Integrated Drought Management System and measures to mitigate the impact of the climate change in Kosovo

Enhancing drought resilience: Action plan for Kosovo

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1. Introduction

Kosovo is currently facing critical drought conditions, with significant depletion of its water reservoirs. 90% of Kosova`s Renewable Water Resources are internal i.e. generate within the country. This place immense pressure on its already strained groundwater reserves. In response, there is an urgent need for a comprehensive action plan to manage and mitigate the impacts of climate change and drought.

This action plan aims to prioritize integrated drought management to support sustainable water management and foster economic development in Kosovo. Key components include enhancing water resource management systems to mitigate drought impacts, bolstering technical expertise and staff capacity, and raising public awareness about the consequences of drought on water resources.

The hydrography of Kosovo's watercourses is divided into 4 river basins: Drini i Bardhë, Lepenc, Ibri, and Morava e Binçes. Kosovo's rivers flow into three sea catchments: the Adriatic Sea, the Aegean Sea and the latter two in the Black Sea. There are 7 Regional Water Companies in Kosovo and 3 Regional Irrigation companies.

Efforts within the broader Drin River Basin initiatives (e.g. Drin project funded through GEF and implemented by GWP-Med) aim to promote collaborative management of shared water resources and integrate Kosovo into a larger, multi-country project. The strategy emphasizes consensus-building among riparian countries, strengthening institutional frameworks for cooperation, and involving both public and private sectors. These steps are critical for ensuring equitable water use, preserving environmental quality, and adapting to the impacts of climate change in Kosovo.

Through these initiatives, Kosovo seeks to establish a robust framework for addressing the challenges posed by drought and climate change. This framework aims to ensure sustainable water resource management and advance economic development while upholding environmental conservation and community resilience.

1.1. Drought policy and preparedness – Setting the stage

A national drought plan should establish a clear set of principles and steps to govern the management of drought and its impacts. The overriding principle of drought policy should be an emphasis on risk management through the application of preparedness and mitigation measures[1] (HMNDP, 2013).

Although the development of drought plans can be a challenging task, the outcome of this process can significantly increase societal resilience to drought and water scarcity.

The European Commission also recommends establishing specific **Drought Management Plans** (DMPs) as part (or as a separate plan) of the RBMP (in Program of Measures part) where relevant and recognizes the value of drought management plans. According to them, these drought (risk) management plans and strategies are administrative tools for the implementation of a drought policy based on the proactive, risk reduction approach and should include three key elements in their frameworks (CIS[2]):

- Indicators and thresholds establishing onset, ending, and severity levels of the exceptional drought circumstances (prolonged drought);

[1] High-level Meeting on National Drought Policy (HMNDP) | World Meteorological Organization (wmo.int)
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52007DC0414

- Measures to be taken in each drought phase to prevent deterioration of water status and to mitigate negative drought effects; and
- An organizational framework to deal with drought and the subsequent revision and updating of the existing DMP.

Three key elements follow the same logic as the Integrated Drought Management approach, which focuses on three pillars: 1) Monitoring and early warning; 2) Vulnerability and Impact assessment; and 3) Mitigation, Preparedness, and Response.

Kosovo doesn't have the National Drought Management Strategy or National Drought Management Plan, but it has a unique approach of Drought Management Plans developed by the 7 Regional Water Companies that cover over 95% of the population. Furthermore, issues of drought and water scarcity are currently addressed through other legal acts, such as the Law on Waters of Kosovo (and the new draft law on water resources management which is in the process of approval and will replace the water law), and strategic documents such as "National water strategy, 2017-2036"[3], "Strategy for climate change", "Disaster risk reduction strategy and plan of action".

1.2. General objectives and scope

Following up activity 1.1. and Review / State-of-the-art that partners prepared in a previous period of the project, showed that the actual situation for Drought Management Plan (DMP) development in Kosovo has some challenges. Shortcomings were found in the implementation of all key elements of the DMPs, namely, indicators and thresholds establishing different drought stages, measures to be taken in each drought stage, and the organizational framework for drought management.

The Action Plan aims to prevent drought through preventive measures and to eliminate the negative effects of climate change (adaptation). Action Plan will support stakeholders in Kosovo with their efforts towards Drought Management Policy/plan preparation.

Action plan targets primarily public bodies and competent authorities responsible for national drought planning. Furthermore, efforts were made to make the Action plan clear and simple to increase understanding by stakeholders and the broad public.

The action plan follows the information collected in report 1.1., requirements defined in Kosovo Drought Management Framework Strategy[4], and was based on the Guidelines (7 steps)[5] and experiences with the process in Slovakia and the broader Danube region.

This action plan is structured to provide concrete general recommendations and actions (next steps) for each of the three pillars of the Integrated Drought Management[6] on how Kosovo can move forward

[3] Water Strategy 2017-2036 http://kepweb.org/documents_custom/water-strategy-2017-2036/, reviewed recently for the period 2023-2027 (https://gzk.rks-gov.net/ActDetail.aspx?ActID=78647)
[4] Kosovo Drought Risk Management Framework
[5] https://www.gwp.org/globalassets/global/gwp-cee_files/idmp-cee/idmp-guidelines-final-pdf-small.pdf
[6] https://www.droughtmanagement.info/

in its efforts to develop national drought plans. The plan will be further elaborated through the engagement with broader drought experts and stakeholders through direct consultation and within the Kosovo Community of Practice. The inclusion of responsible actors in all phases of this process promotes the creation of ownership of the plan, and creates individual and institutional interest in its application beyond the end of the project.

1.3. What is included in this action plan?

The document is structured to provide concrete steps, recommendations, and actions that stakeholders in Kosovo can take to improve their current drought management. This is not the Drought Management Plan itself because that requires many different processes to be implemented and involves many different stakeholders. Instead it is an action plan that follows the structure of three pillars and for each pillar (also based on the 10-step process for preparing a drought management plan/policy) following parts are explained:

- State of the art (primarily based on the report on Act 1.1. and some other available documents)
- Recommendations or proposed steps by SlovakAid experts (based on Slovak and international (DMCSEE, IDMP) experience), and
- Actions defined by Kosovo experts and stakeholders through discussions, meetings, national dialogue, trainings and Kosovo Drought Community of Practice activities.

1.4. Slovak Experience to address the effects of drought and water scarcity

In 2015, Slovakia experienced its most severe drought in 100 years, with temperatures reaching 35 °C over 23 days. Convinced of the need for a concerted effort to prepare for such events in the future, in 2018 Slovakia inaugurated its Drought Action Plan, a first in the region.

Since Slovakia had been an active participant in the Integrated Drought Management Programme[7] and DriDanube project[8] (funded by the European Union's Interreg Danube Programme), the country understood the value of watching for early signs of drought and investing more in preparedness measures.

In 2017, an inter-ministerial working group that included stakeholders from relevant sectors was tasked to prepare a Drought Action Plan (Step 1). Coordination of this group was led by the Ministry of Environment. The group first discussed and defined the plan's objectives (Step 2) and prepared an inventory of available data and gaps that needed to be addressed (Step 3). Stakeholders looked closely at the preventive, operational, and crisis measures needed, including identification of drought-resistant tree species, groundwater surveys, design of new irrigation canals, expansion of the monitoring network, and development of responses to disaster conditions. And because a cross-section of stakeholders was engaged in developing the plan (Step 4,5), the finished product would be well understood by those who would be using it. The plan was prepared in 2017-2018 and adopted in 2018 (Step 5).

[7] Integrated Drought Management Programme

[8] DriDanube - Interreg Danube (interreg-danube.eu)

Fig x: Steps for preparation of Drought Management Plans

Source: Guidelines for the preparation of Drought Management Plans. Development and implementation in the context of the EU Water Framework Directive[9]

The plan had 25 pages with annexes and it's easy to read. Its time horizon was 8 years (2018 – 2025). Progress of its implementation is evaluated annually by the Water Section, Ministry of the Environment (Step 4). The minimum budget to implement measures until 2020 was estimated at 140 million EUR, mainly from EU funds.

The plan starts with its goal and general information about the process. Slovak Hydrometeorological Institute contributed with a chapter on historical drought. The main part of the document is focused on measures – preventive, operational, and crisis.

Preventive measures include agriculture and forestry, settlements, water management, research, and education (adaptation pillar). The operations are mainly focused on the monitoring (monitoring pillar) and the crisis on water supply in the period of prolonged drought (risk and vulnerability pillar)

Finally, research, education, and public awareness were included to ensure that drought became part of everyone's vocabulary and practice. The last part includes budget and institutional setting.

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- The goal, general information, and definitions
- Historical occurrence of drought
- Measures – preventive, operational, and crisis
- Focus on water retention – Catalogue of Natural Water Retention Measures (NWRM)
- Organizational setup and budget

The Drought Action Plan includes a concrete plan with the preventive measures. It plans a renewal of 510 km multipurpose irrigation canals that will store water during floods and use it in dry periods. It promotes also no-till farming in agriculture. In forestry, it is focused on forest road maintenance and planting climate-proof forests. The largest part is devoted to water management – green infrastructure (tree planting in river basins, bio corridors, wetlands restoration), smart solutions,

[9] idmp-guidelines-final-pdf-small.pdf (gwp.org)

monitoring, non-revenue water decrease, and integrated river basin management. It deals also with science (Step 6) and education (Step 7) – modelling of vulnerability and information campaigns. As a follow-up, an information campaign on drought is run by the Slovak Environmental Agency (Step 8,9). The annual evaluation was carried out by the Ministry of the Environment Water Section (Step 10).

1.4.1. Added value of the Action Plan

The Plan stimulated new applied research about erosion and natural water retention capacity. Soil monitoring, and better understanding of the linkages between soil and water, were strengthened. Guidance documents for water monitoring and assessment were improved. And financial support for construction, rehabilitation, and maintenance of existing water retention infrastructure was made available. Most notable was the uptake of the Action Plan by municipalities. Backed by new policy, cities and towns were able to obtain more than four million Euros funding for water retention measures such as roof vegetation and rainwater diversion.

The strategy's implementers also learned the importance of working across sectors, as forestry and agriculture agencies were slower to mobilise their capacities to implement the Drought Action Plan.

As Slovakia began developing a new national Water Policy, and a National Action Plan (NAP) for Climate Adaptation, provisions of the drought strategy were easily incorporated. Slovakia's NAP now includes drought and water scarcity and provide guidance for drought preparedness. A thorough assessment of the NAP that includes social, environmental and economic impacts of the Drought Action Plan will be conducted in 2025. They have decided to follow the EU Water Scarcity and drought expert group to make a revision in line with EU.

2. Recommendations and next steps

2.1. Drought Monitoring

Drought monitoring and assessment are vital for the development of the mitigation measures to cope with drought and climate change impact. In tables below, a number of actions to improve current drought monitoring practices in Kosovo are presented. Some of the actions, defined by stakeholders, are marked as priority (bolded).

State of the art-from review	Recommendations	Action
The responsible body for meteorological, hydrological, ground water, agriculture and hydro-ecological drought is the Kosovo Hydrometeorological Institute, which is part of the Kosovo Environmental Protection Agency.	**Establish joint monitoring capacity for covering meteorological, hydrological ground water, agriculture and hydro-ecological droughts assessment.**	The high priority should be to upgrade existing drought monitoring systems for using the integrating advanced drought indices and a multifaceted approach that includes various data types and sector-specific analysis
According to our experience, joint meteorological, hydrological, groundwater, soil and hydro-ecological monitoring capacity is a good foundation for complex monitoring of all aspects of drought effects. Kosovo already has in place drought monitoring at the national level maintained by Hydrometeorological Institute. It covers many aspects of drought, however only one basic drought index – Standard Precipitation Index (SPI) is implemented. There are no assessment		

systems in place for hydrological and groundwater drought effects (for example could be used indices used in Slovakia). Essential part would be to give into practice the hydro-ecological monitoring of surface water categories (including wetlands).
The 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 implementing a multifaceted (sectoral) approach is encouraged.
Increased cooperation of different sectoral experts and international collaboration (IDMP, DMCSEE and other regional and international fora) is recommended

State of the art-from review	Recommendations	Action
Hydro-meteorological monitoring system in river basin Drini i Bardhe (7 meteo/14 hydro/ 18 precipitation stations). There is only limited information on groundwater and on the using remote sensing to assess the drought events.	**Enhance the existing hydro-meteorological, groundwater, soil and hydrological monitoring systems by incorporating advanced sensors for measured elements as soil moisture, wind, humidity, and solar radiation. Investigate the possibility to incorporate the remote sensing data and information into the overall drought assessment system.**	Actions will be subdivided into following steps: a) Install soil moisture sensors across the Drini i Bardhe basin to accurately monitor soil dryness and optimize irrigation advising. b) Upgrade existing meteorological stations with equipment to measure additional parameters like wind, humidity, and solar radiation for a more comprehensive understanding of the water balance and evapotranspiration rates. c) Develop groundwater monitoring system in the river basin. d) Hydro-ecological monitoring of biological quality elements in exposed water bodies (aquifers). If there are conditions, e) Incorporate the remote sensing results into the drought assessment system.

Modern integrated drought monitoring requires relatively fast, automated to large degree and quality controlled meteorological and hydrological and groundwater measurements data with adequate temporal and spatial resolution. Among needed parameters are (beside obviously precipitation and temperature) also wind, air humidity and solar radiation to enable accurate estimation of evapotranspiration and consequently surface water balance and groundwater yields. It enables also better optimal irrigation advising. Additionally, many countries are now installing soil moisture sensors to detect more accurately soil dryness. Recently, many countries in the region have modernized meteorological measurement networks. Reportedly, Kosovo has adequate number of on-line meteorological stations, however – in order to prepare recommendations – more detailed information about

parameters (type, frequency of data availability) for drought monitoring is needed. This system could be completed and upgraded by using remote sensing data and measurements.

State of the art-from review	Recommendations	Action
Integration of Remote Sensing and NWP Products in Drought Monitoring	Incorporate remote sensing data, specifically satellite-derived vegetation indices, into the drought monitoring system	Utilize open-data from Copernicus, the Earth observation component of the EU's Space Programme, to enhance drought monitoring capabilities. Establish cooperation with national and regional drought observatories for data sharing and analysis
Development of a Comprehensive Drought Early Warning System (EWS)	Develop an EWS that integrates climatological, hydrological, groundwater and agricultural data along with water supply data for effective drought forecasting	Set up a dedicated team to design and implement an EWS. This system should include threshold triggers for timely actions within the drought risk management plan, leveraging both ground measurements and remote sensing data for comprehensive forecasting of different types of droughts.

Drought early warning systems (EWS) typically aim to track, assess and deliver relevant information concerning climatological, hydrological and water supply conditions and trends. Ideally, they have both a monitoring (including impacts) component and a forecasting component (NWP products). 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.
Modern drought monitoring systems (crucial component of EWS) don't rely only on ground measurements. One of most commonly implemented components is remote sensing data, specifically satellite derived vegetation indices. Kosovo can profit from open-data policy of Copernicus, the Earth observation component of the European Union's Space programme, and also from cooperation with existing national and regional drought observatories.

State of the art-from review	Recommendations	Action
Precipitation accumulation and anomalies missing	**Implement standardized protocols for data collection to ensure consistency and reliability across different precipitation measurement methods**	Conduct a comprehensive review of existing precipitation data for consistency and accuracy. Implement a standardized protocol for precipitation data collection across all monitoring stations, including the calibration of

		equipment and training of personnel. Develop a system for real-time data quality checks and anomaly detection to ensure the accuracy of precipitation measurements

Check homogeneity of data time series. If needed, perform data treatment (missing data interpolation, homogenization). Precipitation data is diverse in terms of measurement methods, data acquisition etc.

State of the art-from review	Recommendations	Action
Enhance SPI Implementation for Drought Monitoring	Address the limitations of SPI by integrating temperature data into the drought monitoring framework	Modify the existing SPI calculation framework to include temperature variables, thereby creating a more holistic drought index. This could involve developing a composite index that combines SPI with temperature-based indices like the Standardized Precipitation Evapotranspiration Index (SPEI) to offer a more comprehensive understanding of drought conditions, accounting for both precipitation and temperature factors

According to WMO there are three main methods for monitoring drought and guiding early warning and assessment: 1. Using a single indicator or index 2. Using multiple indicators or indices 3. Using composite or hybrid indicators. In 2009, WMO recommended SPI as the main meteorological drought index that countries should use to monitor and follow drought conditions. By identifying SPI as an index for broad use, WMO provided direction for countries trying to establish a level of drought early warning.

SPI Strengths: Using precipitation data only is the greatest strength of SPI, as it makes it very easy to use and calculate. SPI is applicable in all climate regimes, and SPI values for very different climates can be compared. The ability of SPI to be computed for short periods of record that contain missing data is also valuable for those regions that may be data poor or lacking long-term, cohesive datasets. The program used to calculate SPI is easy to use and readily available. The ability to be calculated over multiple timescales also allows SPI to have a wide breadth of application.

SPI Weaknesses: With precipitation as the only input, SPI is deficient when accounting for the temperature component, which is important to the overall water balance and water use of a region. This drawback can make it more difficult to compare events of similar SPI values but different temperature scenarios. The flexibility of SPI to be calculated for short periods of

record, or on data that contain many missing values, can also lead to misuse of the output, as the program will provide output for whatever input is provided. SPI assumes a prior distribution, which may not be appropriate in all environments, particularly when examining short-duration events or entry into, or exit out of, drought. There are many versions of SPI available, implemented within various computing software packages.

Note: Why to use SPEI index as well:
The Standardized Precipitation Evapotranspiration Index (SPEI) is an extension of the widely used Standardized Precipitation Index (SPI). The SPEI is designed to take into account both precipitation and potential evapotranspiration (PET) in determining drought. The SPEI is really simple to calculate, and is based on the original SPI calculation procedure. The SPI is calculated using monthly (or weekly) precipitation as the input data. The SPEI uses the monthly (or weekly) difference between precipitation and PET.

State of the art-from review	Recommendations	Action
Evapotranspiration assessment is not available	Evapotranspiration assessment is needed for improvement of drought monitoring, if SPEI index is going to be developed and used.	Increase capacity of KHMI staff and engage scientific community to help

The FAO Penman-Monteith equation/method has been selected by FAO as the reference because it closely approximates grass ETo at the location evaluated, is physically based, and explicitly incorporates both physiological and aerodynamic parameters[10].
To accommodate users with different data availability, KHMI is strongly encouraged to use one of the existing different methods to calculate the reference crop evapotranspiration (ETo): Thornthwaite method, Blaney-Criddle, Hargreaves and Priestley-Taylor, modified Penman etc.

State of the art-from review	Recommendations	Action
Hydrological indices	To make research on suitable EWS Indicators along with the trigger values (river flow and reservoir water volume characteristics).	Technical Regulation for forecasting the drought effects on surface water bodies.

This might be based on long-term values of M-daily flows for the reference period and hydrological monitoring station experienced with drought effects. Generally, hydrological drought assessment is based on annual, monthly and daily hydrological characteristics and transferred into the EWS for development of the trigger values.

State of the art-from review	Recommendations	Action
Groundwater indices	To make research for the development of the trigger values (e.g. based on statistical approach) to recast the drought impact.	Technical Regulation for forecasting the drought effects on groundwater resources.

The following approach may be taken into account. For each month in the evaluated period, based on the statistical processing of the average monthly values of the same month for the reference period, separate categories of the degree of influence of groundwater by drought -

[10] https://www.fao.org/land-water/land/land-governance/land-resources-planning-toolbox/category/details/en/c/1027493/

in objects unaffected by anthropogenic exploitation will be created and compared with the affected ground water wells and springs. The limit values of the individual categories for the groundwater level would be established, based on detailed research. Note: As the step of the development of limit values appropriate for Kosovo natural conditions, approaches from other countries can be used.		
State of the art-from review	**Recommendations**	**Action**
Implementation of Compound/Hybrid Indicators for Drought Monitoring missing	**Develop a compound drought indicator that combines various data types, like the Standardized Precipitation-Evapotranspiration Index (SPEI), soil moisture, and vegetation indices.**	Initiate a project to integrate SPEI with remotely sensed vegetation data (e.g., fAPAR) and soil moisture data from models like LISFLOOD. This would create a comprehensive drought monitoring tool that considers precipitation, evapotranspiration, soil moisture, and vegetation health, providing a more nuanced understanding of drought impacts across different sectors.
Just as there is no 'one-size-fits-all' definition of drought, there is no single index or indicator that can accounted for and be applied to all types of droughts, climate regimes and sectors affected by droughts. Recently, other indices are getting more operational attention like: The Standardised Precipitation-Evapotranspiration Index (SPEI) (Vicente-Serrano and Beguería, 2022) and Combined Drought Indicator (CDI) (Sepulcre-Canto et al., 2012).		
State of the art-from review	**Recommendations**	**Action**
Solution Development for Drought Monitoring	**Create a centralized, integrated drought information system**	Implement a platform that combines meteorological, hydrological, agricultural, groundwater, remote sensing and environmental data and information for real-time analysis and visualization, aiding in prompt decision-making
Drought Information Dissemination Strategy	Establish a comprehensive and accessible drought information dissemination network	Develop a multi-faceted communication strategy including a dedicated website, monthly bulletins, and social media updates. Organize regular training and workshops to educate stakeholders on interpreting and utilizing drought information effectively
Drought reports are recommended to collect weather-related information on drought and sectoral data/reports provided by Reference Organisations in Kosovo based on which it		

prepares regular synthesis reports on the current state of drought. Those can be prepared as bulletins, drought platforms or other forms of summaries. 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 the wholesome characterisation of drought situations and its impacts on individual sectors.		
For long-term planning, develop (implement) a forecast (outlook) of drought development in future months/seasons	Use ECWMF statistical seasonal outlooks of mean seasonal temperature and precipitation totals for future seasons and downscale them for Kosovo conditions	At the HMIK in Kosovo - test the statistical dependencies between seasonal and monthly temperatures and precipitation for more detailed outlooks

2.2. Drought impacts and risks

The drought impacts and risks were identified on the detailed analysis conducted at the beginning of this project and experiences from the other countries and projects.

State of the art-from review	Recommendations	Action
Identified current gaps in understanding the impacts and risks of drought in Kosovo	**Develop a comprehensive assessment methodology to quantify and categorize drought impacts on various sectors**	Conduct sector-specific studies to assess the vulnerability and risks associated with drought, focusing on agriculture, water supply, and ecosystem services
No Drought Impact Registry to record and analyse drought effects systematically	Integrate climate data with socio-economic data for a comprehensive impact analysis	Create a digital platform for data collection and sharing among stakeholders for timely and effective drought impact assessment
No dynamic drought impact mapping system	**Utilize GIS and remote sensing technologies for real-time impact assessment**	Collaborate with local universities and international organizations to develop a geospatial drought impact monitoring tool
According to recent investigations in Europe many attempts were performed to collect drought impacts in different regions/environments (EDII, ADII). First step to enable this process in a specific country is to start with the pilot collection of drought impact data in different sectors for limited time period. The origin of data could be statistical databases, some sectoral bulletins, media reports etc. Some examples: European Drought Impact Database (EDID)[11]: The lack of standards on drought impact data collection, EDID provides EU Member States and other stakeholders with a structured template for systematically recording drought impact data.		

[11] https://europeandroughtcentre.com/news/european-drought-impact-report-inventory-edii-and-european-drought-reference-edr-database/

Alpine Drought Impact report Inventory (EDIIALPS)[12] is updated EDID focusing on the Alpine region. It classifies impact reports into categories covering various affected sectors and enables comparisons of the drought impact characteristics.

Knowing which drought impacts have affected our society and ecosystems in the past gives us the opportunity to investigate the risks of these impacts manifesting again in the near and distant future. Risk assessment can use impact information not only to find out which drivers contribute to a specific type of drought risk and how they interact, but also to provide a quantitative estimate of the current levels of risk for different sectors and systems.

2.3. Mitigation, preparedness and response measures

Generally, it can be recognized that measures presented below are based on drought monitoring and assessment data and risk identification (see chapter above).

**bolded actions were prioritized by the stakeholders*

State of the art-from review	Recommendations	Action
PREPAREDNESS		
Enhance public awareness and education on drought risks and management.	**Integrate drought risk management into the national education curriculum.**	Partner with educational institutions and media to disseminate information on drought preparedness and risk reduction strategies
Cross-border cooperation in the field of drought and water scarcity address as a priority within the existing conventions	**Identify vulnerable border basins and parts of them close the borders of Kosovo and propose limits for the crisis solutions in the field of hydrological drought**	Use cross-border cooperation with NHMSs and relevant stakeholders, set up the join expert working group
Determine the priorities of the measures in accordance with local/regional conditions with a proposal of responsibilities, time and financial plan	Prepare an intersectoral discussion on the draft priorities. Compile the order of the proposed measures and submit it for public discussion	Make a survey of stakeholders in the Drin river basin on mitigation groups of action (proactive and reactive, etc.), in the sense of Annex of 1.3 Activity report
Prepare Plan for increasing of the storage capacity in the basins (reservoirs, water bodies and soil)	Initiate a study on the possibility of building new reservoirs, wells for drinking and technical water, implementing new water retention measures	Make an inventory of the current volumes of reservoirs, make an expert estimate of their sufficiency with regard to the future climate change, development of population, industry and agriculture.
Evaluate and design water transfer options and new water resources	Initiate a study on the exploitation of new water	Make an inventory of the current transfer of water between individual basins

[12] https://ado.eurac.edu/impacts

	resources and the future possibilities of water transfer	and to estimate its sufficiency with regard to the future development of climate change, the development of the population, industry and agriculture.
Review of the operation rules of reservoirs	On the basis of the relevant studies, confirm or update the existing operational measures of the reservoirs	Evaluation of the actuality of the operational rules of water reservoirs and the possibility of their modification in a changing climate
Prepare a plan for reduction of water losses	To develop and make surveys of the efficient uses of the water by the public and relevant sectors.	To quantify the losses and develop a plan to prevent them
Investigate options for improving water efficiency (in all sectors)	Preparation of study on the efficiency of water uses, covering both quantity and quality (drinking water, waste water and water used by industry and agriculture.	Preparation of the plan for sustainable and feasible efficiency of water pipes, irrigation systems, water use in industry and energy sectors, and waste water treatment.
Irrigation options and usage of more efficient system	Development of a study for the irrigation systems taking into account the modern and sustainable approaches.	Preparation of a List of the efficient irrigation systems usage from the point of view of the needs of agriculture in the time of changing climate
Involving of ecological aspects into account to sustain biodiversity (wetlands, reservoirs, rivers)	An inventory of the ecological status of the aquatic ecosystem potentially affected by drought events.	Proposal of the action to minimize the effect of drought on the aquatic biota.
Minimize soil erosion to prevent impact on soil, crops, vegetation and reservoirs	**Conduct a survey of the practices used in agriculture sector.**	Develop guidelines for framers to minimize the soil erosion for preventing damages on crops, vegetation and clogging reservoirs and lakes.
Improve agrotechnical practices (new varieties, changes in agronomic terms etc.) in relation to drought	Review of the Best Available Practices and Methods used in EU countries.	Disseminate such Review among the farmers and develop training for them for implementation such new practices.
Prepare a plan for water supply restrictions during drought (farmers, municipalities, etc.)	Carry a research on visible and acceptable restriction for inappropriate uses of the water during and after drought events.	Development and enactment of a legal act (decree or regulation) on restrictions to be applied during drought events.

Establishing and operating a Future Drought Fund, to enhance drought preparedness and resilience	Investigate the capacities of the state budget to create Fund for drought mitigation and for compensation of the damages.	Development of the Regulation on Drought Fund for preparedness and resilience.
RESPONSE		
Review existing response strategies and preparedness measures for drought mitigation	**Strengthen and diversify drought response measures with a focus on sustainable water use and conservation**	Implement water conservation programs, develop emergency response plans for severe droughts, and promote drought-resistant agricultural practices
Develop public-private partnerships for drought resilience projects	Encourage community-based drought management initiatives	Launch pilot projects in vulnerable communities to test and refine drought resilience strategies, including water-saving technologies and community awareness programs
Elaborate the Rehabilitation/recovery programs	**Droughts can make damage on soil, water resources, and ecosystems. Hence, a thorough analysis of these drought impacts is should be done**	Guidance on the development rehabilitation and recovery program due to drought impacts.
Insurance compensation	Government should be prepared to compensate the damages caused by drought events.	Development of the legal document, where conditions will be defined to receive the compensation.

3. Legislation and institutional set up

3.1. EU approach towards preventing and mitigation water scarcity and drought

The Water Framework Directive, adopted in 2000, provides a suitable framework to address water scarcity and drought. The directive promotes sustainable water use via the long-term protection of available water resources and the mitigation of the effects of droughts, contributing to guaranteeing a sufficient supply of good quality surface water and groundwater and protecting territorial and marine waters. The recognition that water quality and quantity are closely related within the concept of 'good status' is fundamental in addressing quantitative water management challenges. EU countries implement integrated river basin management through River Basin Management Plans required by the Directive, and some have adopted Drought Management Plans for vulnerable river basins.

In below chapters, recent developments on Water Scarcity and Drought Risk Management at EU level are emphasized.

3.1.1. Laws and actions

EU introduced several climate adaptation activities in the 2022-2024 Work Programme for the Common Implementation Strategy (CIS) for the Water Framework Directive and the Floods Directive. An **Ad-hoc Task Group on Water Scarcity and Droughts** was established, leading to technical discussions on how to improve water management in the changing climate, particularly addressing increasing droughts and water scarcity. CIS guidance and thematic documents support water quantity management: the 2015 Guidance on Water Balances, Guidance on Ecological Flows and the 2009 Guidance on River Basin Management in a changing climate.

Water scarcity and droughts are recognised as a priority in the European Green Deal and are reflected as such in several major European strategies EU Strategy on Adaptation to Climate Change, 2020 Circular Economy Action Plan and the Biodiversity Strategy for 2030.

The first EU policy on water scarcity and droughts was defined by the 2007 Communication Addressing the challenge of water scarcity and droughts in the European Union, reviewed in 2012 as part of the Blueprint for Safeguarding European Waters.

Scheme: EU policies on water scarcity and droughts

Source: PowerPoint Presentation (unece.org)

3.1.2. Ongoing Developments on Water Scarcity and Drought Risk Management at EU level

a) Stock-taking Analysis and Outlook of Drought Policies, Planning and Management in EU Member States, *October 2023*

This report presents a stock-taking analysis of drought policies, planning and management in EU and an outlook of planned work within the countries and EU levels. It has been developed based on individual country assessments of the corresponding legislation, planning and management, including the latest available versions of (draft) River Basin Management Plans in spring 2022, using a common questionnaire, as well as more than 70 interviews with countries and stakeholders and a wide review process.

b) European Droughts Impact Database (EDID), *2023*

Motivated by the lack of standards on drought impact data collection, EDID provides countries with a structured template for systematically recording drought impact data. This template offers the necessary flexibility in the data model to address specific requirements while retaining a core set of standardized features, enabling the description and comparison of drought impacts in a more consistent manner. Currently, database contains 20.202 recorded drought impacts covering 36 different European countries from 1970 –2022.

c) European Drought Risk Atlas, *October 2023*

Simulates impact of global warming on key economic sectors (agriculture, public water supply, energy, riverine transport, freshwater and terrestrial ecosystems) and with in some sectors also focus on selected product categories. Estimates potential future economic gains and losses due to increase/decrease of precipitation in a +1.5C, +2C and +3C scenario. Atlas is a step towards impact-based drought assessment and can support the development and implementation of drought management and adaptation policies and actions.

d) Network of EU Drought Observatories, *2022*

One of the main objectives of the European Drought Observatory for Risk and Adaptation (EDORA) project is to establish a network of Drought Observatories. The network of Drought Observatories in the EU (hereafter referred to as the network) aims to enhance the capacity of both the EU and the Member States to perform drought monitoring, early warning, and impact and risk assessment.

e) Ongoing work:

- Adaptation measures to droughts in various sectors
- Updated CIS Guidance 24 on river basin management in a changing climate
- Report on good practices on water allocation mechanism
- Report on Water scarcity and droughts in terms of RBMP and risk reduction

3.2. Recommendations and actions for the Kosovo Drought Management Plan

**bolded actions were prioritized by the stakeholders*

State of the art-from review	Recommendations	Action
Law No. 04/L-147 on Waters of Kosova This law regulates all issues with regard to the management of water resources including the legal status of water resources, management of water quality and quantity, institutional organisation etc. The law is expexted to be replaced by a new law shortly (during the first half od 2024) - the adoption of a new water law is in the process.	**In the subsidiary act to be enacted by the Ministry (MESPI) on the content of the River Basin Management Plan, formally stipulate the requirement for the development of Drought Management Plans as part of River Basin Management Plans (RBMP)**	Include drought management plans in the RBMPs in the Program of Measures part or as a seperate document
Law No. 05/L-042 on Regulation of Water Services This law regulates water services (which include water supply and wastewater services), and establishes Water Services Regulation Authority (WSRA) as an independent economic regulator responsible for licensing of water services providers, approving service tariffs, monitoring performance of water services providers, establishing service standards etc. With regard to drought, the law requires from water services` providers (Regional Water Companies) to develop drought management plans.	**Regional Water Companies (RWCs) should review and, if needed, update their drought management plans on regular basis, by taking into account dynamics/developments re: the legal and regulatory framework, the actual conditions of the water supply system, best available information on hydrometeorology and climate changes et.**	Request by the WSRA to the RWCs to update, as needed, their drought management plans. RWCs publish their drought management plans.

The development of a new law is in the process.		
Law No. 04/L-027 on Protection from Natural and Other Disasters This law regulates protection and rescue of people, animals, property, cultural heritage and environment against natural and other disasters, including drought as one of natural disasters as defined in the law. The law stipulates that it is the responsibility of the Government to organize and implement a monitoring and early warning system as well as to manage protection, rescue and assistance structures in cases of natural and other disasters.	**Establishment of a Drought Committee and assign the responsibility to supervise and coordinate the national drought policy development process and to implement the drought policy at all levels including the development and update of a national Drought Management Plan.**	A decision by the Government to establish a Drought Management Committee that should be composed of representatives of relevant national and local institutions including MESPI/RBDA, MESPI/HMIK, ME/PMU of POEs, WSRA, MAFRD, SHUKOS, AME (Agency for the Management of Emergencies). The Drought Committee should be entitled to establish specific working groups.
Law No. 02/L-9 on Irrigation of Agricultural Land This law regulates organisation and management of irrigation and drainage of agricultural land. The la defines roles and responsibilities of various parties in relation with the irrigation as well as the registration of irrigation companies and irrigation tariffs.	**Promote and stimulate water-efficient irrigation methods and systems.**	
Law No. 06/L-035 on Hydrometeorological Activities This law determines the manner in which hydrometeorological activities are conducted, early warning system and the products of	**Enhance institutional and professional capacities of HMIK so as it is capable of developing, upgrading and effectively managing a drought early warning system.**	HMIK to calculate low flow statistics for all river basins and also calculate and report monthly SPI (standard precipitation index) for all river basins.

hydrometeorological services.		

4. Kosovo Drought Community of Practice

Kosovo Drought Community of Practice serves as a dynamic network, uniting a diverse range of stakeholders such as researchers, policymakers, practitioners, community leaders, and affected individuals. It will foster networking, exchanges, and discussions on specific topics of interest to a limited group of people. Simultaneously, the community addresses broader water-related issues, encompassing aspects of Integrated Water Resources Management (IWRM).

Community will provide an environment for collaborative knowledge exchange, experience sharing, and innovative solutions, ultimately enhancing resilience and adaptation to the challenges posed by drought and changing climatic conditions.

What is Community of Practice?

The term Communities of Practice (CoP) describes a "group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger-Trayner & Wenger-Trayner, 2015). A CoP provides a platform for social learning, enabling stakeholders to network, share information, enhance their skills, experiment with new techniques, receive feedback, and collectively develop a practical understanding of a shared challenge or domain.

Kosovo Drought Community of Practice will serve a pivotal role as a dynamic network, uniting a diverse range of stakeholders. It will foster networking, exchanges, and discussions on specific topics of interest to a limited group of people.

Main objective is to engage experts and specialist involved in water sector, practitioners and other interested stakeholders (students, tutors of water disciplines from different educational institutions) specialists from different crosscutting sectors to discuss, debate and learn about drought in water management and establish synergies with other sectors, which will consequently result in its wider recognition, increased capacity, enhanced intersectoral cooperation and new implemented measures and projects related to drought.

The community will:

- Encourage networking among experts and practitioners by exchanging knowledge, experiences on specific issues related to Drought and risks monitoring in water management
- Strengthen existing partnerships and promote connections with other institutions and initiatives
- Encourage dialogue and collaboration as a means to inform and accelerate the development and use of effective drought tools
- Support policy development (to create space to continue the work of WG Group on Drought),
- Reduce the gap among the experts and practitioners by showcasing implementation examples and discussing the main implementation challenges.
- Fostering exchange of knowledge across sectors and countries (Science-practitioners-policy interface)

- Empowering its members by providing access to workshops, webinars, training and other capacity building initiatives.
- Sharing results, outputs, projects
- Create a friendly environment to discuss innovative ideas and develop new projects, serving as a platform to explore innovative technologies and research opportunities.
- Raise awareness on drought related aspects in water management by sharing the news, good examples, case studies and projects from different regions and contexts.
- Encouraging potential fundraising activities

5. Conclusions

5.1. Prioritized actions

The recommendations and actions listed above were discussed and prioritized during the national dialogue held in Pristina on 13-14 May 2024. This event brought together stakeholders involved in the implementation of these actions or who have influence over them. The table below summarizes the prioritized actions in a concise format.

	Recommendations	Actions
Drought monitoring	Establish joint monitoring capacity	Integrate meteorological, hydrological, groundwater, agriculture, and hydro-ecological drought assessments
	Upgrade drought monitoring systems	Incorporate advanced drought indices and multi-faceted data types for a comprehensive approach.
	Upgrade meteorological stations	Equip stations to measure wind, humidity, and solar radiation for better water balance and evapotranspiration data. Add advanced sensors (soil moisture, wind, humidity, solar radiation).
	Enhance monitoring systems	Integrate remote sensing data into drought assessments.
	Develop groundwater and hydro-ecological monitoring	Create a system for groundwater and biological quality element monitoring
	Develop an early warning system (EWS)	Integrate climatological, hydrological, groundwater, agricultural, and water supply data. Design a system with threshold triggers for timely drought risk management actions.
	Standardize data collection protocols	Review and standardize precipitation data collection.

		Implement real-time data quality checks and anomaly detection.
	Develop a compound drought indicator	Integrate SPEI with remotely sensed vegetation data and soil moisture models for comprehensive drought monitoring.
	Create an Integrated Drought Information System	Implement a platform combining various data types (meteorological, hydrological, agricultural, groundwater, remote sensing and environmental data) for real-time analysis and decision-making.
Drought impacts and risks	Develop comprehensive drought assessment methodology	Conduct sector-specific studies on drought vulnerability and risk (agriculture, water supply, ecosystem services). Utilize GIS and remote sensing for real-time impact assessment. Collaborate with local and international organizations to develop a geospatial drought impact monitoring tool.
	Analyze drought impacts	Conduct thorough analyses of drought impacts on soil, water resources, and ecosystems. Develop guidance for rehabilitation and recovery programs in response to drought impacts.
Mitigation, preparedness and response measures	Integrate drought risk management into education	Embed drought risk management in the national curriculum. Partner with educational institutions and media for drought preparedness and risk reduction dissemination.
	Enhance cross-border cooperation	Locate and assess border basins near Kosovo for hydrological drought crisis solutions. Establish a joint expert working group with NHMSs and relevant stakeholders.
	Study new water resources and transfers	Initiate research on new water resource exploitation and future water transfer possibilities. Inventory current water transfers between basins and evaluate sufficiency for future needs considering climate change and population growth.
	Update reservoir operational measures	Confirm or update existing operational measures based on relevant studies.

		Evaluate and possibly modify operational rules of water reservoirs to adapt to changing climates.
	Improve water use efficiency	Conduct surveys on efficient water use by the public and relevant sectors. Quantify water losses and develop prevention plans. Study the efficiency of water use, covering quantity and quality for drinking, waste, and industrial/agricultural water.
	Enhance infrastructure for water use	Create a sustainable plan to improve water pipes, irrigation systems, industrial water usage, energy sectors, and wastewater treatment. Develop a study for modern and sustainable irrigation systems. Compile a list of efficient irrigation systems tailored to agriculture needs.
	Promote sustainable agricultural practices	Conduct a survey of current agricultural practices. Develop guidelines to minimize soil erosion and prevent damage to crops, vegetation, and water bodies.
	Strengthen drought response measures	Implement water conservation programs and emergency response plans for severe droughts. Promote drought-resistant agricultural practices.
	Analyze drought impacts	Develop guidance for rehabilitation and recovery programs in response to drought impacts.
	Promote water-efficient irrigation	Encourage and promote water-efficient irrigation methods and systems.
Drought governance	Formalize requirement for the development of Drought Management Plans as part of River Basin Management Plans (RBMP)	Enact a subsidiary act by MESPI to require the inclusion of Drought Management Plans in River Basin Management Plans (RBMPs). Include Drought Management Plans in the Program of Measures part of RBMPs or as a separate document.

	Regular review of drought management plans	Regional Water Companies (RWCs) should periodically review and update their drought management plans, considering legal/regulatory changes, water supply system conditions, and the latest hydrometeorological and climate change data.
	Establish a Drought Committee	The government should establish a Drought Management Committee composed of representatives from MESPI/RBDA, MESPI/HMIK, ME/PMU of POEs, WSRA, MAFRD, SHUKOS, and the Agency for the Management of Emergencies (AME). The Drought Committee should supervise and coordinate the national drought policy development and implementation, including the development and updating of a national Drought Management Plan. The Drought Committee should have the authority to establish specific working groups as needed.
	Enhance HMIK Capabilities	Strengthen the institutional and professional capacities of HMIK to develop, upgrade, and manage an effective drought early warning system. HMIK should calculate low flow statistics and report monthly Standard Precipitation Index (SPI) for all river basins.

5.2. Conclusions and way forward

Kosovo faces a critical water crisis exacerbated by severe drought conditions and depleted reservoirs, with 90% of its water resources generated internally. Currently lacking a dedicated Drought Management Strategy, Kosovo relies on broader legal and strategic frameworks to address water scarcity and on regional drought management plans produced by regional water companies. This action plan aims to address these gaps by proposing a focused Drought Management Plan (DMP) and actionable steps towards more integrated drought management in Kosovo.

The plan emphasizes three core pillars of Integrated Drought Management.

For drought monitoring, it was recommended to establish a joint monitoring capacity integrating various types of drought assessments, including meteorological, hydrological, groundwater, agricultural, and hydro-ecological. Upgrading the drought monitoring systems was emphasized, incorporating advanced drought indices and diverse data types for a comprehensive approach. Meteorological stations should be equipped with advanced sensors to measure wind, humidity, and

solar radiation, enhancing water balance and evapotranspiration data. Additionally, integrating remote sensing data into drought assessments and developing systems for groundwater and biological quality monitoring were prioritized. An early warning system (EWS) was proposed, integrating climatological, hydrological, groundwater, agricultural, and water supply data with threshold triggers for timely drought risk management. Standardizing data collection protocols and developing a compound drought indicator combining SPEI with remotely sensed vegetation data and soil moisture models were also recommended. Creating an Integrated Drought Information System to combine various data types for real-time analysis and decision-making was highlighted as crucial.

In addressing drought impacts and risks, the development of a comprehensive drought assessment methodology was prioritized, involving sector-specific studies on drought vulnerability and risk. Utilizing GIS and remote sensing for real-time impact assessment and collaborating with local and international organizations to develop a geospatial drought impact monitoring tool were recommended. Thorough analyses of drought impacts on soil, water resources, and ecosystems were proposed, along with developing guidance for rehabilitation and recovery programs in response to drought impacts.

For mitigation, preparedness, and response measures, integrating drought risk management into the national curriculum and partnering with educational institutions and media for dissemination were emphasized. Enhancing cross-border cooperation by assessing border basins for hydrological drought crisis solutions and establishing a joint expert working group was recommended. Research on new water resource exploitation and future water transfer possibilities was proposed, along with inventorying current water transfers between basins. Updating reservoir operational measures to adapt to changing climates, improving water use efficiency through public surveys and prevention plans, and enhancing infrastructure for water use were also prioritized. Promoting sustainable agricultural practices, strengthening drought response measures, and promoting water-efficient irrigation methods were key actions identified.

In terms of drought governance, formalizing the requirement for the development of Drought Management Plans as part of River Basin Management Plans (RBMPs) and enacting a subsidiary act to include these plans were recommended. Regional Water Companies (RWCs) should periodically review and update their drought management plans, considering legal and regulatory changes, and the latest hydrometeorological and climate change data. Establishing a Drought Management Committee composed of representatives from relevant governmental and non-governmental organizations to supervise and coordinate national drought policy development and implementation was emphasized. Enhancing the capabilities of the Hydro-Meteorological Institute of Kosovo (HMIK) to manage an effective drought early warning system, calculate low flow statistics, and report monthly Standard Precipitation Index (SPI) for all river basins was also recommended. Capacity building within Kosovo's Hydro-Meteorological Institute (HMIK) is highlighted to strengthen drought early warning systems and technical expertise. Public awareness campaigns will also be pivotal in fostering community participation and promoting drought resilience.

6. Annexes

Annex 1: State of the art analysis

Annex 2: Selection of a set of measures to mitigate the drought impacts in Kosovo

Annex 3: Kosovo Drought Community of Practice charter