a drought impact inventory managed by national authorities.** Creation of regular, sectoral and centralized impacts inventory enables the national authorities to have at any time an insight into exact drought damage in place in any part of the country. It also presents a basis for any further legal steps.

6. **Put results into practice.** In addition to planned sustainability in the frame of DriDanube project, it is necessary to introduce available tools into daily work routine (i.e. using national data sets, operational use of tools in institutions etc.).

7. **Support knowledge sharing and awareness raising.** Continue searching for good practices to guide drought management activities, with emphasis on learning process and the preventive.

8. **Establish water-related learning curriculums** at all levels, especially in elementary education.

INTRODUCTION TO THIS DOCUMENT

Danube Drought Strategy (hereinafter: the Strategy) is a document proposing a new framework for improved drought management in the Danube region. The core part of the Strategy is the Optimal drought management model, a concept for comprehensively tackling drought management issues. It was created within the DriDanube (Drought risk in the Danube Region) project funded by the Danube Transnational Programme[5].

Through various interactions of regional-wide stakeholder community, awareness and concern over shared drought issue has increased, and the common need for more effective drought management has become more apparent. Their early engagement in the Strategy development process has allowed deeper insight into existing state-of-the-art and fields where improvements are necessary.

The main aim of the Strategy is to build the capacity of the Danube region to overcome common deficiencies in coping with drought, and thus help switch from reactive to proactive drought management approach. This document pursues this aim by identifying the common steps that were used to launch the proactive drought management in the Danube countries. It then gives clear guidance for overcoming the gaps in the drought decision-making processes and for improving drought emergency responses in the countries of the Danube region.

Danube Drought Strategy document is divided into 6 chapters:

- Chapter 1 focuses on the preparation of a **strategic framework for addressing the drought problem** in the Danube countries. By extracting the most recent legal international and national concepts on drought or water scarcity, it moves us towards a more comprehensive understanding of how the drought management process and policy should work as a whole.
- Chapter 2 includes a **state-of-the-art analysis of national drought management.** It also capitalises recent national legislations, initiatives and networks that tackle drought issues in all the involved countries and identifies specific national and regional weaknesses and gaps.
- Chapter 3 describes the **fundamental groundwork** and guidelines on which the proposed concept of proactive drought management is based.
- Chapter 4 introduces the **optimal model for proactive drought management** by describing its theoretical concept, defining its elements in details and providing a general example for the use of the model in practice.
- Chapter 5 proposes the **steps required for practical implementation** of the model at national level and reviews the progress made so far within each of the steps.
- Chapter 6 suggests some **recent international and regional policies** that could be used to position the Strategy globally, regionally or nationally.

Further implementation of the Strategy at national levels can provide a number of economic, environmental and public health co-benefits and save communities money over time.

5 http://www.interreg-danube.eu/approved-projects/dridanube

1 DROUGHT ISSUE AND AIM OF THE DANUBE DROUGHT STRATEGY

1.1 DROUGHT AS AN INCREASING PROBLEM

Although drought as a natural phenomenon presented an issue already in the ancient and recent past, the observations show that the occurrence of drought has been changing over the last decades. Changes in our climate are reflected in more years with above average temperatures, increased evapotranspiration and an unfavourable distribution of rainfall – all of them increasing the occurrence of drought, which is thus becoming more frequent, more intense and no longer only associated with the summer months. Since the early 1980s, the number of drought-affected areas in Europe has been steadily increasing, especially in the countries of the southern, south-eastern and western Europe, as well as in traditionally rainfall-rich countries such as the Alpine region where drought has not been an issue in the past[6,7].

6 https://www.sciencedirect.com/science/article/pii/S2214581815000026

7 https://www.eea.europa.eu/publications/climate-change-adaptation-and-disaster

BOX 1. ACCORDING TO THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) GLOSSARY OF TERMS (2012)[8], **DROUGHT IS DEFINED AS:**

„A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term, therefore any discussion in terms of precipitation deficit must refer to the particular precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture drought, also termed agricultural drought), and during the runoff and percolation season primarily affects water supplies (hydrological drought). Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation."

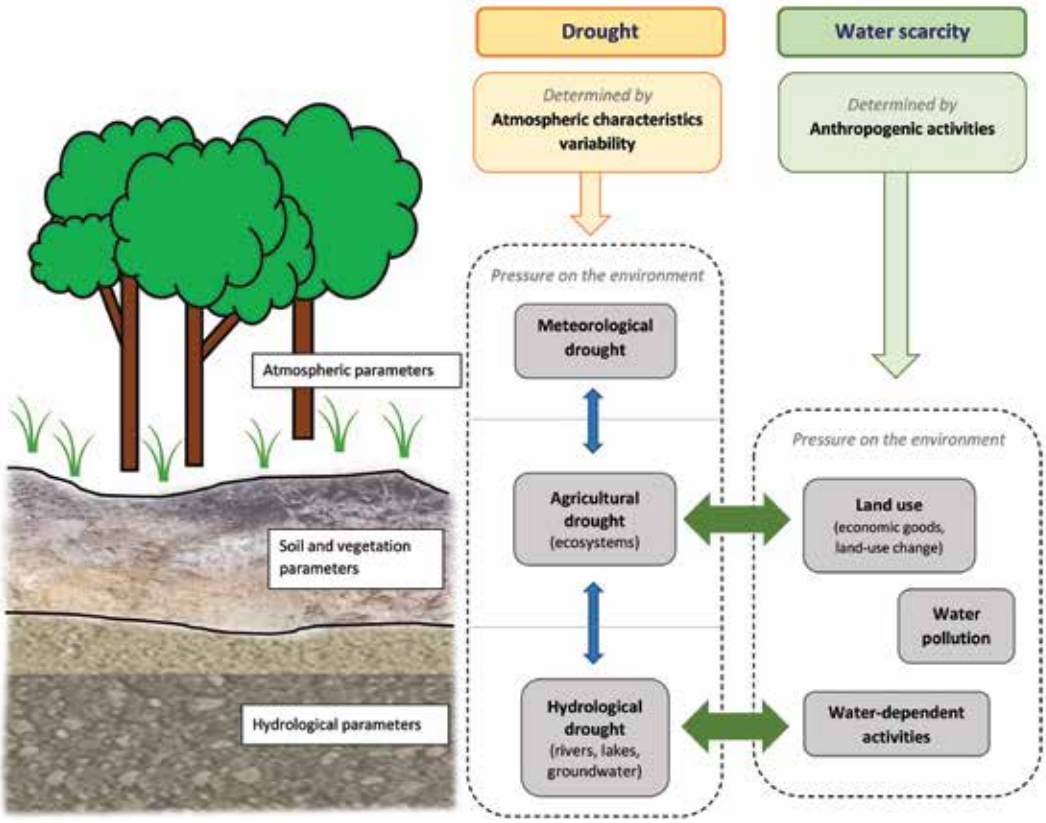


Figure 1: Difference between drought and water scarcity, and their inter-linkage on greater damages.

In the last decades, water scarcity and droughts also hit the Danube region frequently. A series of drought events had large impacts on the economy and welfare of the people[9]. In recent years such as 2003, 2007, 2012, 2015, significant parts of the Danube River Basin (DRB) were affected by drought, which had a negative impact on various water-dependent economic sectors, on vegetation and on the aquatic environment[10]. Also in 2017, significant drought developed across the entire DRB and persisted in its northern parts throughout 2018 and 2019.

8 https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf
9 http://www.dmcsee.org/en/drought_bulletin/
10 https://www.icpdr.org/main/sites/default/files/nodes/documents/icpdr_report_on_2015_droughts_in_the_danube_river_final.pdf

Droughts are generally correlated with large-scale impacts, often driven by regional or even global-scale climate features. The historic classification of drought types has emerged mainly from the meteorological and hydrological sciences in order to tackle agricultural and socio-economic impacts. Nowadays, there are multiple types of drought but only a few of the general definitions are accepted. This lack of clarity has probably hindered the progress in drought management. Droughts are always context-specific and the response to drought needs to reflect specific circumstances. **Severity and frequency of drought can lead to water scarcity situation, while overexploitation of available water resources to meet various water needs can exacerbate the consequences of drought**[11].

Despite extensive damages in the last decades, drought has been traditionally managed only as a crisis situation, by implementing emergency procedures and urgent measures. However, this approach usually fails to achieve the most sustainable solutions. The frequency of drought and low water level in the region is expected to increase, especially in summer and in particular in the south-eastern parts of the DRB[12]. In that view, also the far-reaching impacts of drought are very likely to increase across countries, communities, watersheds, economies and ecosystems in the Danube region.

1.2 ISSUES IN COPING WITH DROUGHT

Comprehensive drought management should combine monitoring of drought development and its impacts, and institutional legal-based reaction, which both in turn define drought according to their type of work. The objective of operational definitions of drought[13] is to define the beginning, the severity and the end of a drought event, as well as the area it covers. These definitions serve as a basis for an effective early warning system. It is impossible to provide a single operational definition of drought that would apply to all circumstances. On the other hand, conceptual definitions are important in the establishment of drought policies. However, conceptual dealing with drought should be driven by (based on) operational detection of drought.

This is probably the reason why policy makers, water managers and others are facing difficulties in coping with drought. Frequently asked questions in this aspect are: is there a drought present and how severe is it, what can be done in different stages of drought, who is responsible for taking certain actions, what kind of measures should be taken, etc. A water manager would likely need to take different actions than a farmer but the steps of management are similar. The Strategy proposes to constantly monitor the presence or absence of drought and act accordingly instead of waiting for the situation to become worse. A lot of emphasis is placed on preventive measures and on preparedness. In this sense, the **Strategy provides a practical template for drought management**.

NATIONAL DROUGHT MANAGEMENT consists of two major parts: monitoring of drought development and its impacts, and corresponding institutional legal-based reaction, which both need to be strongly inter-connected at all times: during the periods of preparedness, response and recovery from drought.

At the same time, drought management should be flexible and able to adapt to the constantly progressing outcomes of drought research: continuous efforts of governmental bodies are required to upgrade drought monitoring (use of new data, tools, drought characterisation method (indices) or others), and to further seek good response practices.

11 https://ec.europa.eu/environment/water/quantity/about.htm

12 https://www.icpdr.org/main/sites/default/files/nodes/documents/icpdr_climatechangeadaptationstrategy_2.pdf

13 https://drought.unl.edu/Education/DroughtIn-depth/WhatisDrought.aspx

1.3 AIM OF THE DANUBE DROUGHT STRATEGY

Consequently, this Strategy provides support for the establishment of common proactive drought management in the countries of Danube region. In order to replace costly and less effective post-relief measures, it primarily targets public bodies and competent authorities responsible for national drought planning to build country resilience to drought.

The Strategy has two goals:

1) **to introduce a concept of institutional working setting for comprehensive drought management**, which would initiate an efficient and proactive drought risk reduction (before, during) and mitigation response (after drought);
2) **to encourage proactive actions in the region** through the adoption of the drought management concept proposed by the Strategy, and to develop/implement national schemes.

Due to its operational nature, this Strategy has the potential to become a drought management plan. Furthermore, it could also serve as a basis for national adaptation strategies. As technologies evolve, new approaches develop and institutional settings and responsibilities change, these plans have to be updated or amended. Therefore, all its components need to be considered adjustable.

2 STATE OF THE ART – LEGAL AND INSTITUTIONAL CHALLENGES

2.1 RELEVANT INTERNATIONAL POLICIES

The Danube countries participate in many international political activities and programmes related to drought issue that strive towards a sustainable future of the environment (Table 1). It is expected that they will be complied with in the spirit of good political will. But even if ratification of international policies demonstrates a country's will to achieve drought-related goals, only a few of those policies are binding.

United Nations Convention to Combat Desertification (UNCCD)[14] is a policy addressing drought management issues on global level. This international agreement links environment and development into sustainable land management. The UNCCD 2018-2030 Strategic Framework presents the most comprehensive global commitment to achieve land degradation neutrality

14 https://www.unccd.int/convention/about-convention

Table 1: International policy activities and programmes adopted by the DriDanube countries. Number in brackets indicates a year when a policy came into force.

	AT	BA	CZ	HR	HU	ME	RO	RS	SI	SK
United Nations Convention to Combat Desertification (1996)										
United Nations Framework Convention on Climate Change (1994); Kyoto Protocol (2005)										
Danube River Protection Convention (1998)										
EU Water Framework Directive (Directive 2000/60/EC) (2000)										
European Climate Change Programme (2000)										
EU Strategy for the Danube Region (2011)										
EU Adaptation Strategy (adopted in 2013); European Climate Adaptation Platform										
Alpine Convention (1995)										
Framework Agreement on the Sava River Basin (2004)										
Carpathian Convention (2006)										

Colour code legend:

Signed, transposed to national law | In process of being introduced | Not relevant

and to reduce the impacts of drought on vulnerable populations. The Convention, signed by all Danube countries, requires its parties to prepare a National Action Programme (NAP) for mitigation of drought impacts, ready to be activated well before the drought strikes. The UNCCD recently launched the Drought Initiative[15] with a goal to promote a paradigm shift in a way drought is managed – from a reactive and crisis-based approach towards a proactive and risk-based one. It further supports signatory countries in their preparation of NAP through its Drought Toolbox [16].

The most important policy instrument for drought management in Europe is the **EU Water Framework Directive (EU WFD)**[17]. The goal of the WFD is to improve the protection of water bodies and aquatic ecosystems by advocating sustainable water use. It is focused on water quality and water scarcity and does not specifically address drought. It provides an organisational and regulation structure at the river basin level. The prominent central administrative document for the implementation of WFD goals at national levels is the River Basin Management Plan (RBMP), which should be updated every 6 years. A significant step was made in 2012 when European Commission Communication (COM (2007) 414)[18] recommended that water scarcity and drought are addressed in context of water policy.

15 https://www.unccd.int/actions/drought-initiative
16 https://knowledge.unccd.int/drought-toolbox
17 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32000L0060&from=EN
18 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0414:FIN:en:PDF

Another important segment of drought management regulated at EU level is the disaster risk assessment through EU Civil Protection Mechanism (Decision 1313/2013/EU)[19]. This mechanism was established in 2001 to improve the EU response to natural and human-induced disasters. The EU Civil Protection Mechanism includes a general policy framework for disaster risk prevention actions at the EU level, aimed at achieving a higher level of protection and resilience against disasters by preventing or reducing their effects and by fostering a culture of prevention. The EU Decision 2019/420[20] amended the Civil Protection Mechanism in terms of risk management, so that Member States can further develop risk assessments and the assessment of risk management capability at national or appropriate sub-national levels. In this regulation, drought is recognised as a natural disaster and Member States can include it in the implementation programmes.

A policy document that acts as an instrument for cooperation and transboundary water management specifically in Danube region is The Convention on Cooperation for the Protection and Sustainable use of the Danube River **(Danube River Protection Convention)**[21]. A transnational body International Commission for the Protection of the Danube River (ICPDR)[22] was established for the implementation of this Convention. It commits the contracting parties to join their efforts in sustainable water management. ICPDR believes that the scope of recent drought events in DRB[23] underline the significance of drought issue at national level, and thus recognised the management of water scarcity and drought as one of the major challenges in the river basin management. ICPDR sees the RMBPs, and more specifically their Programme of Measures, as an opportunity to integrate all aspects of drought management in one place[24]. In line with the European Commission initiative of aligning water and agricultural policies in the Post-2020 Common Agricultural Policy (CAP), the ICPDR has launched a dialogue with the agricultural sector with the aim of developing a guidance document on sustainable agriculture, which would include the best management practices to mitigate nutrient pollution, water scarcity and droughts[25].

BOX 2. FROM RECOGNISING DROUGHT ISSUE TO CONTINUOUS TUNING WITH THE LATEST ON-GOINGs

Although a country's commitment to many international drought policies is most vividly expressed in the time of their signature, the international policies are live initiatives even after being put into force. Regular updates are taking place at international meetings and conferences, new strategic frameworks are being formed, and helpful toolboxes and platforms developed for their implementation at the national level. A country's corner stone for reaching drought-related goals in the signed policies therefore lies in national engagement to continuously tune with these latest on-goings.

19 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D1313
20 https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1553088553036&uri=CELEX:32019D0420
21 https://www.icpdr.org/main/icpdr/danube-river-protection-convention
22 https://www.icpdr.org/main/icpdr/about-us
23 https://www.icpdr.org/main/sites/default/files/nodes/documents/icpdr_report_on_2015_droughts_in_the_danube_river_final.pdf
24 E. Hoedl, ICPDR. DriDanube Final Conference, 2019.
25 https://www.icpdr.org/main/icpdr-publishes-position-paper-post-2020-common-agricultural-policy-and-water-management-danube

Another regional policy framework for drought management is the **European Union Strategy for the Danube Region (EUSDR)**[26]. EUSDR addresses a wide range of issues, which are divided among 4 pillars and 12 priority areas. EUSDR intends to develop coordinated policies and actions in the area of the river basin. The aim of the EUSDR is to coordinate and strengthen the existing and newly established regional and interregional cooperation. One of the key identified issues is water: its quality (pollution, ecosystems) and quantity (navigation, risk prevention and management). EUSDR Priority Area 5-Environmental Risks addresses the need for strengthened cooperation among the emergency response authorities. EUSDR identified that the challenges of water scarcity and droughts should be addressed in the national Danube RBMP.

One of the core documents at the EU level with respect to climate change adaptation is the **EU Climate Change Adaptation Strategy**[27]. It focuses on building response capacity and prevention and on limiting the damage that the projected natural hazards are expected to bring, rather than dealing with their consequences. In the frame of national adaptation strategies and plans, individual countries are thus required to define a set of measures to address climate change. Thus, this Adaptation Strategy could be a reference point for coping with drought in the view of projected climate impacts at all levels.

Two sub-regional policies that mention the drought issue in specific areas of the Danube region are also the **Framework Agreement for the Sava River Basin (FASRB)**[28], the Alpine Convention and the Carpathian Convention. All three sub-regional policies support the development of knowledge and water management capacities, also including the subject of drought. The FASRB underlines the importance of cooperation to limit natural hazards and to reduce adverse consequences also for the case of drought. The **Alpine Convention**[29] promotes sustainable development while considering natural hazards and gives guidelines on how to adapt to the impacts of climate change on water resources. The **Carpathian Convention**[30] aims at protection and sustainable development of the Carpathians. In its Strategic Agenda on Adaptation to Climate Change[31], drought has specifically been identified as one of the challenges posed to the Carpathians by climate change, and thus calls for its integration when formulating responses to climate change by partner countries.

2.2 NATIONAL DROUGHT MANAGEMENT STATUS

As it can be seen from Table 1 in Chapter 2.1, countries in DRB clearly recognise drought as a serious issue and are committed to achieving drought-related goals by signing important international documents addressing drought. However, drought management practices upon the occurrence of drought seem to take place in an ad-hoc manner. In order to recognize the parts of the national drought management that are carried out properly and the parts that should be further improved, different aspects of the existing drought management in each participating country were reviewed[32]. It was examined whether and how the existing national legislation addresses the issue of drought, what kind of methods of monitoring different drought types are used, which institutions carry out drought-related roles, how they communicate before, during and after drought, and in what manner they respond to drought.

26 https://www.danube-region.eu/

27 https://climate-adapt.eea.europa.eu/eu-adaptation-policy/strategy

28 http://www.savacommission.org/dms/docs/dokumenti/documents_publications/basic_documents/fasrb.pdf

29 http://www.alpconv.org/en/convention/framework/Documents/Framework_en.pdf

30 http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/01%20The%20Convention/1.1.1.1_CarpathianConvention.pdf

31 http://www.carpathianconvention.org/tl_files/carpathiancon/Downloads/03%20Meetings%20and%20Events/COP/2014_COP4_Mikulov/Follow%20Up/DOC12_Climate%20Change%20Strategic%20Agenda_FINAL_26Sep.pdf

32 The review was done in the frame of DriDanube project by project partners in cooperation with relevant national institutions for each participating country.

A common report shows a bigger picture on how drought is managed across the Danube region (Annex A). However, it shows that the national drought commitments are not implemented as actively as they should be. The summarized overview of findings at the regional level is given in Table 2 below.

Table 2: Colour-classification of drought management status at regional level based on existing national drought management status in DriDanube countries.

Reviewed drought management aspects		Status of existing drought management			
		National *Unit: number of countries out of 10*			Regional
Strategic elements in nat. legislation	Drought recognized and/or declared as natural hazard	9	-	1	
	National drought management strategy or similar umbrella document on drought exists at governmental level	2	1	7	
	National drought management plans prepared, or in preparation	1	1	8	
Monitoring and early warning	Drought monitoring in place of public bodies with drought indices	7	3	-	
	Defined thresholds for different drought types	1	4	5	
	Regular, periodic and on-time informing of public about the level of severity of drought in place (early warning system)	4	4	2	
Communication on drought	Information about drought spreads spontaneously through media	10	-	-	
	Communication with stakeholders about drought risk, mitigation and damages	-	6	4	
	Communication within different level governmental bodies on drought risk, mitigation and damages	1	1	8	
Drought response	Systematic adoption of actions to prevent further drought damages	-	2	8	
	Regular drought impact collection and/or sectoral damage evaluation in place at public bodies	3	5	2	
	Established national drought damage compensation scheme	6	3	1	

Colour code legend:

	National status	Regional status
	Not in place	Poorly managed
	In place but not systematic	Partially managed
	In place and systematic	Well managed

Strategic elements in national legislation

According to Table 1 in Chapter 2.1, it is well perceived in the region that drought can reach the level of a natural disaster and thus presents a certain threat to national security. Despite that, most countries in the region do not have an umbrella document in place that would directly address the overall drought management. Drought and its management are only partially and insufficiently considered in various strategic documents, laws, regulations, and programmes, mostly only in connection with emergency situations and natural disasters. In addition, terms like dryness, dry periods, heat waves, water scarcity and drought seem in these documents to be used interchangeably. There is also an evident lack of operational national drought management plans.

Food for thought: to distinguish drought and its meaning from other phenomena in the national legislation and/or to develop an umbrella document or at least sections within the existing sectoral policies that would directly address drought as the main topic?

Drought monitoring and early warning

Although all the participating countries reported that they have drought monitoring in place at the national level, it is very diverse in terms of the type of drought that is systematically monitored, variety of indices used for it and consensus on used approach for early warning to public. Only a few countries reported of having monitoring of all three types of drought in place. In others, methodologies for determining concrete thresholds of indices also for agricultural (soil) and especially for hydrological drought are either not in place or agreed upon yet at country level. At the same time, countries in which monitoring of meteorological and agricultural (soil) drought development is based on monthly-scale indices are often faced with delayed early warning as the deviations from the normal state are mostly reported when first signs of drought impacts have already occurred. Consequently, early warning is mostly carried out as a warning upon extreme level of drought.

Food for thought: to encourage improvement of national drought monitoring by means of new, more complex drought indices that would combine a wider range of available data, and by means of using a multifaceted (sectoral integration) approach?

Communication among institutions and with public

The analysis shows a lack of cooperation between relevant national expert institutions as well as across different vulnerable sectors (water, agriculture, fisheries, hydro energy, navigation, tourism etc.). In general, the cooperation between various stakeholders is poor as there is no clear inter-institutional scheme of data flow and responsibility flow. Roles and responsibilities of stakeholders, including those of lead institutions, are often unclear and/or overlapping with regard to the actions to be taken under specific drought conditions. Therefore, the co-responsibility without a clear institutional communication scheme neutralises the response instead of accelerating it. This way, the information for general public and for potentially affected stakeholders on the current state of drought continues to be generated by the press and other public media.

Food for thought: to lay down a schedule of regular meetings between relevant national institutions for briefings, updates, potential improvements of short- and long-term work etc.? In parallel, also to create a single web portal where the public can get as accurate as possible information on state of drought directly from national expert institutions?

Drought response

Despite drought monitoring being relatively well in place, the existing drought response is not based on its outcomes. The existing crisis-oriented drought policies support the adoption of a crisis management (reactive) approach with activation of institutions mostly when drought intensity is already alarming. Consequently, the activities are focused on the treatment of drought symptoms (impacts) rather than on proactive approach which would include also preparedness and early response/actions. In many countries, another weak aspect of the existing drought response is the absence of regular collection of data about sectoral drought impacts managed by national authorities. While many countries have legal framework established on post-drought procedure for economic evaluation of drought damage costs (national compensation scheme), it is usually also the main manner of dealing with drought.

Food for thought: to search for additional long-term measures to strengthen the level of resilience of vulnerable communities? In addition, also to establish regular information flow on observed impacts of drought from those affected to national institutions?

FOUNDATION FOR IMPROVED DROUGHT MANAGEMENT 3

Regional review revealed some needs for improvement that are common to all countries in the Danube region, which can be summarized in three main requirements: having an umbrella document on drought management, a clear plan of inter-institutional cooperation and communication, and establishing links in the drought monitoring-response chain for all drought development stages. The listed requirements strongly point to an interest in the establishment of proactive drought management, which is slowly becoming a priority in the countries of the region.

With the aforementioned weaknesses recognized and noted interest in adopting an alternative to crisis management, an idea has sprung to develop an **optimal drought management model for the practical implementation of proactive approach**. The conceptualisation of such management model found support in Integrated Drought Management Programme

(IDMP)[33], a joint initiative of the World Meteorological Organisation (WMO) and Global Water Partnership (GWP) to address drought issues more effectively. Inter alia, IDMP promotes building drought resilience through proactive response. The conceptualisation of optimal drought management model reflects **IDMP's three pillars of drought management**[34] and follows the ideas promoted in the **National Drought Management Policy Guidelines – A template for Action**[35] and in the **Guidelines for preparation of the Drought Management Plans**[36].

The main aim of Optimal drought management model development was to provide an operational model for collaborative and proactive management of drought at the national level, which would build on relevant international commitments, national legislation and the existing institutional roles in a country.

i

BOX 3. FOLLOW-UP ACTIVITIES OF THE DROUGHT MANAGEMENT CENTRE FOR SOUTHEASTERN EUROPE

In 2006, 13 countries established the Drought Management Centre for Southeastern Europe (DMCSEE) to better monitor the occurrences, the frequency and the impacts of drought. DMCSEE covers all the founding countries: Slovenia, Hungary, Romania, Moldova, Croatia, Serbia, Bosnia and Herzegovina, Montenegro, North Macedonia, Albania, Greece and Turkey. DMCSEE office is located in Slovenia and cooperates with the UNCCD secretariat and the WMO.

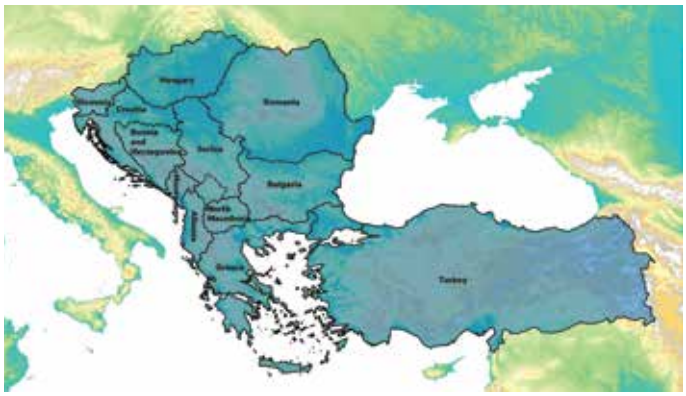


Figure 2: Founding countries of DMCSEE.

Its main activities are:

- Implementation of effective drought monitoring (via drought indices) and early warning. Provision of several monitoring products for southeastern Europe[37].
- Providing information on drought development through a regional bulletin with the use of meteorolog cal models and EUMETSAT[38] data, soil model and high-resolution remote sensing data.
- Promotion of drought risk assessment within the EU civil protection mechanism.

In many aspects, the DriDanube project is a follow-up activity of the initial efforts of the DMCSEE.

33 http://www.droughtmanagement.info/
34 http://www.droughtmanagement.info/pillars/
35 http://www.droughtmanagement.info/find/guidelines-tools/guidelines/
36 https://www.gwp.org/globalassets/global/gwp-cee_images/idmp-guidelines-pdf-small.pdf
37 http://www.dmcsee.org/en/drought_monitor/
38 The European Organisation for the Exploitation of Meteorological Satellites

4 OPTIMAL DROUGHT MANAGEMENT MODEL (ODMM)

Optimal drought management model (hereinafter: ODMM) was developed as an integral part of the Danube Drought Strategy to initiate proactive national drought management in countries of the Danube region or elsewhere. It provides a conceptual scheme to demonstrate how national institutions, organisations and other stakeholders subjected to drought can work together prior to, during and after drought, in order to minimise the damage to the environment and to secure essential water supply across the country. In the model, the **outcomes of national drought monitoring are connected with cooperative national response**, thus corresponding to changing drought conditions: preventive actions during no-drought conditions, early response upon the occurrence of drought first signals and its further development, mitigating the effects when drought is present, and drought recovery afterwards. The model serves as a tool for institutional capacity building in terms of strengthened cooperation and support in decision-making process.

The model organises the existing legislation, institutions and their roles in the country in such a way as to enable optimal cooperation and response. The concept of ODMM has been developed in a way that allows its adoption by any country regardless of its internal organisation of national authorities.

The main aim of the proposed drought management model is to clearly indicate the necessary actions and the responsible institutions that should take those actions in each respective stage of drought – as to determine ***who is doing what and when***. ODMM addresses the institutions within the institutional setting so that they would jointly implement drought-related policies according to the specified protocol of actions (Figure 3). Therefore, the model has 3 main components:

I. **drought policy framework**, which represents the legislative basis for drought management *(documentation)*;

II. **institutional cooperation scheme** through which the drought policy is implemented *(setting)*;

III. **protocol of actions**, which provides a basis for timely response of involved institutions *(implementation)*.

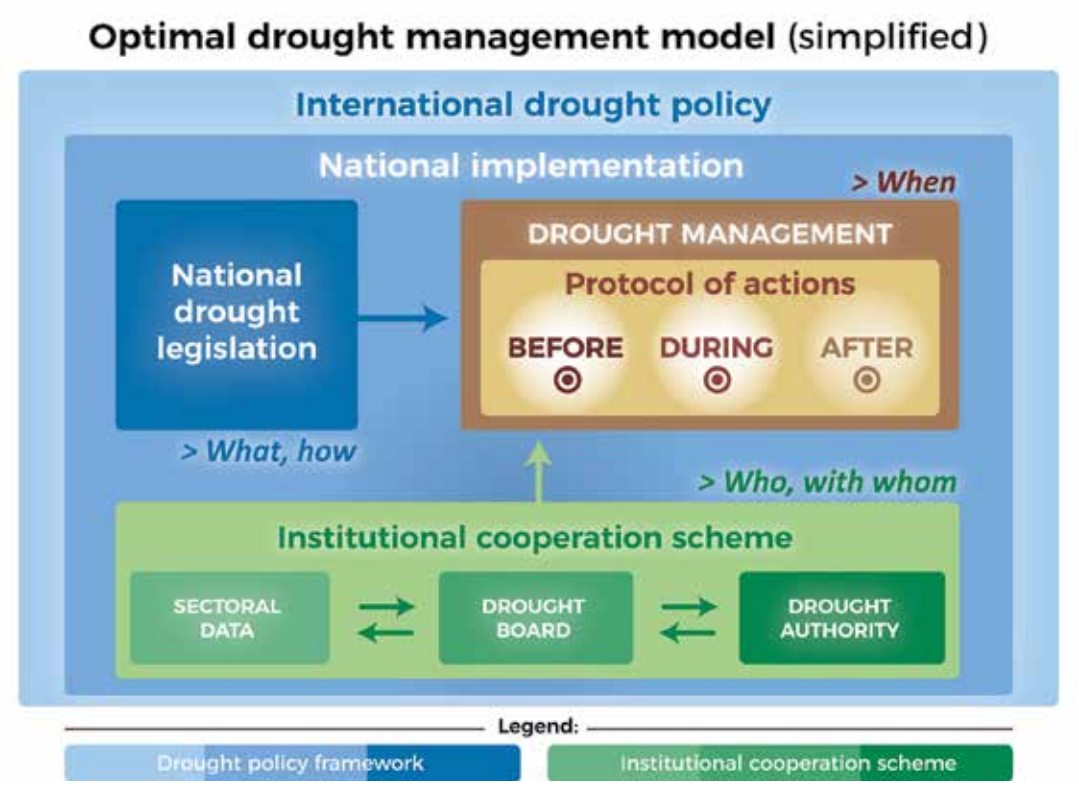


Figure 3: Simplified scheme of optimal drought management model. The drought-policy component is presented in shades of blue while institutional-setting component is presented in shades of green. Protocol of actions, presented in shades of yellow, acts as the driving force of the model.

4.1 DROUGHT POLICY FRAMEWORK AND INSTITUTIONAL COOPERATION SCHEME

To enable the optimal implementation of drought management, it is first necessary to have a clear understanding of the existing national and international legislative framework and to be familiar with the country-level institutional setting in relation to drought risk-management. For this reason, the current drought-related regulations, practices and other documents as well as the institutions involved in drought monitoring and drought management need to be reviewed and assessed. These two components of ODMM are fully determined by the country-specific legislation.

DROUGHT POLICY FRAMEWORK

The basis for national drought management lies in the existing national drought legislation. It presents the **framework of goals of the country with regard to drought and the way they are foreseen to be achieved**. At the external/transnational level, a country is a signatory of many international and/or regional drought-related policies. Those may be written as resolutions, conventions, strategies, agreements etc. To reach the drought-related goals laid down in these transnational policies, a country prepares relevant operational policies and implements them at the internal/national level. Beside these, a country has its own national legislation and operational programmes, plans, resolutions etc. that directly or indirectly address drought. Those consist of various acts, sector-based policies, resolutions, plans, programmes etc. It is recommended that a country should also has an operational document in place, such as an act or another document, that provide a clear guidance on the specific implementation of drought management.

All these policies, listed by topics or by sectors most affected by drought, represent the first of the components of ODMM – national drought policy framework. It provides a legal framework for institutions, who perform certain roles on its basis (Figure 4).

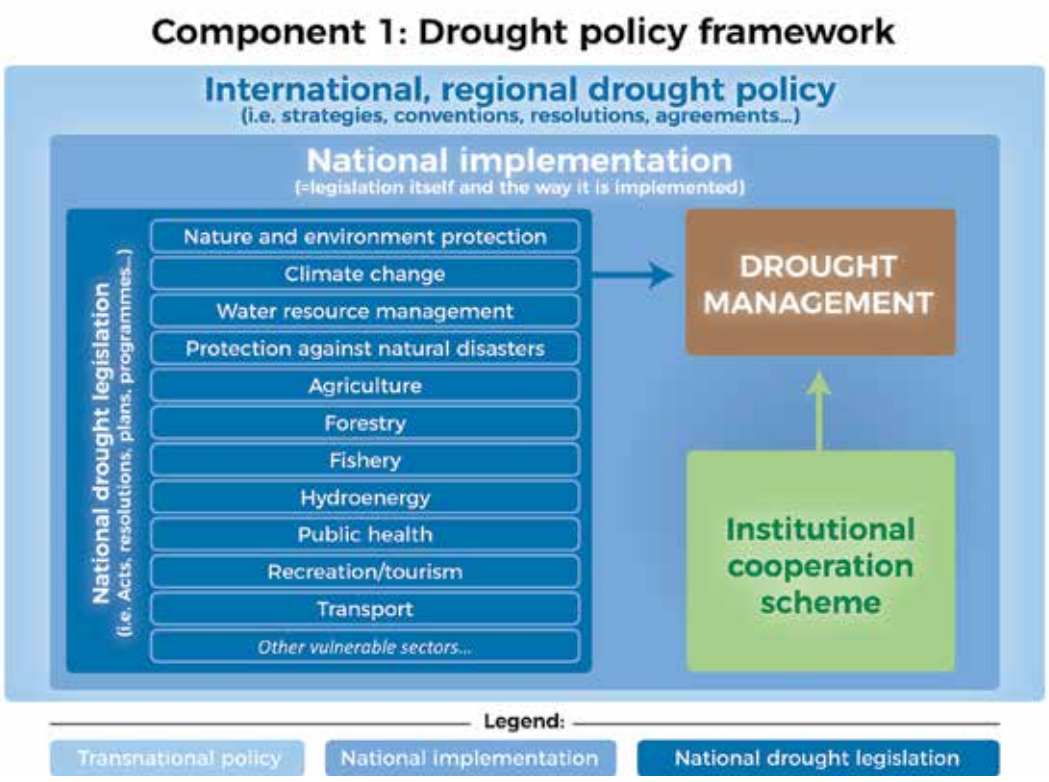


Figure 4: Component 1 of ODMM: drought policy framework, as all operational policies addressing drought within national legislation.

INSTITUTIONAL COOPERATION SCHEME

In some ways, a country already carries out drought-related tasks through its specific governmental, public, non-governmental and civilian activities in this area. Comprehensive drought management requires a clearly defined structure of competent institutions and their cooperation in order to implement the existing national drought policies. This structure needs to identify which institutions are involved in the implementation of drought policies and what kind of roles, responsibilities and inter-institutional links they have.

The ODMM proposes an inter-institutional cooperation scheme of three levels (Figure 5). This scheme lists **all the institutions that have a legal basis for dealing with drought-related topics and are thus authorised to perform drought-related roles**. They can either be affected by drought, carry out drought monitoring, management, analyses, or educate about this subject. This scheme organises the involved institutions according to their nature of work and sets out the roles for each level. In this way, the scheme defines the participants and their cooperation in comprehensive implementation of drought policies. It also defines the communication flow (who should be notified).

At this point, we must emphasize that the proposed institutional scheme only organises existing institutions in a country (*'who'*) and only assigns their existing drought-related activities (*'what'*) into proposed bodies within the scheme. Therefore, *the names proposed in the scheme are given only as common terms for the existing roles* in a country. A country can carry out proactive drought risk management within the existing national institutional setting and legislation, taking into account the relevant international policies described in Chapter 2. Countries should only establish new institutions if those are necessary.

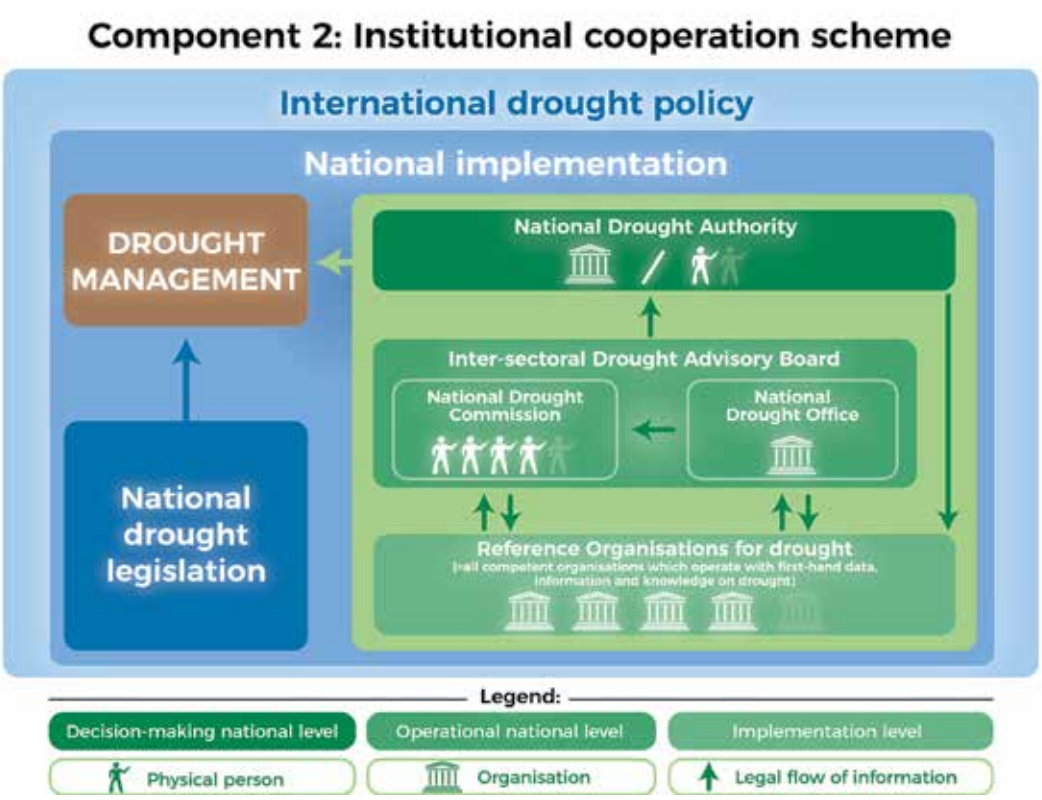


Figure 5: Component 2 of ODMM: institutional cooperation scheme, as the institutional setting through which the existing national drought policies are implemented.

INSTITUTIONAL BODIES WITHIN THE SCHEME ARE ORGANISED IN THREE LEVELS:

1. **Reference Organisations for drought** as the **data collecting & implementation level**;
2. Inter-sectoral **Drought Advisory Board** as the **national operational level**, consisting of two bodies of experts:
    a. **National Drought Office**,
    b. **National Drought Commission**;
3. **National Drought Authority** as the **national decision-making level**.

1. Reference Organisations for drought

Description

Drought management begins already at the level where sectoral data, information and knowledge origin. Therefore, all the competent organisations in a country that are **authorised to perform various drought-related activities in the field of monitoring, educating or raising awareness** are covered in a term "Reference Organisations for drought" (Figure 5). This would include i.e. water supply companies, power plants, food producers, water quality laboratories, habitat safeguards, environmental faculties, advisory services, civil protection, non-governmental organisations (NGOs) etc. By providing first hand information, data and knowledge on drought, they represent the base level of institutional scheme (data collecting and implementation level), whose support is essential for the operation of further levels within the institutional scheme.

An unlimited number of Reference Organisations can be involved in the institutional scheme. It is however advised that at least one Reference Organisation should be included for each field (vulnerable sector) covered by the existing national drought policy in order to enable the monitoring of different indicators of drought across all vulnerable sectors.

Terms of reference, communication flow

- These organisations should regularly perform their drought-related activities, depending on their main field of action: monitoring of variables related to drought, education of younger generations and professionals, raising public awareness.
- They should also regularly inform the National Drought Office about the current monitoring results or educational/awareness-raising activities. This can be carried out once a month in times without dry conditions or more frequently during drought conditions. They should submit a short report with summary information on monitored data or drought-related activities. A synthesis report prepared by the National Drought Office is then shared with the Reference Organisations so that they regularly receive large-scale information about the current drought situation throughout the country.
- In case of worsened drought conditions, they also implement the recommendations and the measures indicated by the organisations at the national level of the institutional scheme.
- At the same time, they can address specific needs and suggestions for new national approaches to Inter-sectoral Drought Advisory Board.

2. Inter-sectoral Drought Advisory Board

Description

The middle level in institutional scheme represents implementation of national operational drought-related tasks. This is done by two national expert bodies: National Drought Office and National Drought Commission (Figure 5).

2.a National Drought Office provides the basis for the operation of the advisory body. Some of the staff is regularly employed there. It initiates **operational implementation of drought management process in all stages of drought**. Because drought progress is weather-related, the National Drought Office should be positioned within the national meteorological service or within any other institution with access to hydrometeorological and/or climatological data.

Terms of reference, communication flow

- The main task of the National Drought Office is the regular monitoring of drought conditions.
- It collects weather-related information on drought and sectoral data/reports provided by Reference Organisations based on which it prepares a regular synthesis reports on current state of drought. Those can be prepared as bulletins, drought platform or other forms of summaries preferred in a particular country. They should be prepared once a month in times without dry conditions or more frequently during drought conditions. This enables a country to be informed on drought conditions at any time of the year by providing the information on wholesome characterisation of drought situation and its impacts on individual sectors etc.
- If drought conditions appear to worsen and thus any imminent risk potentially exists in any of the sectors, National Drought Office also convenes regular meetings of the National Drought Commission.
- The Drought Office serves as the **official channel of communicating drought issue** to Reference Organisations and the public. It provides them with information on drought development including early warnings, gives feedback after Drought Commission meetings, and calls for the implementation of the recommended and/or obligatory measures.

BOX 4. **DROUGHT EARLY WARNING SYSTEMS (EXPLANATION BY WMO)**[39]

"Drought early warning systems typically aim to track, assess and deliver relevant information concerning climatic, hydrologic and water supply conditions and trends. Ideally, they have both a monitoring (including impacts) component and a forecasting component. The objective is to provide timely information in advance of, or during, the early onset of drought to prompt action (via threshold triggers) within a drought risk management plan as a means of reducing potential impacts. A diligent, integrated approach is vital for monitoring such a slow-onset hazard."

39 http://www.droughtmanagement.info/literature/GWP_Handbook_of_Drought_Indicators_and_Indices_2016.pdf

2.b National Drought Commission presents **a board of sectoral experts** and is composed of at least one representative from the National Drought Office and from relevant ministries covering vulnerable sectors. It is a national body authorised to call for implementation of preventive measures (i.e. technological recommendations) and at the same time **acts as a venue/link between** drought-related hotspots in operational work of Reference Organisations and new national operational approaches (system changes).

Terms of reference, communication flow

- Their main role is to be regularly briefed on drought development by National Drought Office and the actual situation within the sectors (the potential risks they may be facing).
- If they conclude at the meetings that drought progress presents a potential risk for individual sectors, they issue technological recommendations (stage 1-yellow drought alert).
- When drought is highly expected to become severe or even extreme in a country or in any part of its territory, the National Drought Commission is entitled to brief the National Drought Authority about the overall severity of the situation and propose it to announce a drought warning (stage 2-orange drought alert) or a drought emergency (stage 3-red drought alert).
- At the same time, it is open for drought-related suggestions from Reference Organisations which it then takes into consideration upon improving national operational activites.

Due to the advisory nature of both Drought Office and Drought Commission, they are altogether called a Drought Advisory Board, which is therefore in charge of implementing the following activities:

- In times of normal or wet conditions, the Board calls for an increase in the education on drought (seminars, lectures, raising public awareness, training of agriculture advisory services etc. performed together i.e. with faculties, advisory services, NGOs), introduces improved operational approaches, and participates in review & updates of drought policies.
- During a drought event, the Board focuses on detailed drought monitoring, gives advice to the National Drought Authority and is responsible for initiating other activities from the Protocol of actions.
- When drought conditions de-escalate, the Board is involved in the drought recovery process. Then, together with National Drought Authority it peforms self-evaluation of carried-out actions during the drought event.

3. National Drought Authority

Description

This is the lead authority for drought issue in a country. It is **responsibile for drought-related policies and overall supervision over matters related to drought management in a country** (Figure 5). Therefore, its decisions have country-wide reach. In operational sense, its major task is to declare risk for drought due to deficiency of water. For this reason, the role of National Drought Authority can be assigned to an authority or a board of representatives with legal power to officially declare a state of emergency due to drought (natural disaster), such as a representative of the national government (i.e. the minister of the environment or water management), a civil protection authority or the president of the country. Alternatively, the role of National Drought Authority can be assigned to any other existing national authority legally empowered to declare state of emergency due to drought.

Terms of reference, communication flow

- Its main role lies in reviewing drought policies in order to propose changes to national government where needed, and guiding overall national drought management process and its implementation.
- It is legally empowered to declare higher drought alerts (stage 2-warning, stage 3-emergency, stage 4-lifting of the state of emergency). Since declarations of exceptional drought should be based on science-driven assessments, it is triggered upon the proposal of the National Drought Commission: when drought conditions aggravate, the National Drought Authority is briefed on current drought severity, water shortage and predicted drought conditions. It should then use this information in order to decide whether to declare the proposed drought stages.

Levels and bodies in ODMM & proposed examples	
National Drought Authority (national decision-making level)	
• An institution or a (board of) person(s) with competence in water management or disaster relief (i.e. minister of the environment or water management, civil protection authority, country president); or • other existing national body or a person in a country with official power to declare the state of emergency (natural disaster).	
Inter-sectoral Drought Advisory Board (national operational level)	
↳ **National Drought Office**	• National meteorological service, or • other institution with access to hydrometeorological and/or climatological data.
↳ **National Drought Commission**	• Representatives from National Drought Office and relevant ministries, or • other sectoral experts and representatives from relevant ministries.
Reference Organisations for Drought (data collecting & implementation level)	
• Water supply companies, • hydro power plants, • food production companies, • water quality laboratories, • habitat safeguards • environmental faculties,	• advisory services, • civil protection (fire brigades and army only in emergency cases), • NGOs, • etc.

National drought authority's declaration of drought stages should automatically trigger response according to the protocol of actions: the implementation of activities by Drought Advisory Board and the implementation of measures or restrictions by companies, institutions and general public in a country (further link with Figure 7 on p. 37 and Table 4 on p. 39).

Table 3: Levels and bodies within the ODMM institutional cooperation scheme and proposed examples of institutions that can be assigned this role, their main tasks (terms of reference) and flow of communication.

Terms of reference (ToR) & communication flow
→ *Lead drought authority with legal power to declare national risk for drought*
• When it is briefed and receives the proposals from the National Drought Commission, this authority makes the decision to declare higher drought alerts (orange or red), which automatically triggers the implementation of measures; • lifting of the state of emergency.
→ *Implementation of operational drought-related tasks at national level*
• Monitoring of weather-related drought situation on a regular basis; • collecting weather-related information and sectoral data/reports provided by Reference Organisations in order to prepare synthesis reports on the current state of drought; • taking the role of official channel for communicating drought issue to Reference Organisations and the public; • convening regular meetings of the National Drought Commission; • coordinating of national drought activities during all stages of drought.
• Discussing potential risks that the sectors may be facing; • issuing technological recommendations (yellow drought alert); • briefing the National Drought Authority about the worsening of the situation and proposing to declare a drought warning (orange alert) or a drought emergency (red alert).
→ *The origin of sectoral data, information and knowledge on drought*
• Monitoring of variables related to drought, education of younger generations and professionals, raising public awareness; • regularly informing the National Drought Office about the current monitoring results or educational/awareness-raising activities; • implementing the recommendations and the measures indicated by the institutions from national level of the scheme; • addresses their specific needs and suggestions for new national approaches to Inter-sectoral Drought Advisory Board.

4.2 PROTOCOL OF ACTIONS

In order for drought management to be successful, it must be clearly indicated who are the participants in the process and in what way they need to cooperate in the implementation of drought policies. However, a shared understanding of responsibilities also *per changing drought conditions* is an equally important condition of success. Therefore, the third component of the ODMM is a predefined protocol of actions. It **determines institutions' behaviour mode vis-à-vis drought development** (before, during, after drought). The key items in this protocol include a list of activities to be carried out, institutions responsible for individual activities and the list of measures to be implemented by stakeholders in each stage of drought (Figure 6). In this way, the *"what & how"* (drought policies) and the *"who & with whom"* (institutional scheme) in the model are completed with *"when"* these activities are carried out, meaning that the protocol presents the **driving force of the model**. By enriching the protocol with specific activities to be carried out prior to the occurrence of drought or during its early stages, a country's approach stops being crisis-oriented and becomes proactive.

The protocol of actions proposed in the Strategy is designed as a **5-stage scale of drought development and the accompanying behaviour mode** to be adopted by institutions listed in the scheme (Figure 7). The protocol is structured in four stages of drought development (its first signals, very dry conditions, extremely dry conditions, decrease in drought intensity)

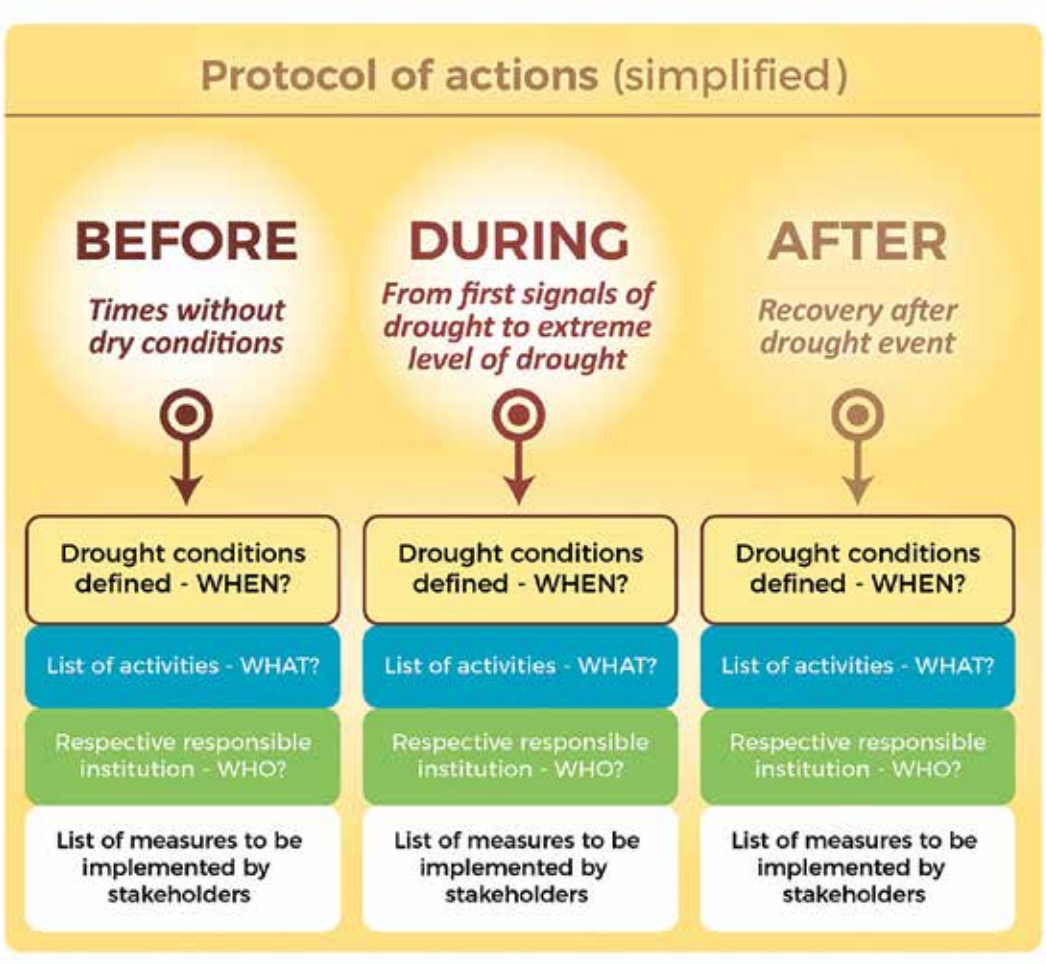


Figure 6: General form of protocol of actions with its key topics to be specified in it.

in addition to the "zero" stage that represents an active period in times without drought conditions,. Drought stages are separated by thresholds which can be freely determined by individual countries, taking into account their national characteristics such as climate, soil, (sectoral) exposure and others. They can also be set differently for specific sectors, depending on the nature of the sector.

The accompanying behaviour mode in each stage of drought is determined by clearly defined activities to be carried out **(terms of reference)** for all the institutions involved in drought management: Reference Organisations, National Drought Office, Drought Commission and Drought Authority (further link with Table 3 on p. 34-35 and Table 4 on p. 39). In addition to institutional activities, the protocol needs to include also specific measures to be implemented by the stakeholders which are determined with regard to the severity of drought: long-term measures to be carried out in times without drought conditions, and short-term measures which are carried out during drought event. While long-term measures (preparedness activities) need to strive towards sustainable development, short-term measures should be determined in such a way as to lessen the level of being affected and at the same time still contribute to the long-term objectives of environmental protection.

This way, a weather-related condition at a given time is classified into one of the 5 stages of drought. The classification itself acts as trigger for predetermined activities and, when necessary, implementation of measures.

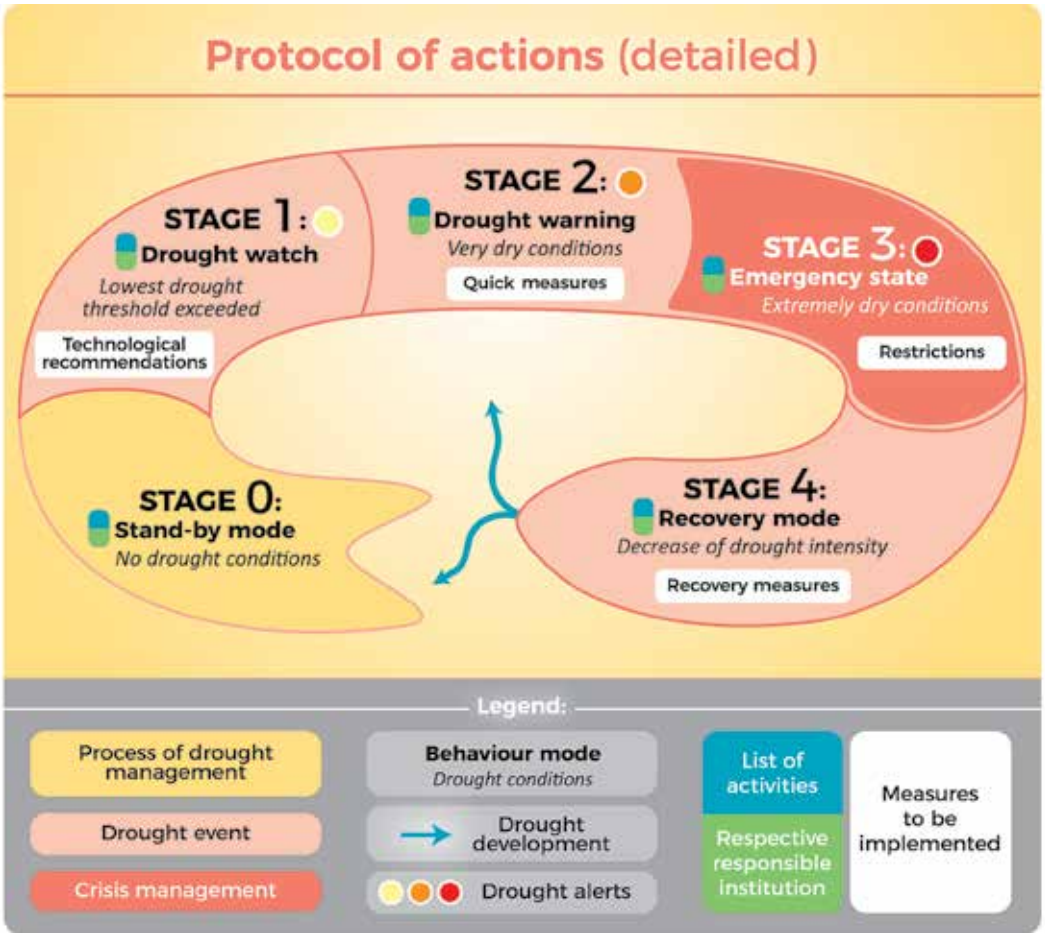


Figure 7: Proposed protocol of actions as a third component of ODMM, which suggests also the behaviour mode of involved institutions.

Behaviour mode governs concrete actions in each stage of drought by everyone involved:

- Institutional Terms of reference present the national activities to be carried out in each stage of drought.
- Measures to be implemented present obligations for Reference Organisations and the public across the entire area under specific drought alert.

STAGE 0 – Stand-by mode: Proactive drought management starts already in times without drought conditions, meaning sufficient water capacity. Stage 0 in the protocol thus covers the period of normal or even wet conditions. This is the time to carry out preparedness activities as defined in the protocol. This includes ongoing meteorological monitoring, education of professionals (farmers, advisory services, officials of vulnerable companies etc.), organising thematic workshops, raising public awareness about water and how it should not be taken for granted, etc. This is also a great time to prepare and/or improve development strategies and long-term measures, and for the sectoral experts and policy makers to work together. This would include reviewing the existing legislation on drought and its application in practice, aligning sectoral policies on drought and working further on their improvement.

STAGE 1 – Close monitoring: If it is detected that the lowest drought threshold was exceeded based on the continuous monitoring of drought indices, this is considered as stage 1, which indicates the beginning of a drought event. The detection of first signals of drought and the occurrence of moderate drought conditions can be communicated as a yellow drought alert. The situation is now monitored more closely, with special attention being paid to the potential worsening of drought conditions. Meetings among institutions are arranged so that they can inform each other about the sectoral situations and potential risks. Technological recommendations are issued to stakeholders in order to prevent them from being affected in the event of worsened drought conditions.

STAGE 2 – Drought warning: If the monitored situation becomes worse and exceeds the threshold that indicates very dry conditions, this is considered as stage 2, which marks severe drought conditions. An orange drought alert is declared, triggering the implementation of the predefined quick measures from the protocol in the affected sectors in order to limit the extent to which they would be affected in the event of worsened drought conditions.

STAGE 3 – Drought emergency: A red drought alert is declared upon further worsening and exceeding of the threshold for extremely dry conditions. At this point, drought is coped with through a crisis-oriented approach. Emergency activities are taking place at all levels and restrictive measures are applied at the regional/national level in order to secure the basic needs of the population and of the affected environment.

STAGE 4 – Recovery mode: When the results of the continuous drought monitoring indicate a decrease in drought intensity to moderate level, mitigation measures are taken and other post-drought activities are initiated in order to ensure the recovery of the population and of the environment to better (living) conditions. However, the drought conditions may intensify again before fully decreasing to a normal state. In the context of drought management, this means that stage 4 may be directly followed by stage 1 or 2. Therefore, continuous monitoring and institutional activities are required during stage 4, even if the extremely dry conditions are no longer present.

Only when dry conditions are fully over, the drought management process returns to stage 0 and into stand-by mode, with preparedness activities relaunched in order to strengthen the country's ability to cope with a potential next drought.

For strengthened preparedness for next potential drought **it is of key importance** that everyone involved in the drought management model performs a practical self-evaluation of their management during recent drought event and finds room for improvement.

Table 4: Drought development and accompanying behaviour of institutions involved in each drought stage, as proposed by the Protocol of actions in the ODMM. ToR as per each involved institutional body please see Table 3 in Chapter 4.1.

Drought stage		Drought development		Accompanying behaviour	
		Drought conditions	**Drought alert**	**Type of institutional activities (carried out via ToR)**	**Type of measures**
Before	**0 –** Stand-by mode	Normal or wet conditions	→ None or green	Preparedness, capacity building	→ Long-term measures
During	**1 –** Drought watch	Lowest drought threshold exceeded	→ Yellow	Increased attention paid	→ Technological recommendations (preventive)
	2 – Drought warning	Threshold for severe drought conditions exceeded	→ Orange	Intense activation	→ Quick measures
	3 – Drought emergency	Threshold for extreme drought conditions exceeded	→ Red	Crisis management	→ Restrictions
After	**4 –** Recovery mode	Decrease in extreme drought conditions	Depends on drought condition (orange, yellow)	Recovery and evaluation	→ Recovery measures (mitigation)

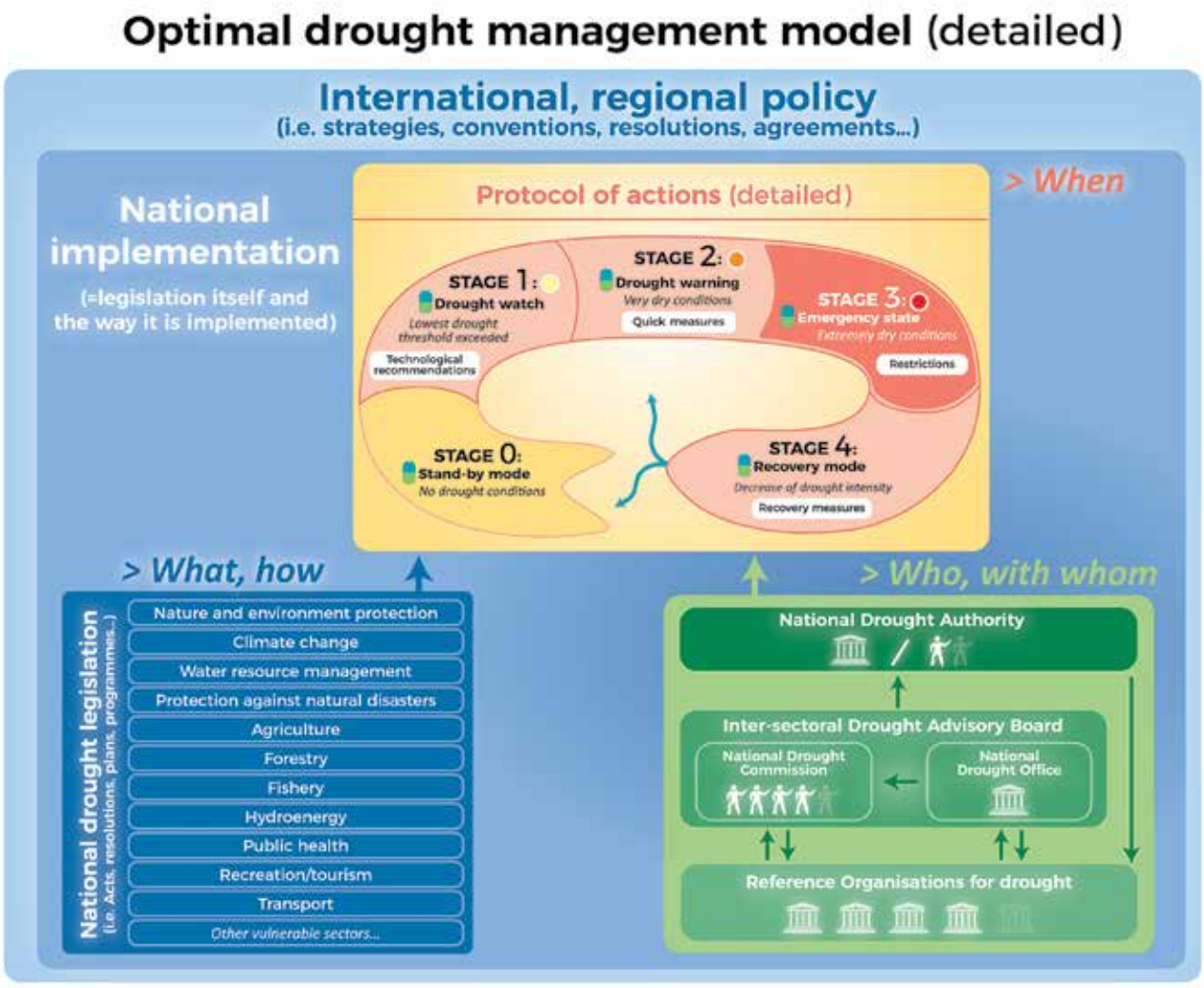


Figure 8: ODMM with all its three components in details.

5 ASSISTING A COUNTRY IN DANUBE DROUGHT STRATEGY/ODMM IMPLEMENTATION

Regional cooperation and the currently proposed ODMM can only improve national drought management practices to a certain degree. **Due to specific national characteristics**, such as the geographical and climatological features, and due to different legislation and social arrangements, the **details of ODMM can only be determined via national dialogue within each country**. Continuous efforts are necessary by the operational level to put the model into practice and overcome obstacles in staff difficulties, national regulations and technical know-how. It is thus strongly recommended that the model is introduced to and discussed together with stakeholders.

5.1 PROPOSED ACTIVITIES FOR ODMM IMPLEMENTATION

Several activities are proposed to make the model operational and enable the beginning of proactive drought management implementation in the country. Required activities are listed by respective ODMM components in Table on page 42. The activities are not interdependent. They can take place in parallel with the exception of the initial ones which are marked with (▸). The proposed activities can be adjusted according to the country's preferences.

Activities to set ground for ODMM implementation	Proposed bodies to carry out each activity
Institutional cooperation scheme	
▸ **Identify groups at risk** and develop a network of stakeholders, initiate discussions.	*Relevant institutions from all levels – implementation, operational and decision-making.*
▸ **Nominate National Drought Office** and assign their concrete responsibilities.	*Nominated through cooperation of sectoral experts and representatives from relevant ministries.*
▸ **Nominate National Drought Commission** and assign their concrete responsibilites.	
▸ **Nominate Reference Organisations**. Select among the existing public, governmental or private institutions.	
▸ **Nominate National Drought Authority** and assign their concrete responsibilities.	
Further strengthen institutional cooperation among sectors (and across the Region) via joint dialogue on drought issue in the country.	*The activity to be led by National Drought Office.*
Drought policy	
▸ **Review and evaluate** existing national drought management **policies and plans**.	*National Drought Commission.*
Identify conflicts among water users.	*National Drought Commission in cooperation with respective Reference Organisation.*
Develop and define objectives and goals of national drought management for each vulnerable sector, then define relevance and national-level priorities.	*The document to be drafted by National Drought Commission in cooperation with Drought Office, and submitted for discussion and approval to National Drought Authority.*
Prepare an inventory of drought data in a country (monitoring data, data on impacts by vulnerable sectors), and data on financial resources available.	*National Drought Office in cooperation with Reference Organisations.*
Prepare national plan for drought management (with concrete protocol of actions as its driving force).	*Activity to be led by National Drought Office. Plan to be prepared in cooperation with Reference Organisations and National Drought Commission.*
Find place for drought management plan **in national legislation**.	*National Drought Commission.*
Propose national drought management plan **to national government**.	*National Drought Commission.*
Protocol of actions	
Improve national drought monitoring approach by means of available results from research (additional integrated drought indices, methods, tools etc.).	*National Drought Office in cooperation with researchers.*
Define thresholds for drought stages (and for each vulnerable sector if needed).	*National Drought Office in cooperation with researchers.*
Develop a method to inform the public about drought at national level (specific national website for drought status and early warning information for users).	*National Drought Office in cooperation with researchers.*
Define specific measures for each stage of drought.	*National Drought Commission.*
Prepare national drought protocol of actions – an operational roadmap with specifics on "who does what and when".	*Draft document to be prepared by National Drought Office, and discussed with National Drought Commission and Reference Organisations.*
Identify research needs for each vulnerable sector, and develop a way for assessing drought risks and collecting data on sectoral drought impacts.	*National Drought Commission in cooperation with National Drought Office and researchers.*
Education, media	
Raise public awareness, share knowledge and information.	*National Drought Office and Reference Organisations.*
Develop educational programmes for all age and stakeholder groups.	*National Drought Commission in cooperation with relevant national educational organisations who prepare educational materials and confirm education programmes.*

The recommended **initial activities** to set ground for ODMM implementation are:
review of existing drought management status in the country (**state-of-the-art**), especially its weaknesses; identification of groups at risk and preparation of **database of key stakeholders**; nominating national-level bodies within the **institutional scheme**. Since national operational drought-related tasks are carried out by National Drought Office and National Drought Commission, it is recommended to nominate these two first - through cooperation of sectoral experts and representatives from the relevant ministries - and to establish their terms of reference.

A practical template for shaping the ODMM to the national characteristics is provided in Annex I of this Strategy.

5.2 DRIDANUBE TOOLS SUPPORTING THE IMPLEMENTATION

To support proactive drought management in the countries of Danube region, DriDanube project developed also a tool for monitoring of drought development and unified methodologies for drought risk and impact assessment, which enables cross-border comparability and support an earlier response to drought.

Drought Watch tool
Early detection of drought signals can be supported with Drought Watch tool[40], an open interactive web application that offers an insight into the development of drought conditions across the entire Danube region. It provides the user with a spatial and temporal view of the state of soil moisture and vegetation through various drought-related datasets: remote sensing products, modelled indices and static products at regional and national level (Table 6). Drought indices in the tool are updated daily, weekly or every 10 days. This way, they enable a harmonized view of changing drought conditions in near-real-time across all the region. To facilitate its use in practice, Drought Watch also includes a user manual with additional information on diverse functionalities of the tool, on datasets background, and on the system itself. It was designed as a user-friendly yet feature-rich tool to strengthen the operational work in drought early warning. It is mainly designed for national authorities and drought experts, but also for other end-users such as farmers or water managers, so that they can make appropriate decisions that lead to the application of relevant short-term measures. National authorities and expert services can further benefit from the possibility to integrate other national datasets into the Drought Watch tool.

BOX 5. DROUGHT WATCH LINKS

- tool available at:
www.droughtwatch.eu,
- video animation on how it works:
Drought Watch - What is it?
(Youtube video by GWP CEE)
- Drought Watch Tutorial:
Drought Watch tutorial
(Youtube video by GWP CEE)
- Drought Watch Manual:
www.droughtwatch.eu/#/manual.

Figure 9: Drought Watch. Soil Water Index, 9 April 2019.

40 Access to Drought Watch: www.droughtwatch.eu

Table 6: Drought datasets integrated into Drought Watch.

Datasets in Drought Watch	Temporal scale	Spatial scale	Coverage
Soil Water Index	1 day	1 km	Europe
Soil Water Balance	10 days	9 km	Italy, DMCSEE
Normalized Difference Vegetation Index	10 days	1 km	Danube countries
Relative Vegetation Condition	7 days	5 km	Central, eastern Europe
Drought impact assessment	7 days	NUTS3, LAU1	DriDanube countries
Yield prediction	7 days	NUTS3	Danube countries
60-day Average Temperature Percentile	10 days	9 km	Italy, DMCSEE
10-day Average Temperature Percentile	10 days	9 km	Italy, DMCSEE
24-hour accumulated precipitation	1 day	9 km	Europe
Rainless Period Duration	Static product	1 km	DriDanube countries
Drought Risk	Static product	0.036 °	DriDanube countries
National products	Depends on respective country		Country level

Drought impact assessment

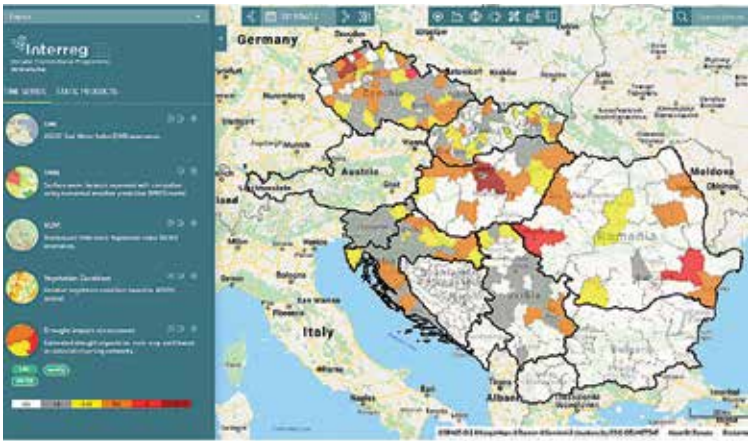


Figure 10: Observed estimations of drought impacts on main agricultural crops, 14 April 2019.

The drought impact assessment carried out through a National reporting network (NRN) helps to deliver early awareness of drought damage in place. NRN consists of engaged individuals on the field, mostly farmers and technicians with knowledge in agriculture and forestry, who weekly report their observations on the state of soil, vegetation or even loss of yield on their specific location, throughout the season or the year. The reporting process runs through an online questionnaire[41], available for agriculture and forestry, with a few single-choice questions (Figure 11). Collected data on drought impacts are aggregated on administrative units (NUT3 or LAU1) and then shown regularly in the Drought Watch tool through a 5-level intensity scale (Figure 10).

NRNs are a valuable source that validates and complements drought indices with information on drought impacts on the field. This way, they help to fully characterize the current drought condition. At the same time, they greatly contribute to a systematic collection of data on the impacts of drought on the agricultural land, with its added value in regular collection of impact information data rather than post-drought assessment. Data collection is also a learning process for farmers who see their input used in further processes of early warning preparation. So far, NRNs were established in 10 Danube countries, which enables a cross-border comparison. Participating countries also have agricultural advisers and experts from meteorological services engaged in their NRNs in order to assure a more sustainable nature of NRNs. NRNs can be used as an alternative to other systems of drought impact assessment, such as application of drought indicators as proxy data or institutional drought impact assessment campaigns.

41 A Link for registration in the national reporting networks: https://questionnaire.intersucho.cz/en/

Figure 11: The process of reporting drought impacts in the national reporting network.

Drought risk assessment

Another product within the Drought Watch tool, also developed in the DriDanube project, are informative drought risk maps. They were prepared with a harmonized approach for 10 countries and thus enable comparative risk assessment among Danube countries. One set of drought risk maps considers the climatological aspect of drought occurrence. Based on the analysis of precipitation regimes in the Danube countries in the years from 1961 to 2010, these maps present the number of days in the longest expected rainless period during vegetation season (April to September) under a given return period (rainless periods, Figure 12)[42]. They can be used as an alternative to traditional drought indicators to identify dry periods. The other complementary set of maps considers drought risk in terms of occurrence of impacts due to drought. Based on a combination of past meteorological data and historical information about impacts on crops, these maps indicate the areas where the risk for crop yield loss for 4 main agricultural crops (maize, wheat, rape and barley) can be considered as high, medium or low (crop yield loss, Figure 13)[43].

Figure 12: Expected length of longest rainless period during vegetation season having a 5-year return period.

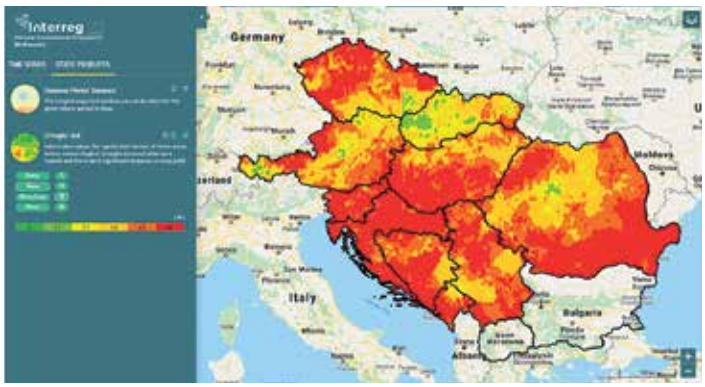


Figure 13: Colour-code drought risk map for estimated maize yield loss upon 20 % drought probability level.

This drought risk assessment method can be used to recognize the areas prone to rainfall deficit and the areas where significant drought hazard and/or considerable crop losses are expected. It can be included in the appendices of national strategies and action plans for reducing vulnerability and exposure to water scarcity and drought.

42 Methodology was developed by Faculty of Agriculture, University of Novi Sad.

43 RED (Risk Estimation of Drought) software was developed by the Hungarian Metorological Service in cooperation with the company Varimax Bt and is freely availabe for use and testing.

Drought Watch presents an advanced regional tool for drought monitoring as it combines climatological and yield loss information on drought risk areas, regular monitoring through drought indices, and weekly information on drought impacts detected on the field, all in one place (Figure 14). Its additional added value lies in unified cross-border view of drought situation across DRB on a fine scale, from 1 km to 9 km, rather than a point-value display.

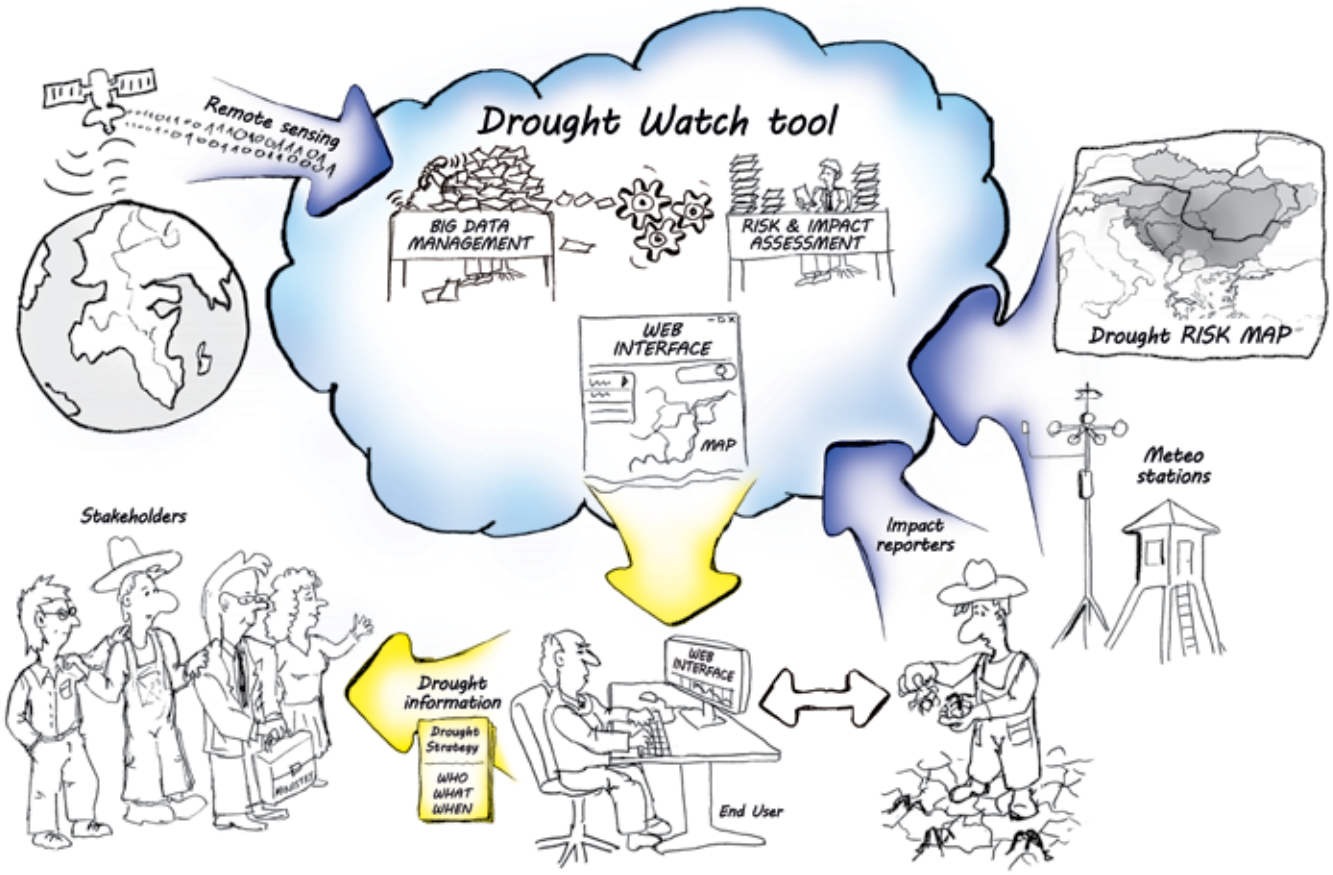


Figure 14: Drought Watch tool operating sketch with drought risk and impact assessment maps. Its web application displays datasets indices (drought datasets from different sources: satellite, modelled and reported) through colour-classified values which can be interpreted as triggers for early warning.

5.3 DANUBE RIVER BASIN: PROGRESS SO FAR AND OUTLOOK IN DRIDANUBE COUNTRIES

Some initial work has already been done in the participating countries as a starting point for further ground-setting activities described in Chapter 5.1. It was carried out in different countries, depending on the division of work in the DriDanube project and on internal initiatives. In order to develop an ODMM that would be applicable in any country regardless of its internal institutional scheme, the following has been prepared with joint efforts in all 10 participating countries:

- Stakeholders database with identified key public and private organisations involved in national drought management as per countries. They are listed by the type of target groups (national public authorities, sectoral agencies, interest groups including NGOs, international organisations).
- Common report on the existing drought management status, in which a wide range of drought management aspects is reviewed in order to study how drought is currently managed across the region. Reviewed aspects include drought monitong approach, national legislation addressing the drought issue (existing or not, in what way it addresses drought), institutions with drought-related roles, manner of inter-institutional communication before, during and after a drought event, manner of assessing drought impacts (existing or not, how it works), and past or on-going educational and research programmes, and projects targeting the drought issue.
- Several events, national seminars and working meetings have been organised, where the identified key stakeholders were actively involved in the discussion on ODMM, its applicability within national drought management structures, and on possibilities for implementation in their country.

Details on the progress achieved so far under respective ground-setting activity are summarized in the Table 7 below.

Activities to set ground for ODMM implementation	Progress so far regarding proposed activity	More details
Institutional cooperation scheme		
▸ **Identify groups at risk** and develop stakeholder network, initiate discussions.	Preparation of stakeholder database and organisation of national events, where discussions on drought management in the country took place in all the participating countries: AT, BA, CZ, HR, HU, ME, RO, RS, SI, SK.	Annex B1 Annex B2
▸ **Nominate Reference Organisations.** Select among the existing public, governmental or private institutions.	Potential institutions for this role were identified in all the participating countries: AT, BA, CZ, HR, HU, ME, RO, RS, SI, SK.	Annex C
▸ **Nominate National Drought Office** and assign their concrete responsibilities.	Potential institutions for these roles were identified in HU, RS, SI. More or less already implemented in SVK through National Action Plan.	Annex D
▸ **Nominate National Drought Commission** and assign their concrete responsibilities.		
▸ **Nominate National Drought Authority** and assign their concrete responsibilities.		
Further strengthen institutional cooperation among sectors (and across the Region) via joint dialogue on drought issue in the country.	There were several dialogues on ODMM implementation in more detail during working meetings of involved institutions in BA, HR, RS, SI, SK.	Annex E

Activities to set ground for ODMM implementation	Progress so far regarding proposed activity	More details
Drought policy		
▸ **Review and evaluate** existing national drought management policies and plans.	Current status of drought management was reviewed in all the participating countries: AT, BA, CZ, HR, HU, ME, RO, RS, SI, SK. Joint report is available in Annex A.	Annex A
Identify conflicts among water users.	Mostly detected in BA, CZ, SK.	
Develop and define objectives and goals of national drought management per each vulnerable sector, then define relevance and national-level priorities.	In progress in RS and SK.	
Develop an inventory of drought data in a country (monitoring and impacts data per vulnerable sectors) and financial resources available.	/	
Prepare national plan for drought management (with concrete protocol of actions as its driving force).	SK	
Find place for drought management plan **in national legislation.**	Options were reviewed in BA, RS, SI at working meetings. Already in place in SK.	
Propose national drought management plan **to national government.**	Already achieved in SK.	
Protocol of actions		
Improve national drought monitoring approach by means of available results from research (additional integrated drought indices, methods, tools etc.).	- In cross-section, soil moisture and vegetation indices in the Drought Watch tool cover all the participating countries: AT, BA, CZ, HR, HU, ME, RO, RS, SI, SK; - Drought Watch indices and/or NRN data analysed in relation to national ground-measurements data in CZ, HR, ME, RO, RS, SI.	Annex F
Define thresholds for drought stages (and for each vulnerable sector if needed).	In place for agriculture in RS, SI, SK.	
Develop a manner of national-level communication on drought with public (national website for regular up-to-date drought status and early warning information for users).	General websites to national meteorological services are available in all the participating countries.	
Define concrete measures for each drought stage.	IDMP measures were reviewed in BA, RS, SI, SK.	Annex G
Define national drought protocol of actions – an operational roadmap with concrete "who does what and when".	In process of preparation in SK through inter-ministerial working group.	
Identify research needs for each vulnerable sector, and develop a way of assessing drought risk and collecting sectoral drought impacts.	NRN on status of soil and vegetation were established in all the participating countries: AT, BA, CZ, HR, HU, ME, RO, RS, SI, SK. Weekly reported data are also available in Drought Watch tool.	Annex H

Activities to set ground for ODMM implementation	Progress so far regarding proposed activity
Education, media	
Build public awareness, share knowledge and information.	During the project, the partnership included the input of all relevant target groups in shaping the final results via several meetings, seminars, workshops and/or email correspondence. Altogether, this included the following: • 43 public authorities, • 44 sectoral agencies, • 49 interest groups including NGO's, • 12 international organisations, • reached an estimate of 1,6 million people. • 292 social media post, • 198 articles in newspapers, newsletters, online articles, scientific journals, • 49 media appearances on TV and radio, • 154 international and national events, including training of trainers on the use of project results who further trained the end users in their country.
Develop educational programmes for all age and stakeholders groups.	For SK, actions addressing this topic have already been included in their National Action Plan.

Table 7: Table of proposed activities to be carried out in order to set ground for the implementation of national ODMM (left column) and progress achieved so far by the DriDanube project partners as per respective proposed activity (right column). Further details are available in the Annex file where indicated.

OUTLOOK FOR IMPLEMENTATION BY PARTICIPATING COUNTRIES

Austria

Drought Watch: The tool has potential for application by insurance companies and the environment agency to get an insight into the situation on the field and to assess drought damage.

NRN: Current insurance compensation scheme for damage caused by drought works well. Reporting of drought impacts through NRN is therefore seen as an informative activity rather than as a replacement.

ODMM: Drought issue has only recently begun to be adressed. The implementation of the model is currently not planned but it may be used as a reference in the future.

Bosnia and Herzegovina

Drought Watch: Some stakeholders are already using the tool and are satisfied with it. Plan is to continue to spread and support the usage.

NRN: The aim is to extend the reporting network, especially with focus on the forestry sector.

ODMM: There is a will to continue with cross-sectoral discussions on model implementation. The model is in line with the existing management scheme that became a part of the National Drought Plan.

Croatia

Drought Watch: It is seen as a good operational tool to complement the existing drought monitoring and could also be used for educational purposes.

NRN: Drought impacts maps prepared via NRN provide useful products in the operational work of Advisory service for Agriculture and Forestry of the Ministry of Agriculture. The network was conceptualised in a sustainable manner although further efforts are needed to extend the existing reporting network and to ensure relevant coordination of the NRN.

ODMM: There is a general interest in the ODMM among stakeholders and a strong will for inter-sectoral cooperation on drought issue. However, more efforts have to be done to implement it in the current institutional and legislation framework.

Czech Republic

Drought Watch: It is a good tool for additional, improved monitoring. Positive feedback was received from a wide range of stakeholders since the tool is freely available.

NRN: NRN methodology has been included in the national compensation scheme. Further plan is to expand the network to the field of forestry.

ODMM: The model is in line with the existing management scheme that became a part of the Water Law.

Hungary

Drought Watch: Some stakeholders are already using the tool and are satisfied with it. Further plan is to continue to spread and support its use.

NRN: NRN is useful for practical and informative assessment of drought impacts that took place. However, there are objective indicators already being used for drought impacts assessment within the national risk management. One of the challenges in ensuring NRN sustainability is the automated transfer of the NRN data collected from the reporters directly to CzechGlobe as the impacts maps provider.

ODMM: It is currently difficult to apply specific changes in the adoption of the ODMM. There is an agreement that institutional cooperation needs to be strengthened. If the needed resources will be available, there is a possibility of further long-term implementation of the model.

Montenegro

Drought Watch: It gives a great regional overview, and also has a great potential for operational monitoring of soil moisture. An agreement has been reached with the biotechnical faculty who will carry out a detailed analysis of Drought Watch and of another national tool, in order to use the best parts of both to improve the existing drought monitoring practices.

NRN: Further plans on extending the NRN with the national Forestry Service reporters.

ODMM: There is an evident interest in the adoption of ODMM. It will however take a long time to adjust the existing sectoral legislation and institutional setting, data flow and responsibilities.

Romania

Drought Watch: With additional verification of Drought Watch indices in relation to the existing ground measurements for Romania, it presents a reliable complementary tool to improve the operational work of national drought monitoring.

NRN: Observations acquired through NRN present valuable additional information that complements ground measurements and thus gives added value.

ODMM: It is a good concept, although current common position is that there is a greater need for a faster response to drought. With more emphasis on adaptation and education within the model, it could serve as a basis for improvement of the existing Romanian Drought Management scheme.

Serbia

Drought Watch: It is seen as a great tool for irrigation management experts although it is necessary to further promote it and educate farmers and professionals on its use. It is planned to integrate also other national indices into the tool as well as non-meteorology-related indicators as proposed by the stakeholders.

NRN: First steps were done in ensuring further cooperation with Ministry of Agriculture, Forestry and Water management after the end of the project to keep NRN process operational.

ODMM: There is a noted interest in implementation of ODMM and the process of preparing ground for its implementation has started although it is expected to be a long process.

Slovakia

Drought Watch: There is a lot of interest in the tool because it is free and can be used also in other projects and operational work. It is planned to add additional base layers of smaller units (river basins, municipalities etc.) and make an effort to assure the sustainability of the tool.

NRN: Current government is keen on sustaining the NRN, and interest is noted in incorporating the NRN information into the national compensation scheme. Further work is planned on adjusting the questionnaire for the forestry sector and organising more meetings for active and new reporters.

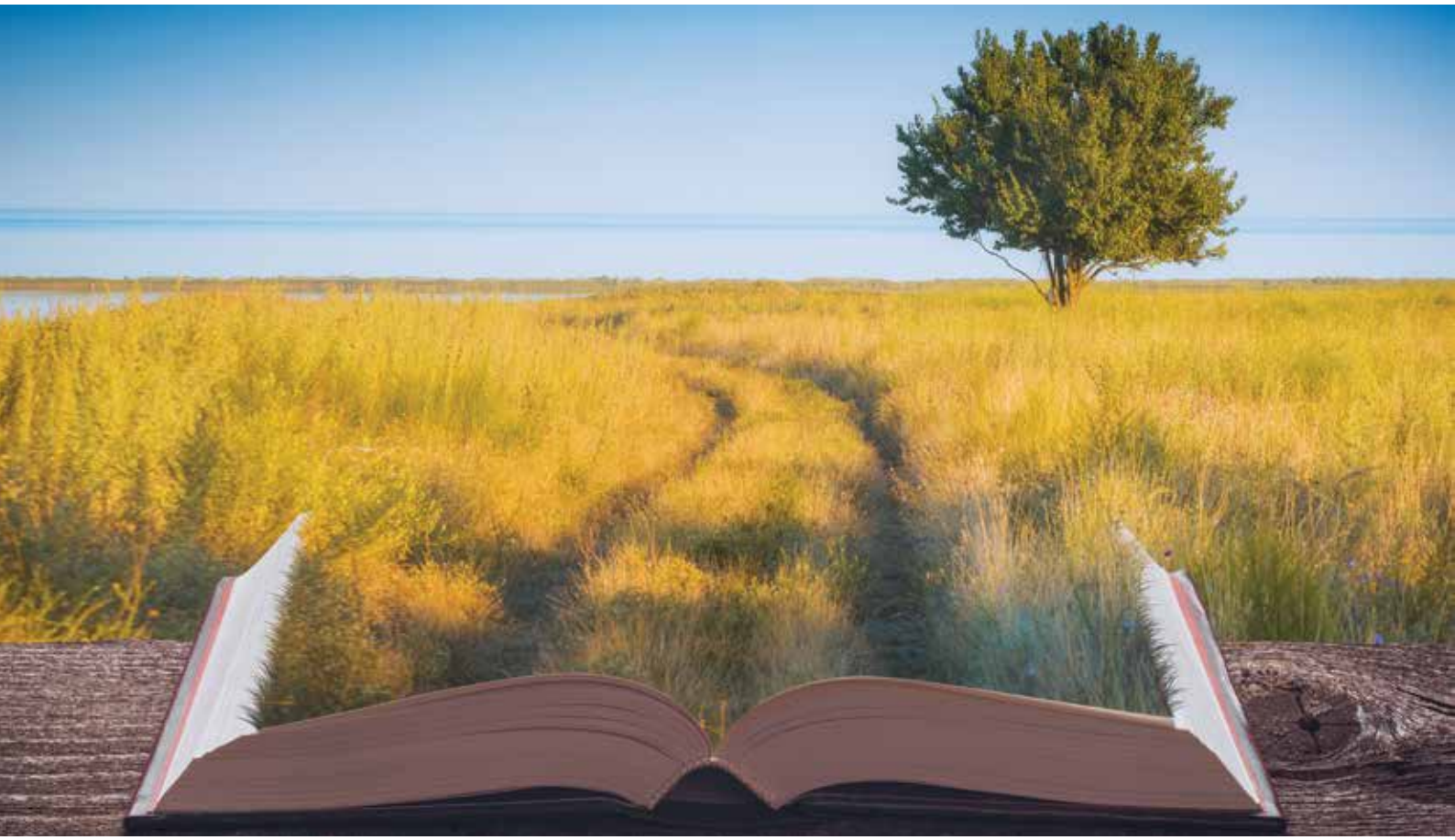
ODMM: Everyone involved in the preparation of the National Action Plan for drought for Slovakia is well informed about the model, and the institutional setting has already been implemented to a major degree through the Slovakian National Action Plan.

Slovenia

Drought Watch: It is considered as a very useful tool for the optimization of the operational work of the national services, and has a great potential for early warning for agricultural and hydrological droughts. The fact that the tool is freely available facilitates its adoption at the national operational level.

NRN: There is strong motivation to keep the NRN alive, as it presents the first example of regular drought impacts assessments at the national level as opposed to the post-drought assessment approach. NRNs are also jointly considered as a useful manner of impacts assessments to be introduced also to other vulnerable sectors (water management, hydropower etc.).

ODMM: The Strategy and its ODMM present a welcome novelty to renew the existing drought management approach and avoid ad-hoc solutions during drought. Cross-sectoral discussion on its implementation and position in the legislation continues to take place.



6 WAY FORWARD

6.1 DANUBE DROUGHT STRATEGY IMPLEMENTATION POSSIBILITIES AT NATIONAL LEVEL

In this chapter, Danube Drought Strategy addresses the legal aspects of introducing proactive drought management and suggests which existing legal policy frameworks can serve as a foundation for the Strategy implementation in countries of the Danube region. The main purpose of legally addressing drought management is to reduce the economic and environmental damages associated with drought and personal hardships of the affected citizens, which the Strategy can effectively help to achieve.

As stated in Chapter 2.1, there is a variety of ways at the global/regional as well as at the national level that could be used to implement the policy related to drought. A more **result-oriented implementation of the Strategy necessitates a strong political will and a clear assignment of responsibilities and roles**. This includes the development of actions and integration of the tools proposed in the Strategy into the operational process and into action plans. With all that in mind, the recommended legislative framework options are summarized in Table 8.

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

Table 8: Some policy options for the implementation of drought policy with auxiliary information.

Legislative framework at regional level	Existing implementation mechanism at national level	Implementation period	Associated obligations of the countries	Additional information on implementation
United Nations Convention to Combat Desertification (UNCCD)	National Action Programme (NAP)[44]	UNCCD 2018-2030 Strategic Framework for implementing the Convention	PRAIS UNCCD reporting proces[45] (started in 2018)	Drought Initiative & Drought Toolbox
EU Water Framework Directive (Directive 2000/60/EC)	River Basin Management Plan (RBMP)[46]	Ongoing WFD 2nd cycle (2016–2021), WFD 3rd cycle (2021-2027)	Reporting & evaluations	Water Information System for Europe (WISE)[47]
EU Strategy on Adaptation to Climate Change (EUSACC); **European Climate Change Program** (ECCP)	National Adaptation Strategy with National Adaptation Plan[48]	2020	Reporting & evaluations	European Climate Adaptation Platform (Climate-ADAPT) – reference information system[49]
Sustainable Development Goals (SDGs) & **The 2030 Agenda for sustainable development**	Aligning national priorities with the 2030 Agenda & SDGs[50]	2030	National targets (i.e. SDG 15.3)	SDGs HelpDesk[51]
EU Common Agriculture Policy (EU CAP)	Rural Development Programmes (RDPs)	Post-2020	Implementation of RDPs actions	EC information on national RDPs[52]

6.2 ONGOING DROUGHT MANAGEMENT IMPROVEMENTS

According to WMO, as described in its *Guidelines on the Role, Operation and Management of National Meteorological and Hydrological Services*[53], warning systems designed to help protect life, property and livelihoods are the most important among all the services provided by National hydrometeorological services (NHMSs). In contrast to other services, WMO recommends national regulations to follow a "single authoritative voice" on weather warnings within the countries in order to avoid public confusion. Other providers of weather-related information are discouraged to style their products in shape of warnings. Therefore,

44 https://knowledge.unccd.int/search?f%5B0%5D=type%3Aaction_programmes
45 https://prais.unccd.int/
46 https://ec.europa.eu/environment/water/participation/map_mc/map.htm
47 https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd
48 https://climate-adapt.eea.europa.eu/countries-regions/countries
49 https://climate-adapt.eea.europa.eu
50 https://www.un.org/sustainabledevelopment/sustainable-development-goals/
51 https://sdghelpdesk-elearning.unescap.org/
52 https://ec.europa.eu/info/publications/cap-your-country_en
53 https://library.wmo.int/doc_num.php?explnum_id=4221

NHMSs are key players to convey drought related information – even more if it is a warning – to the public. Early warning on extreme weather events is essential for national emergency responses or mitigation activities, which shall therefore be directly tied to extreme weather alerts, further completed within a drought plan.

In order to facilitate a common weather warning system, WMO has started the Global Multi-Hazard Alert System project and organised Severe Weather Information Centres, while at the European level such an initiative, namely the Meteoalarm, was established in the frame of EUMETNET[54]. **Meteoalarm**[55] is a system that provides warnings by NHMSs across all Europe in common categories, scales and representation (i.e. colour codes). Due to its specific properties – mainly its slow onset and development – drought was not included in this process. On the continental scale, the first drought monitoring and warning information system named **European Drought Observatory (EDO)**[56] was established by the Joint Research Centre under the European Commission. Data sources for EDO are provided by global providers, such as remote sensing operators and global meteorological modelling centres.

A logical development of drought early warning systems would be to combine the information from EDO and NHMSs and standardize them to a degree that would enable their inclusion in the Meteoalarm. Enabling regular drought information within the Meteoalarm would also address the lack of attention given to drought at the global scale (or at the regional/ continental scale).

Another initiative related to drought monitoring appeared under the **Global Earth Observations** partnership, which is building up regional drought monitoring (and prediction) activities within the NHMSs of the countries. It is called **Global Drought Information System**[57] and works in a "bottom up" manner to provide a more accurate, spatially detailed continent-by-continent mapping (and documentation) of global drought.

BOX 6. NETWORKING EXAMPLE – DMCSEE

DMCSEE's mission is **to coordinate and facilitate the development, assessment and application of drought risk-management tools and policies** in southeastern Europe with the goal of improving **drought preparedness and reducing drought impacts**. It performs training of experts NHMSs in the region in order for them to obtain extra skills for increased drought management capacity. DMCSEE is involved in several regional projects to enhance preparedness and mitigation action in the region[58], including the IDMP for Central and Eastern Europe[59], and is connecting its activities with EDO and other global drought initiatives.

54 A network of 31 European national meteorological services.
55 https://www.meteoalarm.eu/
56 https://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000
57 https://www.earthobservations.org/activity.php?id=123
58 http://www.dmcsee.org/en/events/
59 http://www.gwp.org/en/GWP-CEE/WE-ACT/Projects/IDMPCEE/

6.3 RECOMMENDATIONS FOR THE SUSTAINABILITY OF THE DANUBE DROUGHT STRATEGY AT NATIONAL LEVEL

The Danube Drought Strategy concludes with some brief recommendations on how to enhance capability of the society to better cope with droughts on the long run. Many of these recommendations have been previously discussed in DriDanube countries at different occasions during the project development and some suggested actions were extracted from the meeting notes and from the target groups' feedbacks.

General recommendations for the implementation of the Strategy:

1. **Initiate political will and call for coordinated legal approach.** Policy coherence related to drought on the regional/national level is one of the guiding principles of the Strategy implementation. For achieving the aim of the Strategy, countries are encouraged to acknowledge drought among national priorities.
2. **Encourage collaboration and partnerships.** Strengthen existing partnership between project partners and stakeholders, and connect with other institutions and initiatives to gain extra knowledge and good practices.
3. **Resourcing.** Activities to perform fundamental maintenance of project results on the regional level will be completed with the existing resources or future budget decisions (DMCSEE, partners). At the same time, it is reasonable to expect national efforts ensuring the integration of the results, such as investing in data, products, tools and human capacities that support Strategy implementation.
4. **Develop and adopt a national strategic document on drought management.** It shall cover strategic view on drought issue, set long-term goals and a manner of achieving them, and define a matrix of drought timeline and corresponding course of institutional actions. Support for its preparation can be found in Danube Drought Strategy.
5. **Form a drought impact inventory managed by national authorities.** Creation of regular, sectoral and centralized impacts inventory enables the national authorities to have at any time an insight into exact drought damage in place in any part of the country. It also presents a basis for any further legal steps.
6. **Put results into practice.** In addition to planned sustainability in the frame of DriDanube project, it is necessary to introduce available tools into daily work routine (i.e. using national data sets, operational use of tools in institutions etc.).
7. **Share knowledge and help to raise awareness.** Continue searching for good practices to guide drought management activities, with emphasis on learning process and the preventive.
8. **Establish water-related learning curriculums** at all levels, especially in elementary education.

BOX 7. **LEGISLATION EXAMPLE – SLOVAKIAN ACTION PLAN FOR DROUGHT**[60]

The Slovakian Action Plan for drought approved by the Slovakian government in 2018 consists of three parts: monitoring and warning systems for drought, science and research, and adaptation measures combating drought in the fields of water management, agriculture, forestry and urban areas. According to the methodology and institutional framework of public policy-making, the Action Plan is a separate document that is linked to Water Act. In the future, it is envisaged to develop an Action Plan for each drought stage. The measures are categorized according to their purpose and sorted into groups and sub-groups by sectors. Results of the DriDanube project are considered to be included in the plan.

60 https://www.minzp.sk/files/sekcia-vod/hodnota-je-voda/h2odnota-je-voda-akcny-plan-riesenie-dosledkov-sucha-nedostatku-vody.pdf

ANNEXES

All annex files to this Strategy along with the other results of the DriDanube project are available on the project official website under the Library tab:
www.interreg-danube.eu/approved-projects/dridanube/outputs

Annex A – Common report on the existing drought management status in the Danube region
This report reviews a wide range of drought management aspects in order to study how drought is currently managed across the region. Reviewed aspects include drought monitoring approach, national legislation addressing the drought issue, institutions with drought-related roles, manner of inter-institutional communication before, during and after a drought event, manner of assessing drought impacts, past or on-going educational and research programmes, and national projects targeting the drought issue.

Annex B1 – National stakeholders database
This document lists the engaged organisations per DriDanube country that actively contributed to the project results via several meetings, seminars, workshops and/or email correspondence.

Annex B2 – Summary Report of the National Briefing Seminars
This report summarises National Briefing Seminars that were organised for stakeholders and end-users of drought-related information at the beginning of the DriDanube project in all 10 participating countries. The planned outputs of project activities were presented and stakeholders' expectations and requirements were collected regarding the aspects of drought management on which DriDanube was focusing: drought monitoring, drought impact and risk assessment, drought management and communication.

Annex C – Potential institutions for the role of Reference Organisations in each DriDanube country
The document lists potential institutions that could take the role of Reference Organisations in the frame of Optimal Drought Management Model in each participating country. The listed institutions were proposed by project partners in cooperation with key stakeholders.

Annex D – Potential institutions for the role of National Drought Office, National Drought Commission and National Drought Authority
The document lists potential institutions that could take the role of the National Drought Office, the National Drought Commission and the National Drought Authority in the frame of Optimal Drought Management Model in three countries: Hungary, Serbia and Slovenia. The listed institutions were proposed by project partners in cooperation with key stakeholders in respective countries.

Annex E – Summary Report of the final National Drought Seminars
This report provides conclusions from National Drought Seminars that were organised for project stakeholders in final months of the DriDanube project in all 10 participating countries. The aim was to gather stakeholders' feedback on usability of the developed DriDanube tools and to examine options on how partners and stakeholders can work together to support the integration of the results into daily operational work, and how to assure outputs' sustainability.

Annex F – Pilot cases on testing Drought Watch and NRN vs. national ground measurement data
This document provides a summary on the approach used for testing Drought Watch and National reporting networks data with national ground measurement data, along with main conclusions. Pilot testing was performed in Croatia, Czech Republic, Montenegro, Romania and Slovenia.

Annex G – Review and classification of IDMP examples of long- and short-term drought measures
This document provides a review of IDMP measures and information of their applicability in some of the DriDanube countries. IDMP measures were discussed with key national institutions in drought management at the Strategy-focused meetings in four countries: Bosnia and Herzegovina, Serbia, Slovakia and Slovenia.

Annex H – Status of National Reporting Networks in each DriDanube country (September 2019)
This Annex provides information on the number of active reporters in each DriDanube country, reporting window in a year, the structure of NRN reporters and institution responsible for coordination of NRN in each country. There is also information on additional national characteristics of NRNs.

Annex I – Template for shaping the ODMM according to the national characteristics
This template serves as a support to set ground for ODMM implementation on national level.

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Thanks goes also to the participants of DriDanube events, national seminars, workshops and conferences who have been an important source of insight and advice.

Thank you.

Be prepared. Know the risks. Take action.

BETTER PREPARED FOR DROUGHT

DANUBE DROUGHT STRATEGY

LEAD PARTNER:

- Slovenian Environment Agency (ARSO), Slovenia

PARTNERS:

- EODC Earth Observation Data Centre for Water Resources Monitoring GmbH (EODC), Austria
- Global Change Research Institute CAS, (CzechGlobe), Czech Republic
- Global Water Partnership Central and Eastern Europe (GWP CEE), Slovakia
- Hungarian Meteorological Service (OMSZ), Hungary
- Vienna University of Technology (TU Wien), Austria
- Szent Istvan University (SZIU), Hungary
- National Meteorological Administration (NMA), Romania
- Centre of Excellence for Space Sciences and Technologies (SPACE-SI), Slovenia
- Meteorological and Hydrological Service (DHMZ), Croatia
- Slovak Hydrometeorological Institute (SHMU), Slovakia
- Faculty of Agriculture, University of Novi Sad (FAUNS), Serbia
- Republic Hydrometeorological Service of Serbia (RHMSS), Serbia
- Institute of Hydrometeorology and Seismology (IHMS), Montenegro
- Republic Hydrometeorological Service of Republic of Srpska (RHMZ RS), Bosnia and Hercegovina

ASSOCIATED STRATEGIC PARTNERS:

- International Commission for the Protection of the Danube River (ICPDR), Austria
- Administration of the RS for Civil Protection and Disaster Relief (URSZR), Slovenia
- The State Land Office (SLO), Czech Republic
- Agricultural Station/Forecasting and Warning Service of Serbia in plant protection (PIS), Serbia
- Environment Agency Austria (EAA), Austria
- Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW), Austria
- Ministry of Environment and Energy, Water management directorate (MZOIE), Croatia
- Ministry of Agriculture (FM), Hungary

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