D.T3.2.1.Report on key bottlenecks for the implementation of services and their requirements - transnational report

D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply - transnational report

D.T3.2.3. Local application: recommendations for optimal governance structures for resilient water supply - transnational report

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Contents

1. Introduction

Task description from the Application Form:

Specific component of the water supply resilience is inter-agency cooperation (Utilities, Civil Protection, Water Agencies), but also other i.e. health system etc. Inter-agency communication should be efficiently performed under different circumstances (regular, contingency) with standardized procedures. These services will be addressed under this WP3 as a part of strategy development.

After identified bottlenecks in the pilots (WP T2) and in general (WP T1) the main key services that are still missing will be identified and descripted (planning, logistics, public communication, interagency cooperation service, communication/messaging section, situation service) and their linkage.

In Activity T3.2, key services for the implementation of the multi-hazard management tools and strategies are developed.A.T3.2 is generally approached as it is presented in Figure 1.

- D.T3.2.1 is a Report on key bottlenecks for the implementation of services and their requirements
- D.T3.2.2 is a deliverable on Key guidelines for improved inter-agency operation services in the field of resilient water supply
- D.T3.2.3 is a deliverable on Local application: recommendations for optimal governance structures for resilient water supply

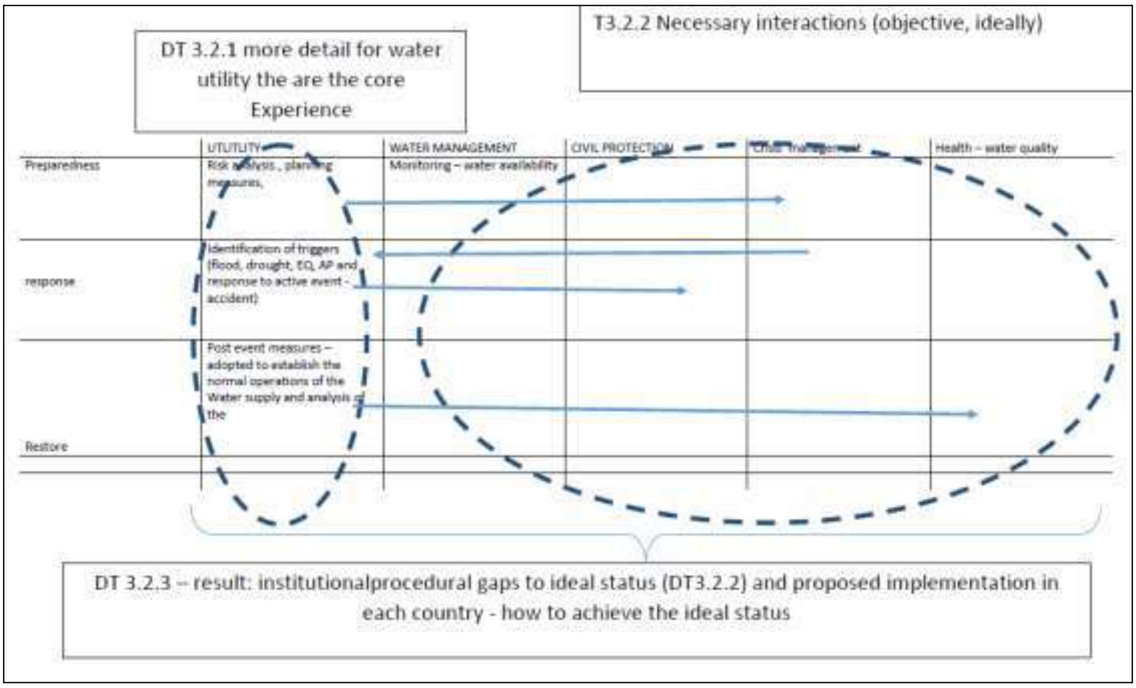

Figure 1 Activity 3.2 Key services for the implementation of the multi-hazard management tools and strategies

The reports are adapted to each specific country reality - availability of information, communication process, legislation, number of utilities, etc.

All project partners, who were assigned for this task, they followed this procedure:

1) Prepare a **draft** of the report covering the key questions (following paragraphs).
2) This deliverable (draft document) was advised to be **communicated to the stakeholders** (association of water utilities, water supply service regulators, water utilities, health authorities, association of local communities, and similar), in order to get their **reply/improvements/comments** – not necessarily official approval. Their responses could be incorporated in the final document.

2. Key questions for D.T3.2.1 D.T3.2.2 D.T3.2.3

D.T3.2.1. Report on key bottlenecks for the implementation of services and their requirements - "name the country"

Identification of gaps and weaknesses identified in WPs T1 and T2 and implemented specific tools developed in T3.1 with recommendations drafting the necessary solutions.

Based on the results from the national consultations carried out under DT1.1.1. describe Water Safety Plans development & implementation status (providing feedback for the progress – if applicable).

Point out the issues of your concern stem from the consultation main outputs that will be under consideration within the activity 3.2.

NOTE: WSPs' implementation status is the basis for the PPs experience and their ability to identify key bottlenecks in terms of water services requirements under the MUHA project perspective.

Based on the information reported in D.T2.2.4.- Evaluation reports for each pilot action - MUHA Toolbox- identify the capabilities provided by the toolbox in your case (advantages and disadvantages with respect to water service requirements, identified gaps), focus on the aspects in the following paragraphs 2.1 &2.2

Evaluation of the toolbox in making of PA Water Utility WSP

Evaluation of the toolbox in making of PA Water Utility WSP (missing parts/additional information, reporting requirements, difficulties in the use of the tool-implementation bottlenecks and reliability issues. Consider difficulties in the use of the tool-implementation, bottlenecks and reliability issues, reevaluation requirements will also be assessed and included.

In this context, structure your analysis on the following:

<u>General comments (link to WPT2 reports)</u>

- Is the reporting structure of the toolbox useful for the development of WSP?
- Is there any specific report that is not exported from the MUHA Toolbox? Can you recommend any (e.g. near misses recording)?
- Which kind of information included in the MUHA Toolbox is considered as the most useful for the development of the WSP?

- Are there additional information/data you started collecting after the use of MUHA toolbox? why?
- Which do you think should be the MUHA toolbox re-evaluation period?
- Which do you think (in your case) is the appropriate timeframe for the revision or update of the WSP?
- Are there "components" of your water supply system not considered or partially considered by the MUHA toolbox? If so, which ones?
- Is the MUHA toolbox comprehensive of all the hazards potentially impacting on the analysed water supply system (WSS)? Can you indicate possible hazardous events not included in the toolbox?

"Drought" hazard

- Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?
- Are there hazardous events due to drought considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?
- Are there hazardous events due to drought considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?
- Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?
- Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the drought hazard?
- Does any other institution of your country play or would play a specific role for developing a water safety plan related to the drought hazard?

"Flooding" hazard

- can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?
- Are there hazardous events due to flooding considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?
- Are there hazardous events due to flooding considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?
- Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?
- Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the flooding hazard?
- Does any other institution of your country play or would play a specific role for developing a water safety plan related to the flooding hazard?

"Accidental pollution" hazard

- Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?
- Are there hazardous events due to accidental pollution considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?
- Are there hazardous events due to accidental pollution considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?
- Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?

- Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the accidental pollution hazard?
- Does any other institution of your country play or would play a specific role for developing a water safety plan related to the accidental pollution hazard?

“Earthquake” hazard

- can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?
- Are there hazardous events due to earthquake considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?
- Are there hazardous events due to earthquake considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?
- Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?
- Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the earthquake hazard?
- Does any other institution of your country play or would play a specific role for developing a water safety plan related to the earthquake hazard?

Evaluation of PA goals fulfillment

Considering the information reported in paragraph 2.1, point out the contribution of the MUHA toolbox to the fulfillment of your goals. Except for the usefulness of the toolbox provide information on the other parties/actors (at the external environment of the Water Utility-) that are directly involved in the Water Safety Plan development and implementation (e.g. Institutions/organizations, regulatory or civil protection authorities).

NOTE: Based on the information reported in WP1 to focus on the stakeholders that directly related to the water services management (Water Utility level) under multi hazard risk analysis and management.

Addressing weaknesses/bottlenecks in the implementation of the multihazard management – Water Utility Level

After identified bottlenecks in the pilots (WP T2) and in general (WP T1) the main key services that are still missing will be identified and descripted (planning, logistics, public communication, interagency cooperation service, communication/messaging section, situation service) and their linkage.

Based on DT3.1.1, DT3.1.2, DT3.1.3, DT3.1.4, from SWOT analysis at Water Utility Level, determine the weaknesses and gaps in terms of services requirements. The outcomes of the SWOT analysis will be the baseline to extend your analysis in order to include possible inter-services and interdependencies (if applicable) in overcoming the weaknesses of Water Utilities. Use the results of consultations with stakeholders (water operators, agencies etc.) on the deliverables of Activity 3.1. and provide recommendations to address the issues of your high concern (identify good practices – if applicable-).

NOTE: Please mind that the above requested information should go a step further from basic reports of previous deliverables, facilitating the scope of action planning and strategy development. In this context try to stay in line with the simplicity, clearness and applicability of the guidelines will be produced within WP3.

D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply - “name the country”

Guidelines to overcome gaps and weaknesses identified with the improved water safety plans. The guidelines will be based upon the ICS (Incident Command System) theory. In addition, guidelines should be structured on the Inter-agency operation services that strongly affect the capacity of the key water services (water utilities, water authorities-local/regional level, institutions) to meet incident requirements (within the framework of the mutlihazard risk analysis and management). It is noted that coordination between the different Bodies in ordinary conditions should also be considered.

Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs)

To this end, input from DT 2.3.1Validation of implemented Improved Water Safety Plans (IWSPs) and implemented measures in PAs will be used. Information regarding the overall evaluation on the efficiency and effectiveness of implemented IWSPs and measures performed in PAs within the MUHA project will be the basis for drafting the guidelines, while some hints could be found also in DT 1.2.4 “Report on cross-institutional procedures”

Table Top Exercise Results to define and bridge inter -agency operation services

Given that Table Top Exercises support bridging the gap between Civil Protection Authorities and other water cycle managers (Water Authorities) and service providers (Water Utilities), information reported in DT2.3.4 Reports on the performed table-top exercises can also be used by the 5 PPs of Pilot Actions that will perform TTEs.

Key guidelines

Based on the paragraphs 3.1 and 3.2 proceed to the guidelines for the improvement of inter-agency operation services toward the resilient of water supply.

Guidelines should be structured (at least) on the following points:

- Clear definition of the scope of the provided guidelines/requirements,
- Identification of institutional actors and stakeholders
- Recognition of existent procedures
- Emergency Planning Process,
- Water System Information,
- ICS Integration and Organization, Operations,
- Communication Procedures (Command Chain),
- Restoration and Recovery Activities.

Guidelines should be focused on ICS Integration and organization, where inter agency services plays a crucial role.

NOTE: Internal consultations/structured personal interviews within water services of PPs are proposed in order to identify substantial dimensions like goals and sub goals of the entities oriented to the enhancement of water supply resilience (planning and finance are among the most fundamental factors that should be included). Consultation/interviews procedures could be implemented for drafting recommendations regarding the core elements of the ICS: management ("Command" at the Field Level), Operations, Planning/Intelligence, Logistics and Finance/Administration.

D.T3.2.3. Local application: recommendations for optimal governance structures for resilient water supply - "name the country"

This deliverable will analyse status of the governance structures necessary for resilient water supply and suggest feasible implementation options.

- **Input from DT1.1.1 Report on National consultations on water supply safety mechanisms, DT1.2.4 - Report on the cross-institutional procedure & D.T1.1.3 - Report on status of Civil Protection Response Mechanisms – water related plans and procedures**

  - Provide the entire scheme (STRUCTURE/FLOW CHART) of institutional relations at these levels of governance that directly reach the water utility level, interactions and relations between the parties involved necessary to build the resilient of water supply.

  - Have all institutions involved developed and issued management plans (addressing measures for accidental pollution, flooding, drought and failure of critical infrastructure due to earthquakes). Do they include in their plans measures for resilient water supply.

  - Define the gaps (in terms of structure, communication, collection of data, reporting, post event analysis, and consensus on important decisions).

  - Propose corrective and preventive actions

NOTE: To deal with the aforementioned aspects, paragraph 3.2 and 3.3 should also be the basis for drafting of recommendations. Special focus on mapping of the key players, inter agency services and operational capabilities/gaps is proposed in order recommendations to be structured on a practical/feasible basis.

PPs could define the "local scale" according to their case. Thus the final action plan at local level could cover all PPs cases (e.g. municipal, regional structures that interact with the water utilities or even a national authority). Local scale could be referred to the area of utility and involved services' jurisdiction.

To increase the robustness of the DT3.2.3, information stemming from focus group discussions/personal (structured) interviews related to governance structures could be used.

3. DT3.2.1 transnational report - common issues & differences

Country	General	Droughts	Accidental Pollution	Floods	Earthquakes
IT	• Setting up a multidisciplinary team involving also all the institutional data providers • For medium and large water supply systems it is necessary to develop different water safety plans related to different subsystems • Consider the spatial connections of the different components of a water supply system, possibly based on structured geodatabase • Connection with existing external database • Tools adopted for risk analysis by the water utilities officially endorsed by the national control Institutions • Use of models to analyse direct monitoring data	• An update analysis of the current modification of the precipitation and temperature regime appears • Development of a centralized database	• Link to the environmental monitoring network of the exploited water resources - Database collecting real-time data • increase the frequency of monitoring by adopting real-time or quasi real-time monitoring techniques • Database for mapping sources of contamination	• Availability of flood hazard maps for the whole territory to be included in the WSPs • Use of the high-resolution satellite data • Description of the WSS on a GIS basis, for all MUHA hazards	• Interaction with environmental and hydro-geological agencies • Update the current status of the WSS infrastructures and their actual vulnerability to seismic events

SL	• Lack of legislation that includes mitigation and adaptation to climate change • Large number of small water utilities	• Transfer planning of water scarcity from local to national level • Forecasting model to define hydrological water deficit	• -lack of internal information	• flood proof pumping stations are needed; • Improved planning on areas exposed to erosion; of water supply system; on landslide areas.	• aged infrastructure is currently under intensive rehabilitation investment cycle to improve resilience • Include advice in the WSPs on operational inspections and inspections of infrastructure after earthquakes
CR		• Growing water demand in the summer periods (growing population, increasing agricultural demand etc.) due to the amount of water for water supply is reduced, the reason for which is the occurrence of drought • longer periods of drought, which lead to a lack of available fresh water and thus to an inability to meet the increased water demand, can lead to water crises	• lack of skilled staff in small WU • lack of technical and financial resources in small WU and • poor water supply maintenance in some smaller WU	• not awarded enough of the existence of residual flood risks and the inability to ensure full flood protection • lack of technical resources in small WU • in some places old infrastructure • not enough activities to monitor the functionality of flood defences systems, and their maintenance	• no official list of the impact of the earthquake on drinking water sources or water supply networks • an impact of earthquakes on the infrastructure (for example, older water supply pipes, - damage to pipes or a possibility of corrosion) • possible changes of the chemical composition of the water and turbidity (sand in the water) due to the consequences

					of liquefaction • turbidity of water in water wells (for example, the water in the public water supply system may not be satisfactory for a long time; a recommended measure: boiling drinking water) • possibility of elevation of heavy metals' concentration in waters affected by the earthquake and presence of dominant ions in groundwater for up to a year after the earthquake
GR	• Adoption of an innovative monitoring system for real time water quality monitoring • Development of the Master Plan that provides for water supply in a long-term time frame • Regular evaluation of the effectiveness of the WSP, by	• Development of teams consisting of both water utility members and external ones, such as local civil protection representatives, water users, etc • Increase the availability of internal and external data sources	• Development of a vulnerability plan for accidental pollution • Use of sophisticated tools such as the hydraulic simulation model of the water network for the assessment of the impacts of such a hazard	• Increase cooperation of civil protection organizations with the water utilities in case of a flood event • WSPs teams should consist of external members including a representative of the civil protection services • Creation of a	• Development of databases at regional level for recording of incidents (and relevant information), response/mitigation measures. • Development of regional/ local cooperation networks with the participation of institutes and

	both internal and external inspections • Development of a data base for systematic and standardised recording of hazardous incidents • Use of integrated simulation models (for hydraulics & water quality) of the water network should support water pollution impacts assessment • Adoption of an organised sequence of standardized procedures for internal cooperation (work allocation and communication flow) among the different departments of a water utility • External information provided by other institutions/authorities (if any) should be incorporated in the available data		• Increase availability of external information related to accidental pollution	specific registry for failures related to floods	interdisciplinary groups of experts • Involvement of civil protection representatives in the WSP team as external members is considered of high importance • Research Institutes and Universities could participate in the development of WSPs as they could provide their expertise

	• Exploring the possibilities and the way of high skilled staff recruitment • Improvement of inter -agency operation through participation of external members in the Water Safety Plan team				
Country	• General	• Droughts	• Accidental Pollution	• Floods	• Earthquakes
SR	• Difficulties in the treatment processes of the north part of Serbia • WSPs do not consider accidental pollution • Aged infrastructure	• On many sources water availability has a decreasing trend due to several reasons. • Limitedness of resources (technical, financial) particularly in small WUs. • Not always qualifying stuffs capable to do the best when Drought situation occurs, particularly in small WUs. • Global warming increase water demand and decrease water resources availability. • Likely worse	• Accidental pollution with smaller impact (like turbidity) are often neglected, especially in smaller community. • Not qualifying stuffs capable to do the best when AP situation occurs, particularly in smaller WUs. • Limitedness of financial resources.	• Lack of funds in WUs. • Flood risks zones are not properly addressed in the RB and spatial plans at the local level. • Floodplains uncontrolled urbanization.	• Limitedness of resources (technical, financial) make repairs difficult when earthquakes happen. • The most vulnerable are cities and regions with a lot of old infrastructure, more present on the south than in the other regions.

		precipitation pattern occurs related to extreme events.			
MN	• -	• Significant level of water losses in water supply systems. Limited storage capacity in some WUs	• Insufficient number of qualified and experienced staff. • Inadequate technical capacities in small WUs. • Significant level of water loss in individual WUs.	• Some municipalities do not have adopted plans for protection from floods • Lack of plans for protection from floods for WU • Aged infrastructure • Lack of qualified staff	• Aged infrastructure. • Limitedness of resources especially in smaller water supply companies. • Insufficient number of qualified and professional staff.

4. DT3.2.2 - transnational report - key issues, TTX results & guidelines similarities & differences

Country	General	Droughts	Accidental Pollution	Floods	Earthquakes
SR	• Difficulties in the treatment processes of the north part of Serbia • WSPs do not consider accidental pollution • Aged infrastructure	• On many sources water availability has a decreasing trend due to several reasons. • Limitedness of resources (technical, financial) particularly in small WUs. • Not always qualifying stuffs capable to do the best when	• Accidental pollution with smaller impact (like turbidity) are often neglected, especially in smaller community. • Not qualifying stuffs capable to do the best when AP situation occurs, particularly in	• Lack of funds in WUs. • Flood risks zones are not properly addressed in the RB and spatial plans at the local level. • Floodplains uncontrolled urbanization.	• Limitedness of resources (technical, financial) make repairs difficult when earthquakes happen. • The most vulnerable are cities and regions with a lot of old infrastructure, more present on the south than in the

		Drought situation occurs, particularly in small WUs. • Global warming increase water demand and decrease water resources availability. • Likely worse precipitation pattern occurs related to extreme events.	smaller WUs. • Limitedness of financial resources.		other regions.
MN	-	• Significant level of water losses in water supply systems. Limited storage capacity in some WUs	• Insufficient number of qualified and experienced staff. • Inadequate technical capacities in small WUs. • Significant level of water loss in individual WUs.	• Some municipalities do not have adopted plans for protection from floods • Lack of plans for protection from floods for WU • Aged infrastructure • Lack of qualified staff	• Aged infrastructure. • Limitedness of resources especially in smaller water supply companies. • Insufficient number of qualified and professional staff.

Country	KEY ISSUES/BOTTLENECKS/ SUGGESTIONS

IT	1. Overlapping, unclear allocation of roles and responsibilities. Difficult coordination between urban water use, agriculture, land use and energy policies 2. General lack of mutual knowledge of the roles and competences of each participant 3. Lack of technical capacity, staff, time, knowledge and infrastructure, resources (mainly economic) 4. Lack of common information frame of reference 5. Conflicting use of the shared resources due to multi-purpose WSSs 6. Lack of citizen concern about water policy and low involvement of water users association 7. Lack of structured decision-making processes and limited availability of scientifically-sound tools and methods	8. Institution of permanent Observatories of Water Uses 9. Organization of “light” TTXs 10. Set-up of a regional coordination table 11. Set up of common databases acknowledged by all the public and private bodies involved in the water management 12. Set up of a more efficient communication system (platform with limited access to key actors) 13. Set up a strategy of shared communication towards the citizens (shared templates) 14. Development of documents with examples, best practices, guidelines, lessons learned

SL	1. For the water supply emergencies there is no state level planning framework (protection and rescue plans), but there is some planning framework on the regional and especially on the local level (municipalities / water utility). 2. Civil protection HQ should have up-to-date spatial information about all core water supply components (capture, pumping stations, transport pipes). 3. Organization of complex TTXs with stakeholders for different hazardous events 4. Training and exercises for all participants 5. Up-to-date spatial information of Civil protection HQ, about all core water supply components (capture, pumping stations, transport pipes) 6. Setting up a database on the availability of spare parts 7. Setting-up stakeholder cooperation (especially municipality – water supply department, civil protection department and/or HQ of municipality and water utility) for the preparation of emergency response plans
CR	Input is necessary from DT 2.3.1. and DT2.3.4 (not finalized yet)
	KEY ISSUES/BOTTLENECKS/SUGGESTIONS
GR	1. Cooperation among the various departments-combined work and data from many sub-sectors of the utility (preparation phase) 2. Instruments to facilitate inter- sectoral cooperation inside the utility (a data basis gathering data shared by all the departments) 3. Continuous funding is necessary for the implementation of the proposed measures 4. Human Resources for monitoring of WSP's implementation & staff engagement for continuous implementation 5. Integration of the WSP in "day to day business" on the basis of a constant cooperation among Managers 6. Administration support to result- oriented WSP implementation 7. Establishment of a command chain 8. Establishment of a core group for emergencies 9. Ensuring that all stakeholders and services will get the fullest possible information 10. Conduction of exercises (extended to full scale implementation) 11. Technologies and procedures for public information

	12. Proper allocation of human resources (in the field) 13. Recording the contact details of the key response partners and regular update of the related information 14. development of contingency plans 15. Adoption of written procedures and instructions based on the experience and lessons learnt from past incidents 16. Identification of resources on hand and assessment additional resources needed 17. Maintenance of the necessary equipment and development of alternative communication networks 18. Clear mapping of the key agencies 19. Early integration of crisis management team of the water utility into the relevant authorities' crisis management system 20. Joint exercises by the agencies involved at the area of water of utility (local level) should be performed in a regular base . 21. The establishment of the command chain and line of succession plan (at water utility's level) / An Incident Notification Flow Chart 22. Development of a Water Utility Emergency Operations Centre (EOC) 23. Internal communications and notification lists 24. Communication Strategy 25. Restoration and Recovery Plan 26. Public information 27. Development of a Training Plan for the Staff 28. Incorporation both the preparedness and rehabilitation interventions in water systems in the investment activity and in their master plan
Country	KEY ISSUES/BOTTLENECKS/ SUGGESTIONS
SR	1. Development of the Water supply information system (Scada), 2. Continuously WUC's staff education, 3. Continuously improvement of WSPs in WSS, 4. Using defined Toolbox in MUHA project, and it further development, 5. Development of Cooperation between relevant actors (WUC, National and Local Civil Protection agency, and other relevant Institutions),

	6. Development of the Water source availability, including treatment and distribution network, 7. Development of the procedures for all type of hazards 8. Improvement availability of information about the Water supply system, 9. Improvement of WUC staff's knowledge regarding the national legislation, and existent procedures, 10. In addition to Civil protection Agency, and relevant Ministry, identification of other institutional actors and stakeholders (like Universities, Institutes, private companies), 11. Improvement of WUC staff's knowledge regarding the functioning of National or/and Local Civil Protection and Rescue Service, 12. Cooperation WUC and Local Civil Protection and Rescue Service, including implementing TTX occasionally, 13. Improvement of WUC staff's knowledge related to possible hazard events, relevant for their WSS, 14. Defining of Emergency Planning Process, including Communication Procedures (Command Chain), 15. Defining of funds and the way of Restoration and Recovery Activities, B. Related to Drought hazard 1. Doing continuously analysis of all relevant patterns related to drought occurrence possibilities, 2. Plans preparation and construction of alternative water sources, with adequate treatment and distribution to the relevant point of existing WSS, C. Related to Accidental pollution hazard 1. Improvement of knowledge related to predictive (and possible) different Accidental pollution situation, 2. Improvement of cooperation with the relevant Institutes and Universities, 3. D. Related to Flood hazard 4. Upgrading and maintenance of monitoring system for flood prevention, E. Related to Earthquake hazard 1. Building Facilities in accordance with the seismic requirements for that region,
MN	

5. DT3.2.3 - transnational report - Local application: recommendations for optimal governance structures for resilient water supply

Country	planning inefficiencies, monitoring weaknesses, information gaps	
IT	• Overlapping, unclear allocation of roles and responsibilities • Mismatch between hydrological and administrative boundaries • Asymmetries of information between central and subnational governments • Lack of technical capacity, staff, time, knowledge and infrastructure • Lack of citizen concern about water policy and low involvement of water users association (OECD 2011) • Very limited interaction occurs with the users. • Increased coordination is required. • Improved coordination among WUs . • Improved cooperation with the CP. • Stronger interaction between the Civil Protection System and the water utilities c • Identifying a fast communication flow among agents in case of accidental pollution events potentially impacting on the quality of resources	• Water Utilities to be part, directly or indirectly, of the Observatories of Water Uses • Establishment of a technical coordination table, both at regional and district level • Continuous dialogue with the stakeholders • The role of the district basin Authorities must be strengthened • Consider specific key point for drafting the drought management plan • A drought management plan, and water scarcity in general, must include the possibility of a civil protection plan • Regular and periodic organization of TTX • Adoption of the "bottom up" approach • Customized model according to the types of WSS
SI	• No central body to coordinate the three key ministries • Disasters addressing water supply are not encompassed in the Slovenian legislation • Incidents related to the drinking water supply are not defined on a state level plan	• Necessity for improved definition of regions, together with their political, executive and financial mandate

Country	• planning inefficiencies, monitoring weaknesses, information gaps	
CR	• Water utilities are not authorized to implement TTXs • No updated data regarding staff, updated information on available staff, equipment or other necessary things which they can use in hazardous event (except their own). • Lack of communications between all the actors. • Lack of information about data, reporting, post event analysis, consensus on important decisions.	• Necessity to better connect civil protection and water utilities and give feedback regarding important matter in case of hazardous events. • Necessity to have operational plans if they use hazardous substances. Beside operational plan. • Necessity to perform field exercise on the location where they have hazardous substances every two years.
GR	• Planning inefficiencies: water utilities could be considered insufficient with significant delays even in their development. • Monitoring weaknesses: observed due to the lack of innovative monitoring technologies. • Information gaps: Utilities do not apply a standardised registry for failures related to disaster events. • At state level, a registry for drought events is not in place • Limited human resources.	• Establishment of regional cooperation networks with the participation of institutes and interdisciplinary groups of experts. • Development of databases at regional level for recording of incidents (and relevant information), response/mitigation measures. • Adoption of mutual agreements between water service providers in the wider area of a utility's jurisdiction on the basis of emergency planning and response support/assistance • Adoption of the involvement of interdisciplinary groups of experts as external members in the utilities' WSP teams • Joint TTXs • Development of applicable and practical communication patterns

Country	**planning inefficiencies, monitoring weaknesses, information gaps**	
SR	• WSP do not exist, or are not enough developed. • All numerated type of gaps exists	• Further developing communication and coordination between WUCs and CPA, • Providing significant funds at the municipal and national level for emergency situations, and their rapid activation when needed, • Continuously WUCs staffs education (especially

		high qualified youngers), • Upgrading monitoring system wherever is possible.
MN	• Civil protection system is not developed as it should be. • Communication with various instances of the system is almost non-existent, • Data collection, post-event reporting are not defined in the best possible way.	• Improving legislation in the field of civil protection and further improving the procedure of the protection and rescue system in Montenegro; • Improving the communication between the government and local levels in the protection and rescue system; • Improving the communication between the municipal structures of the system of protection and rescue and water supply companies; • Government investments in the field, especially in strengthening technical and human capacities

6. DT3.2.1, DT3.2.2, DT3.2.3 transnational report- Conclusions (correlations/recommendations)

- **Common issues (strategic level) should be 1st priority actions**

✓ Adoption of more proactive approaches, than reactive ones, oriented to preparedness, emergency responses and efficient operations

✓ Development of applicable and practical communication patterns

✓ Increasing interagency cooperation effectiveness, against the improvement of operational capacity of the entities in emergency conditions

✓ Adoption of organizational patterns

✓ Use of innovative technologies

✓ Interdisciplinary safety planning groups participating in the decision making schemes at the water utilities' jurisdiction area (local level)

✓ Development of databases for recording of incidents

- **Prioritization of differences**

✓ Adoption of the involvement of interdisciplinary groups of experts as external members in the utilities' WSP teams (GR)

✓ Joint TTXs (GR)

✓ Establishment of regional cooperation networks with the participation of institutes and interdisciplinary groups of experts (GR)

✓ Necessity to perform FSEs on the location where they have hazardous substances every two years (CR)

✓ Water Utilities to be part, directly or indirectly, of the Observatories of Water Uses (IT)

7. Annexes – National reports

a. Italy

DT.3.2.1

1. Evaluation of the toolbox in making of PA Water Utility WSP

This report summarizes the outcomes from the testing phase of the MUHA toolbox WASSP-DSS on the Italian pilot (the water supply system connected to the Ridracoli reservoir) focused on the four project hazards (drought, flooding, accidental pollution). In order to link the WPT2 to the WPT3 activities, feedback is structured according to the guidelines provided by UTH (WPT3 leader).

Some general conclusions are also provided to drive the draft of guidelines and strategy documents to be delivered by the WPT3 activities.

It is worth stressing that the provided comments are based on the knowledges acquired by CNR and DPC on the water supply system of Ridracoli through the specific activities performed so far and are not revised by Romagna Acque, the water utility entrusted of the management of the WSS. This is due to the fact that Romagna Acque acts as “gross supplier” for another larger water utility, Hera, which in turn is entrusted for the drinking water distribution to the Romagna coast. The Hera group is following other procedures for the development of water safety plans, shared among also with Romagna Acque. As a consequence, the latter provided general feedback on the use of the MUHA toolbox WASSP-DSS, but not specific feedback on the four hazards.

To introduce the specific analyses for drought, flooding, accidental pollution and earthquake, we reported here a short description of the pilot action already reported in DT2.2.4 (Evaluation report for each pilot action).

1.1 Description of the pilot action

The Ridracoli dam, one of the largest and most important dams in northern Italy, is an arch-gravity dam that blocks the Bidente River near the town of Ridracoli (Forlì-Cesena). The dam is built where the Bidente river meets the Celluzze stream, forming the artificial lake of the same name. It is 103 and a half meters high, with a maximum width of 36 meters at the base and, on the upper walkway, the width is only 10 meters (see Figure 1). The reservoir, managed by Romagna Acque – Società delle Fonti company, has a depth that can reach 82 meters and can store a maximum of 33 million cubic meters of water. The stored water is made drinkable by passing through a large drinking water treatment plant and is supplied to fifty municipalities in the provinces of Ravenna, Forlì-Cesena, Rimini and the Republic of San Marino, guaranteeing 950,000 inhabitants, as well as millions of tourists in summer, excellent water quality. The Ridracoli artificial reservoir is able to satisfy approximately 50% of Romagna's water needs and is part of a complex water supply system characterized, at a regional level, by a very high degree of network interconnection with the possibility of differentiating and integrating supplies with multiple types of sources, depending on the different needs and situations of availability. Potentially the Ridracoli aqueduct can also distribute resources from Bologna and Modena, but the water distributed with the Ridracoli reservoir as source is around 55 Mm3 per year.

Figure 1 – Ridracoli dam

The distribution network is organized into seven main delivery areas: Area 1: Santa Sofia; Area 2a: Faenza; Area 2b: Alfonsine; Area 3a: Cesena; Area 3b: Ravenna; Area 3c: Rimini; Area 3d: Gabicce. Water needs of each area, estimated at monthly scale, are partially met by the Ridracoli reservoir, the remaining part being supplied by “local resources” (generally wells) or “alternative resources”, namely waters from an irrigation canal diverted from the Po river and made drinkable after treatment in a water purification plant (NIP2).

In Figure 2, a topological scheme of the Ridracoli water supply system is shownFigure 2.

Figure 2- Topological scheme of the Ridracoli water supply system

Specific activities have been carried on the Italian pilot of the MUHA project, in relation to the following hazards: flooding, earthquake, drought, accidental pollution (microbiological pollution).

These are specific activities were designed on the Italian pilot, to improve the water safety plan of Romagna Acque - Società delle Fonti s.r.l. In the following a summary of the activities carried out on the Ridracoli pilot for each hazard are reported. For a complete description of the activities, please refer to deliverable DT2.2.2 Partner – specific pilot action documentation – Italy.

Fore sake of simplicity, the questions used to drive the analysis of each hazard are reported here below:

¤ *Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?*

¤ *Are there hazardous events due to drought (flooding/accidental pollution/earthquake) considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?*

¤ *Are there hazardous events due to drought (flooding/accidental pollution/earthquake) considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?*

¤ *Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?*

¤ *Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the drought (flooding/accidental pollution/earthquake) hazard?*

¤ *Does any other institution of your country play or would play a specific role for developing a water safety plan related to the drought (flooding/accidental pollution/earthquake) hazard?*

1.2 Drought

IRSA-CNR, supported by DPC and by Romagna Acque tested and developed the user-friendly tool *INOPIA$_{QGIS}$* on the Ridracoli water supply system. The proposed methodology (implemented as plugin in a software developed on a GIS open-source platform) is based on a guided procedure aiming at individuating the climatic conditions that can potentially lead to a significant decrease of the exploited water resources and to possible water shortages, considering both the existing infrastructure and the management options for multiresources-multiusers water supply systems. The Ridracoli pilot has been used as a benchmark of *INOPIA$_{QGIS}$* by comparison with the existing model with the aim of extending its use to other water supply systems of the ADRION area. Moreover, the tool provided information on the actual probability of occurrence of water shortage events on the analysed water supply system. These elements fed the MUHA toolbox for the "drought" section (see chapter 2.1).

¤ **Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?**

The Ridracoli water supply system is prone to water shortage crisis during periods of precipitation significantly under the mean. Significant drought events occurred in 2003, 2007, 2011, and 2017. It is worth stressing that in 2017 the Council of Ministers declared the "state of emergency" for water crisis after the request of the Emilia-Romagna region for the provinces of Parma, Piacenza, Bologna, Modena, Reggio Emilia, Ravenna, Forlì-Cesena, Rimini, the last three being supplied by the water supplied system connected to Ridracoli.

The testing of the MUHA tool on the Ridracoli WSS is able to evaluate the risks related to drought events on all the components possibly involved. However, the testing phase highlighted three main issues:

1. Ridracoli is a multiresources-multiusers water supply system, with different resources of the same typology (several well fields, springs and three purification plants). Risks related to each of them can be very different each other's: for example, in case of scarce precipitation one pumping station located close to the sea can be impacted by sea water intrusion, exacerbated by possible overexploitation, while another pumping station appear to be less prone to level decrease due to decrease of recharge. In such case, differentiating the risk assessment between the two sources appear to be mandatory. This issue makes necessary to develop different water safety plans related to different subsystem: for the largest water utilities this could imply developing tens of water safety plans, requiring large efforts in terms of necessary time and personnel.
2. For the same reason presented above, the user should have the possibility to duplicate some "components" or "subcomponents."
3. For most of the hazardous events related to drought we evaluated a probability of occurrence in the order of 10 years (maybe something less). Such a probability associated

with an assessed impact classified as “major” leads to an evaluation of risk estimated as “low”. This appears not to be correct, as impact of drought can potentially last for several months with serious concerns in water supply. The issue is related to the probability of occurrence which is not differentiated (in terms of categories) among hazards.

¤ Are there hazardous events due to drought considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?

In general, Romagna Acque has an optimal monitoring network to collect data representative of the actual status of the water resources. Moreover, the water utility uses several modelling tools, developed also by Italian universities and research centres, which effectively support the management (addressing of the water needs and allocation of the resources) both in ordinary and emergency conditions.

¤ Are there hazardous events due to drought considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?

Management of drought events are much improved when information on possible future precipitation are available (mid-term weather forecast, in the order of 3-4 months). In Italy these information are provided the “group for climate forecast” coordinated by the Department of Civil protection, and composed by several research institutions. This group provides a 3-month precipitation and temperature forecast, assessing the foreseen tendencies. However such kind of forecast is reliable over a time span of 2-3 weeks, while management of scarcity episode would need of forecast on at least 3-4 months.

¤ Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?

Most of the data used as input for quantitative management under emergency and ordinary conditions are directly collected by Romagna Acque or provided by other institutions (mainly Regional Environmental Protection Agency, ARPAE and Emilia Romagna region) and are of good quality. The use of the modelling tools allows for a sound estimate of the possible impact of reduction of water resources due to prolonged precipitation deficit. However, it is worth stressing that this kind of tools in Italy is in general not available for small and medium water utilities, preventing for a robust estimate of the drought impacts, while concerning the climate, data are usually available.

• Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the drought hazard?

So far, the National Civil Protection Service has not generally been involved in the activities aimed at drafting and developing the Water Safety Plans (WSPs) in relation to the drought hazard. On the other hand, there are no technical procedures or regulations at national level driving the involvement of the different components of the national civil protection service in the development of WSPs for drought.

However, it is believed that the National civil protection Service, in its different territorial components, could play a very significant role in the activities aimed at developing WSPs for the drought hazard. In particular, representatives of the National civil protection service could be part of the multidisciplinary teams, whose establishment for the purposes of drafting the WSPs is strongly recommended both by the international guidelines of the WHO (World Health Organization) and, at national level, by the National Institute of Health. These teams include not only members of the Water Utilities, but also external contacts from Administrations and stakeholders.

Within the aforementioned teams, and with particular reference to the drought hazard, the National civil protection service representatives could provide data and information useful for updating the event and impact scenarios, deriving from the operational

experiences of previous water crises, from critical issues recorded, from the studies and technical investigations performed, from the collaboration network with other institutional subjects, etc.

On the other hand, the civil protection activities aimed at reducing the risk could benefit considerably from the inclusion in multidisciplinary teams, being able to have access to data, information and knowledge sometimes not easily available and useful, especially as regards the knowledge of water infrastructures , the framework of interconnections between infrastructures, the water availability data, etc.

Many of the subjects who could be involved in the development of the Water Safety Plans are part of the Observatories on water uses based on the District basin authorities. These are collegiate bodies that collect, process and share data, information and knowledge regarding both the trend of meteorological and climatic indicators (in particular of precipitation and temperature), and the variation over time of water availability, both surface and underground.

• Does any other institution of your country play or would play a specific role for developing a water safety plan related to the drought hazard?

The development of a WSP related to drought is undoubtedly a complex undertaking which always requires multidisciplinary skills.

The international guidelines of the WHO (World Health Organization) and, at national level, the National Institute of Health strongly suggest the establishment of special multidisciplinary teams made up of representatives of numerous administrations and stakeholders.

Already today, in practice, numerous Administrations and stakeholders are involved in the development of WSPs.

With regard specifically to the drought hazard, and due to the almost universal use of water resources, it is considered advisable to involve in the development of a WSP relating to drought hazard not only the Public Administrations competent in various capacities in the management of water resources but also users and, in general, stakeholders.

For this reason, purely by way of example, and on the basis of international and national guidelines, it is suggested to involve in the drafting of a WSP for the drought hazard, the various offices competent for the territory in the field of drought prevention, and in particular, the district basin Authorities and the Regional Offices competent for the management of water resources, health aspects, water quality, civil protection, as well as the trade associations both with regard to drinking water uses, and for what it concerns irrigation, hydroelectric uses, etc.

In this regard, it should be noted that many of the subjects who could be involved in the development of the Water Safety Plans are part of the Observatories on water use based on the district basin authorities. These are collegiate bodies that collect, process and share data, information and knowledge regarding both the trend of meteorological and climatic indicators (in particular of precipitation and temperature), and the variation over time of water availability, both surface and underground.

Furthermore, the participation in the working group of representatives of consumer associations active in the territory or of local communities is certainly desirable as it can contribute to improving the system with respect to the expectations on the characteristics of the service and to know any local problems complained about on quality of waters or services.

1.3 Flooding

Within the activities of the MUHA project concerning the flood risk investigation, a study is carried out with the aim of analysing and verifying the lamination of the historical flood

events affecting the Ridracoli dam, which is the Italian pilot area selected for the project.
To this end, the first phase of the analysis concerns the reconstruction of the inflow discharge hydrographs during the most severe flood events occurred in the last years. Specifically, six major floods are selected for the study in the period 2010-2019.
The lack of level records at a monitoring station located immediately upstream of the reservoir, capable of representing the hydrograph coming into the dam, makes it necessary to proceed with the reconstruction of the incoming hydrographs. These are estimated by applying the LAMINA model (Castorani e Moramarco, 1995) starting from the knowledge of the released flow rate, the variation of the lake level and the reservoir curve, i.e. the lake level-storage volume relationship.
In detail, we first proceed to reconstruct the outflows from the reservoir, known the equations and graphs of the regulating devices, starting from the performed release manoeuvres. Then, based on the recorded lake levels and the available reservoir curve, we reconstruct the incoming discharge hydrographs, which are used during a second phase of analysis addressed to investigate different scenarios for the dam management. Specifically, the most severe discharge hydrographs affecting the reservoir during the last years have been considered as input to the reservoir by assuming different initial lake level conditions to test possible scenarios. These elements fed the MUHA toolbox for the "flooding" section (see chapter 2.2).

• Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?
The MUHA toolbox structure and its potentiality make the evaluation of the possible flood risk on the various components of the WSS possible. Basically, the tool is well planned for this analysis, but the present version only allows to identify the possible issues and to describe them through a text box. Even though quantitative information can be included in the description, the main limit of the available version of the tool is the lack of a GIS section that would allow the user to import maps and other geodata important to figure out the location and overlap of flood-prone/flooded areas and WSS components.
• Are there hazardous events due to flooding considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?
The toolbox allows to consider hazardous flood events and to indicate possible impacts on the WSS components. As already stressed, the lack of a GIS interface is an important limit that forces the user to develop the necessary comparison and investigation outside the tool. The flood hazard maps for different return periods represent the main input for the analysis. For the Italian pilot area, the Ridracoli dam, the necessary information would be: flood hazard maps downstream the dam and a lamination study for the reservoir. Currently, the downstream maps were not provided by the WU because an update study is currently on-going and official maps are still not available. Moreover, the WU during the past years developed deep studies on the management of water scarcity issue, but not on the lamination process to face flooding issues. Specifically, a first attempt to fill this gap has been carried out during the MUHA project activities concerning flood risk investigation: a study was developed with the aim of analysing and verifying the lamination of the historical flood events affecting the Ridracoli dam. To this end, the first phase of the analysis concerned the reconstruction of the inflow discharge hydrographs during the most severe flood events occurred in the 2010-2019 years. The reconstructed historical floods were used during a second phase of analysis addressed to investigate different scenarios for the dam management. These results are not enough to identify possible failure of the water withdrawn from the reservoir, even because no indications were provided by the WU.

• Are there hazardous events due to flooding considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?

External information on hazardous events due to flooding basically are the flood hazard maps developed for fixed return periods. The Italian pilot area belongs to the District Po Basin Authority. Currently, the system of the flood hazard maps is under review to be made homogeneous and updated. The available maps referring to the pilot area (Bidente-Ronco rivers) are hazard maps P1, P2, P3. P3 refers to 'Low probability' of floods or extreme event scenarios (500 years); P2 refers to 'Infrequent floods': return time between 100 and 200 years (average probability of occurrence); P1 refers to 'Frequent floods': return time between 20 and 50 years (high probability of occurrence). The above-maps can be downloaded by the web-site of the Emilia Romagna Region (both as pdf and shape files). However, the maps have to be compared with the WSS network and the analysis is required to be developed outside the tool where, currently, only the outcomes can be described. If the tool will be extended in order to allow importing GIS data, the analysis could be developed internally.

• Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?

The input data for the analysis about flood risk mainly concern flood maps. The official available maps are subject to strict controls before being approved and are the outcomes of complex chain of hydrological-hydraulic models and they refer to estimated data (they essentially describe possible scenarios). Therefore, if the information included in the tool derived from these maps, we can say that the data are reliable. The magnitude of flood waves for different return periods can be important data, but they are basically included in the flood hazard maps delineation. Other possible data refers to historical flooded areas; in this case, we refer to observed/measured data, but their reliability mostly depends on the way of survey. Traditionally, the information of the extension of the flooded areas were derived by fragmentary ground/remote data (e.g. pictures, videos, direct testimonies, indications derived from videos recorded during helicopter flights, etc.), therefore uncertainty can affect the identified area. Nowadays, the use of the high-resolution satellite data can represent a significant improvement for flooded areas identification also integrating different satellite images.

• Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the flooding hazard?

Floods come with huge costs in terms of lost lives and economic impact, and those costs are expected to rise significantly with climate change. Managing flood risk has traditionally focused on structural measures such as embankments and levees to keep floods away from urban areas. Increasingly, this traditional approach is seen as inadequate in managing the growing risk of floods. There are now calls for the employment of a diversity of approaches, and especially a larger implementation of non-structural measures. To date, the National Civil Protection Service has generally not been involved in the activities aimed at drafting and developing to the flooding hazard Water Safety Plans (WSPs). However, there are no national technical procedures or standards for involving the different components of the national civil protection service in the development of WSPs related to flooding hazard.

However, it is believed that the National civil protection Service, in its different territorial components, could play a very significant role in the activities aimed at developing WSPs for flooding hazard. In particular, representatives of the National civil protection Service could be part of multidisciplinary teams, whose constitution for the purposes of drafting WSPs is strongly recommended both by the WHO (World Health Organisation) international guidelines and, at national level, by the National Institute of Health. These teams include not only members of the Water Utility, but also external representatives from administrations and stakeholders.

The Italian civil protection service could currently play a specific role in the development of a water safety plan related to flood risk. In fact, the Civil Protection Department, within the implementation of the Floods Directive 2007/60/CE through the Legislative Decree 49/2010, plays a coordinating role between the Regions, the Autonomous Provinces and the District Basin Authorities. In particular, with point 8 of the Directive of the President of the Council of Ministers 24 February 2015 "Operational guidelines concerning the preparation of the part of the management plans related to the national, state and regional warning system for hydraulic risk for civil protection purposes as per Legislative Decree 23 February 2010, n. 49, implementing Directive 2007/60/EC", the Department of Civil Protection (DPC) has created, with the important support of the Institute for Environmental Protection and Research and made available to all competent authorities (Regions, Autonomous Provinces and District Basin Authorities) the FloodCat (Flood Catalogue) platform with the function of national catalogue of flood events allowing the systematic collection of information on past floods. FloodCat is a web-GIS platform with restricted access for CAs (Competent Authorities) developed in the wider context of the implementation of the Floods Directive 2007/60/CE (FD), implemented in Italy with the D.Lgs. 49/2010, with the aim of providing a unitary and homogeneous overview of flood events (Flood Events FE) occurred on the national territory and of the consequences occurred after such floods. The webgis data presented in this platform are implemented by the Regions, according to articles 4.2 b) and 4.2 c) of the Flood Directive, they are processed following the state of emergency requests and are geolocalized technical data - e.g. damage data - from which it is often possible to deduce the involvement also of aqueduct networks for human use.

•Does any other institution of your country play or would play a specific role for developing a water safety plan related to the flooding hazard?

Developing a WSP related to flooding hazard is undoubtedly a complex endeavour that always requires multidisciplinary expertise. Regarding flooding hazard, as indicated by the Flood Directive, the Italian national territory was subdivided into 47 Unit of Management over which 54 Competent Authorities had jurisdiction. The administrations and stakeholders are Regions, Autonomous Provinces, National, Interregional and Regional Basin Authorities, the Ministry of the green transition (former Ministry of the Environment) and the National Civil Protection Department. The Italian flood risk management was assigned to Regions, River basin Authorities, DPC and the Italian Institute for Environmental Protection and Research.

The review activities under the Floods Directive proceed in coordination with the review activities under the Water Framework Directive. The Water Framework Directive - WFD (Directive 2000/60/EC), establishes a framework for Community action on water resources, for the protection of inland surface, transitional, coastal and groundwater resources, in order to ensure the prevention and reduction of pollution, facilitate sustainable water use, protect the environment, improve the condition of aquatic ecosystems and mitigate the effects of floods and droughts, through the involvement of stakeholders and the public.

1.4 Accidental pollution

The accidental pollution of drinking waters is mostly owed to either the poor quality of the influent water or malfunctioning which may occur along the potabilization treatment train. The microbiological contamination levels following accidental contamination events are of great concern, since contaminated waters could be distributed and consumed before a microbial hazard is detected by the current cultivation-based monitoring approach.

The objective of this research activities carried out on the Ridracoli water supply system was to explore the use of innovative parameters for the real-time monitoring of water microbial

quality to complement the current assessments of microbiological contamination. We hypothesized that varying treatment and supply schemes will result in different microbial removal performances following the quality of the influent raw water (as affected by seasonal fluctuations), and the efficacy of water filtration steps.
It is worth stressing that the information collected through the activities described above allowed to feed the MUHA toolbox, in the section "pollution" only for the "biological contamination" (see chapter 2.3)

- **Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?**

In general, the MUHA toolbox is able to identify possible risks due to accidental pollution related to different components, from the Ridracoli reservoir to downstream. All the components possibly impacted by accidental contamination events are taken into account by the toolbox. Moreover, the catalogue of possible hazardous events related to accidental pollution appears to be complete.

- **Are there hazardous events due to accidental pollution considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?**

The dataset collected by the water quality monitoring system of the Ridracoli water supply system is in general able to characterize the actual risk level due to accidental pollution events. However, it is worth stressing that the management of pollution events could be improved if real-time assessments (e.g., through sensor-based approach) will be available for selected targets (e.g., inorganic/organic contaminants) to be evaluated from the different water sources.
Another issue to be accounted is the multi-hazard dimension of the microbiological contamination: in particular, an increase of harmful aquatic microorganisms during drought events is expected following the water temperature increase, but a reduced water turbulence will also reduce sediment resuspension and nutrient circulation in the water column. Further evidence is also required to understand the effects of flood waves on water quality, since (i) flood waves can increase the total load of suspended solids by soil/sediment resuspension, (ii) a larger flooding area could increase the water pollution sources.
Such "multihazard" risks cannot be evaluated through the MUHA toolbox, and needs further investigations, especially in a context of climate change.

- **Are there hazardous events due to accidental pollution considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?**

Some concerns arise from the quality monitoring of the exploited resources, in particular on the well fields used as alternative during the periods water shortage: the environmental monitoring is entrusted to the Regional Environmental Protection agencies (ARPA), that usually perform monitoring with a frequency not always adequate to prevent withdrawal of contaminated water. Moreover, possible sources of contamination (i.e. industries) are not systematically mapped. Among such "hazard centres" we can also mention the sewage systems in close proximity to the withdrawal sites that in case of failure can temporarily compromise the quality of source waters, either ground waters or surface waters.

- **Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?**

All additional water quality data, mostly including those assessed on-site and in real-time, can improve the reliability of management actions. In this regard, non-regulated water parameters can convey critical information to better support management actions.

▫ **Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the accidental pollution hazard?**

Until now, the National Civil Protection Service has not generally been involved in the activities aimed at drafting and developing the Water Safety Plans (WSPs) relating to the risk of accidental pollution. Nor there are national rules or procedures that foresee a formal involvement of the NCS at the various levels.

▫ **Does any other institution of your country play or would play a specific role for developing a water safety plan related to the accidental pollution hazard?**

According to what is extensively described in the "Water Safety Plan Manual-2009" Guidelines of the World Health Organization, taken up in Italy by the National Institute of Health (Istituto Superiore di Sanità) with the ISTISAN Report 21 of 2014 and also in the D.T. 1.1.4, the WSPs are developed and drafted by a multidisciplinary team of experts, with a transversal knowledge of the water supply system.

The Team is led by the Water Utility which will involve all the managers of the water supply chain, in terms of infrastructures, resources and processes for risk assessment and analysis.

As regards the accidental pollution hazard in Italy, it is considered advisable and appropriate to involve for the implementation of the WSP, in addition to the SNPC, the National System for the Protection of the Environment, constituted by the Higher Institute for Protection and Environmental Research and from n. 21 Environmental Protection Agencies of the Regions and Autonomous Provinces (No. 19 ARPA and No. 2 APPA), which carry out monitoring and control aimed at environmental protection of water resources and the water ecosystem. In particular, the ARPAs preserve the water resource, implementing, also through sector planning (Water Protection Plans - PTA and Water Management Plans - PGA), actions aimed at preserving and / or rehabilitating the water heritage from pollution and depletion of resources in quantitative terms.

As regards the assessment of risk on human health, it will be appropriate to involve, for the implementation of the WSP, the Local Health Authorities, which, through the Hygiene and Public Health Service, monitor the drinking water quality on the aqueduct network before distribution, in order to prevent the health risk resulting from environmental pollution.

Other actors who may be involved are: municipal and regional administrations which, based on regional and / or local laws, have administrative tasks regarding water protection; the non-profit environmental protection associations that carry out checks on the water system.

1.5 Earthquake

The present work aims at providing a summary of the methodological approach being used and of the preliminary activities undertaken at pilot level, with specific reference to the Romagna Acque case. Particularly, this section aims to provide an overview of the activities that are being performed to support the analysis of the drinking water supply infrastructure, focusing on the assessment of the impacts potentially associated to earthquakes. As will be discussed in the following, the approach is not hazard specific, and can therefore be potentially used for a multi-hazard analysis.

The key objective is to develop a straightforward tool that could be used for easily identifying and modeling the impacts of extreme events (including, but not limited to earthquakes) on a generic water supply system, as well as to aid decision-makers in the identification of potential solutions for improving system resilience. Starting from an overview of the most relevant approaches and methods used in the scientific literature, and based on the background and the previous experiences of the research group, a novel methodology based on the integration of multiple topological metrics through Bayesian Belief Networks is proposed and is currently being tested.

The main added value associated with the proposed model can be summarized as follows:
¤ it provides a simple yet effective approach to support a risk assessment of drinking water supply systems without using detailed hydraulic simulations or complex models. In principle, a topological scheme of the water distribution network (WDN) to be investigated, and only a few general information (e.g. pipe diameter and length) is needed to perform the analysis.
¤ It supports the analysis of the water supply system independent on the specific hazard under investigation, thus being in principle useful for a real multi-hazard assessment.
¤ It may be used both for the purpose of risk assessment (e.g. to analyze the impacts of failure scenarios) and for supporting the planning phase (e.g. to test and compare multiple resilience enhancing measures).

The information assessed through the described model fed the MUHA toolbox for the "earthquake" section (see chapter 2.4).
¤ **Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?**

The tool, in its current form, is suitable to support risk assessment for the different components of a water supply and distribution system. Particularly, all elements and potential hazards are clearly identified.
A remark is related to the difficult classification of earthquake probability of occurrence based on a temporal basis (e.g. weekly, annual, etc.). Other classifications for seismic hazard would be more suitable to characterize the hazard magnitude.
In general, adding spatial data (e.g. maps with the location of infrastructures and assets) would provide more detailed and distributed information on risk level over a complex infrastructural system, and help directly identifying suitable mitigation measures. Also, an explicit connection with existing database (e.g. seismicity maps) can provide an added value also in view of performing the risk assessment at the local scale (i.e. taking into account seismic micro-zoning). Lastly, it is worth to consider that both the issues raised before might also help better understanding the impacts ('severity of consequence') that depend on the location of the element being analyzed and on its role in network operation.
¤ **Are there hazardous events due to earthquake considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?**

The hazardous events considered are complete and provide comprehensive information on the potential impacts of earthquakes. However, typically, WUs lack updated and reliable information on the local state and conservation of infrastructures (particularly buried ones). This may have an impact on the correct assessment of the severity of consequences for each hazardous event.
¤ **Are there hazardous events due to earthquake considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?**

The hazardous events considered are complete and provide comprehensive information on the potential impacts of earthquakes. However external information might not be immediately available for correctly analyzing specific events, such as e.g. the risk of contamination of water source (both SW and GW, as a secondary impact of the earthquake) and the earthquake-induced landslides (which may keep evolving for several days after the quake). In such case, the interaction with environmental and hydro-geological agencies responsible for environmental monitoring activities would be crucial. Same holds true for the potential shortage of GW resources due to the changes in GW pathways as a consequence of earthquakes. In such cases data related to the impacts of the hazard over broader area (i.e. the whole catchment) are collected by environmental agencies, regional authorities, etc.

▫ **Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?**

WUs typically do not have a direct estimate of earthquake hazards. Regarding hazardous events related to earthquakes, in some vulnerable areas there might be monitoring activities (e.g. displacement measurements) and, in general, there are distributed water quality monitoring activities over the network (from sources to tap) that are useful in case of earthquakes. Information related to key structures and assets (e.g. water tanks) and related risk level are typically associated to structural/seismic modelling procedures and if needed/required by periodic field measurements (e.g. for dams). An assessment of potential impacts of hazardous events can be also calculated through mathematical pipe network models. In general, most of the information can be preliminarily estimated based on the expert knowledge on the systems state, conditions and operation.

• **Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the earthquake hazard?**

Until now, the national civil protection service has not generally been involved in the activities aimed at drafting and developing the Water Safety Plans relating to the earthquakes hazard. However, there are no technical procedures or regulations at national level that provide for the involvement of the different components of the national civil protection Service in the development of WSPs for earthquake.

It is believed that the National civil protection Service, in its different territorial components, could play a very significant role in the activities aimed at developing Water Safety for the earthquake hazard. In particular, representatives of the National civil protection Service could be part of the multidisciplinary teams, whose establishment for the purposes of drafting the WSPs is strongly recommended both by the international guidelines of the WHO (World Health Organization) and, at national level, by the National Institute of Health. These teams include not only members of the Water Utilities, but also external contacts from Administrations and stakeholders.

Within the aforementioned teams, and with particular reference to the earthquake hazard, the National civil protection Service representatives could provide data and information useful for updating the event and impact scenarios, coming from the operational experiences of previous seismic events, from critical issues recorded, from the studies and technical investigations performed, from the collaboration network with other institutional subjects, etc.

The subjects belonging to the National civil protection Service that could be involved in the development of WSPs with particular attention to earthquake hazards are the research bodies and institutes of national importance with civil protection purposes, in particular the National Institute of Geophysics and Volcanology and the National Research Council.

• **Does any other institution of your country play or would play a specific role for developing a water safety plan related to the earthquake hazard?**

The international guidelines of the WHO (World Health Organization) and, at national level, the National Institute of Health strongly suggest the establishment of special multidisciplinary teams made up of representatives of numerous administrations and stakeholders.

Already today, in practice, numerous Administrations and stakeholders are involved in the development of WSPs.

For this reason, by way of example, the National Institute of Geophysics and Volcanology, operational structure of the National Civil Protection Service, responsible for the management of national monitoring networks for seismic phenomena, which carries out

surveillance activities and seismic hazard assessment, collecting, processing and sharing data, information and knowledge regarding the earthquake hazard.
Considering that the earthquake is a hazardous event that can cause damage to the aqueduct network and to all its components and therefore cause possible contamination of the water in every part of the water system, we also report:

- the "Genio Civile", a peripheral state body with a regional function (not in all regions). Its main function is to verify, monitor and supervise public works, with the aim of checking that they are legitimately carried out following the regulations in force.
- the district Basin Authorities, local public bodies, which, considering the strong seismicity of the Italian territory, believe it is necessary to deal with the problem of the water supply safety of the infrastructures in a structural way, working both on the existing networks and on the measures capable of guaranteeing flexibility management.
- the Higher Council of Public Works, based at the Ministry of Infrastructure and Sustainable Mobility, within the scope of the tasks assigned to the State and in compliance with the prerogatives of the regions and autonomous provinces, provinces and municipalities, which exercises consultative and expresses opinions.

2. Suggestions and conclusions

In Table 1 the main outcomes of the presented survey are summarized

	DROUGHT	FLOODING	ACCIDENTAL POLLUTION	EARTHQUAKE
Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?	Yes There could be different risks associated to the same typology of component (for example a pumping station can be more vulnerable than another one). the user should have the possibility to duplicate some "components" or "subcomponents"	Yes The main limit of the available version of the tool is the lack of a GIS section that would allow the user to import maps and other geodata really important to figure out the location and overlap of flood-prone/flooded areas and WSS components. The lack of a GIS interface is an important limit that forces the user to develop the necessary comparison and investigation outside the tool where only the outcomes of the analysis can be described. However, even the present version of the tool is useful because it allows to organize the identified information on flooding hazard impacts.	Yes All the components possibly impacted by accidental contamination events are taken into account by the toolbox. The catalogue of possible hazardous events related to accidental pollution appears to be complete.	Yes Adding spatial data (e.g. maps with the location of infrastructures and assets) would provide more detailed and distributed information on risk level over a complex infrastructural system, and help directly identifying suitable mitigation measures. Also, an explicit connection with existing database

Are there hazardous events due to drought / flooding / accidental pollution / earthquake considered by the toolbox, but not fulfilled due to the lack of internal (at the WU level) information? Which ones?	No Romagna Acque adopts several modelling tools, developed also by Italian universities and research centres, which effectively support the management (addressing of the water needs and allocation of the resources) both in ordinary and emergency conditions	Yes The flooding hazard maps developed for the territory located the dam were not provided by the WU because an update study is currently on-going and official maps are still not available. This gap has been overcome in the MUHA project though specific studies (detailed in DT 2.2.2) that allowed to reconstruct the main flood hydrographs entering into the artificial reservoir during the last years and to simulate possible management scenarios.	No The management of pollution events could be improved if real-time assessments (e.g., through sensor-based approach) will be available for selected targets (e.g., inorganic/organic contaminants) Lacking of "multihazard" risk assessment	Yes The hazardous events considered are complete and provide comprehensive information on the potential impacts of earthquakes. WUs lack updated and reliable information on the local state and conservation of infrastructures (particularly buried ones).
Are there hazardous events due to drought (flooding/accidental	No Available information for Ridracoli WSS allows to characterize the drought events and to	Yes External information on hazardous events due to flooding basically are the flood hazard maps developed for fixed	No It would be advisable a stronger link to the environmental Monitoring network of the exploited water	Yes External information might not be immediately available for correctly analysing specific events, such as

	DROUGHT	FLOODING	ACCIDENTAL POLLUTION	EARTHQUAKE
pollution/earthquake) considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?	perform robust risk analysis.	return periods (i.e. 50, 100, 200, 500 years). As stressed before, this kind of information is lacking on the pilot area and, hence, they have not been used for flood risk investigation in the project activities, while a flood lamination study has been developed for the dam allowing to identify the flood hydrographs affecting Ridracoli also simulating possible management scenarios.	resources possible hazard centres identifying locations that can constitute sources of contamination (i.e. industries) are not mapped systematically	e.g. the risk of contamination of water source (both SW and GW, as a secondary impact of the earthquake) and the earthquake-induced landslides (which may keep evolving for several days after the quake). In such case, the interaction with environmental and hydro-geological agencies responsible for environmental monitoring activities would be crucial
Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?	Most of the data used as input for quantitative management under emergency and ordinary conditions are directly collected by Romagna Acque or provided by other institutions (mainly Regional Environmental Protection Agency, ARPAE and Emilia Romagna region) and are of good quality.	External information on hazardous events due to flooding are the flood hazard maps developed for fixed return periods. Therefore, if the information included in the tool come from these maps, we can say that the data are reliable considering that they are subjected to a severe verification and tested procedure that comes to a final approval. Other possible data refer to historical flooded areas that currently can be provided by the use of the high-resolution satellite data.	All additional water quality data, mostly including those assessed on-site and in real-time, can improve the reliability of management actions.	Information related to key structures and assets (e.g. water tanks) and related risk level are typically associated to structural/seismic modelling procedures and if needed/required by periodic field measurements (e.g. for dams). An assessment of potential impacts of hazardous events can be also calculated through mathematical pipe network models.

Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the drought (flooding/accidental pollution/earthquake) hazard?	So far, no The National civil protection service representatives could be part of the multidisciplinary team to be established at the beginning of the WSP development process. They may provide data and information useful for updating the event and impact scenarios, deriving from the operational experiences of previous water crises, from critical issues recorded, from the studies and technical investigations performed, from the collaboration network with other institutional subjects, etc	So far, no The Italian Civil Protection Department plays a coordinating role between the Regions, the Autonomous Provinces and the District Basin Authorities. DPC has created, with the important support of the Institute for Environmental Protection and Research and made available to all competent authorities (Regions, Autonomous Provinces and District Basin Authorities) the FloodCat (Flood Catalogue) platform with the function of national catalogue of flood events allowing the systematic collection of	So far, no Lack of national rules or procedures that foresee a formal involvement of the NCS at the various levels	So far, no The National civil protection service representatives could be part of the multidisciplinary team to be established at the beginning of the WSP development process and could provide data and information useful for updating the event and impact scenarios, coming from the operational experiences of previous seismic events, from critical issues recorded, from the studies and technical investigations performed, from the collaboration network with other institutional subjects, etc

	DROUGHT	FLOODING	ACCIDENTAL POLLUTION	EARTHQUAKE
		information on past floods.		
Does any other institution of your country play or would play a specific role for developing a water safety plan related to the drought (flooding/accidental pollution/earthquake) hazard?	Yes The various offices competent for the territory in the field of drought prevention, and in particular, the district basin Authorities and the Regional Offices competent for the management of water resources, health aspects, water quality, civil protection, as well as the trade associations both with regard to drinking water uses, and for what it concerns irrigation, hydroelectric uses, etc. should be involved in the multidisciplinary team for developing WSP. In this regard, it should be noted that many of the subjects who could be involved in the development of the Water Safety Plans are part of the Observatories on water use based on the district basin authorities.	Yes Regions, Autonomous Provinces, National, Interregional and Regional Basin Authorities, the Ministry of the green transition (former Ministry of the Environment) and the National Civil Protection Department. The Italian flood risk management was assigned to Regions, River basin Authorities, DPC and the Italian Institute for Environmental Protection and Research.	Yes National System for the Protection of the Environment, which carry out monitoring and control aimed at environmental protection of water resources As regards the assessment of risk on human health, it will be appropriate to involve, for the implementation of the WSP, the National and Local Health Authorities	Yes research bodies and institutes of national importance (in Italy the National Institute of Geophysics and Volcanology, operational structure of the National Civil Protection Service, responsible for the management of national monitoring networks for seismic phenomena, which carries out surveillance activities and seismic hazard assessment, collecting, processing and sharing data, information and knowledge regarding the earthquake hazard)

Table 1 – Summary of the main outcomes of the testing phase of the WASSP-DSS tool on the Ridracoli pilot.

Based on the analyses carried out through the WASSP-DSS MUHA toolbox on the water supply system of Ridracoli and on the general knowledge of CNR and DPC at the national level, some final remarks to drive the forthcoming WPT3 activities can be drawn:

1. For medium and large water supply systems it is necessary to develop different water safety plans related to different subsystems. In this regard, the choice of the correct space scale is fundamental: the “subsystems” should consider the chain of impact of hazardous events considering the propagation of impacts. However, for the WUs this could imply developing tens of water safety plans, requiring large efforts in terms of necessary time and personnel.
2. Some of the WSP risk analyses are based on information that should be provided by other institutions than the water utility and that are not available (or because are not produced, or because are not made available by the Institution that provided them). The flood hazard maps, usually developed for fixed return periods, represent a typical example of developed data that can not be included in the WSPs because not provided as official approved studies.
3. Some of the information necessary for risk analysis are not simply based on direct monitoring, but rely on models able to simulate physical processes. Models are not usually adopted, especially by the small and medium water utilities. It would be

advisable that at least for some hazards, a “modelling team” to be shared among several water utilities is constituted to support development of water safety plans.

All the hazards considered in this study need for all the steps of analysis (risk analysis, management, mitigation, etc) several competences (both technical and institutional) to draw robust and most of all effective water safety plans. It is worth stressing that the necessity of constituting multidisciplinary teams for WSPs is strongly recommended by the World Health Organization (WHO, 2009). What clearly appear from our survey is that such multidisciplinary teams could be different in relation to the considered hazards.

2.1 Evaluation of PA goals fulfillment

Some conclusions can be drawn based on the testing phase of the WASSP-DSS MUHA toolbox carried out with the support of three Italian water utilities: Romagna Acque – Società delle Fonti (water manager of the pilot action), SMAT – Società Metropolitana Acque Torino and VERITAS - Veneziana Energia Risorse Idriche Territorio Ambiente Servizi:

1. WASSP-DSS appears a very useful tool to support the initial screening for developing robust water safety plans, ranking the riskiest hazardous events. Such an initial phase is fundamental, although for the medium to large water utilities it is not sufficient.
2. For medium and large water supply systems it is necessary to develop different water safety plans related to different subsystems. In this regard, the choice of the correct space scale is fundamental: the "subsystems" should consider the chain of impact of hazardous events considering the propagation of impacts. However, for the WUs this could imply developing tens of water safety plans, requiring large efforts in terms of necessary time and personnel.
3. The three water utilities that tested the MUHA toolbox manage complex or very complex water supply systems. As reported much more in details in DT2.2.3 (Pilot action cluster reports – Italy), the tool does not allow to take the spatial connections of WSS infrastructures into consideration, implying that spatial relations and related impacts among components (as well as the direction of such impacts) are not explicitly considered. In general, adding spatial data (e.g. maps with the location of infrastructures and assets, flood hazard maps, historical events flooded maps) would provide more detailed and distributed information on risk level over a complex infrastructural system, and help directly identifying suitable mitigation measures. Also, an explicit connection with existing database (e.g. seismicity maps) can provide an added value also in view of performing the risk assessment at the local scale (i.e. considering seismic micro-zoning). Lastly, it is worth to consider that both the issues raised above might also help better understanding the impacts ('severity of consequence') that depend on the location of the element being analysed and on its role in network operation
4. The tool itself by proposing a common scheme of analysis to all the water utilities at national and transnational scale is an added value to foster exchanges of information among water utilities and toward Institutions entrusted for controls (i.e. in Italy: National Institute of Health- Istituto Superiore di Sanità. See for reference Lucentini et al. 2014). However, in order to be actually adopted on a national or transnational scale, an official endorsement by the national control Institutions is mandatory and it is currently missing.
5. The assessment of the "probability occurrence" usually need long time series of data to perform statistical analyses. The lack of long time series is one of the main problems to be faced. Sometimes this is due to an actual lack of data, sometimes to the fragmentation of data providers and/or accessibility of the existing database.

6. Some of the assessments of the “probability of occurrence” need specific modelling approaches (see DT2.2.3 for further details), not simply the collection of available data. In complex systems, this is fundamental and the necessary skills and knowledge are seldom internal to the small and medium water utilities.
7. A key point is constituted by the first module of the guidelines of the WHO (2009): “assembly the WSP team”. As will be detailed in DT2.2.3 in relation to the 4 MUHA hazards (drought, flooding, accidental pollution, earthquake), a multidisciplinary team involving also all the institutional data providers (e.g., environmental data, national monitoring network for seismic phenomena, etc.), as well as those institutions entrusted for planning, management or emergency is strongly advisable. Of course, the composition of such a team depends on the hazard taken into consideration. Detailed suggestions will be given in DT2.2.3 in relation to specific hazards.
8. Some of the WSP risk analyses are based on information that should be provided by other institutions than the water utility and that are not available (or because are not produced, or because are not made available by the Institution that provided them). The flood hazard maps represent a typical example, they could be not available or not included in the WSPs
9. Some of the information necessary for risk analysis are not simply based on direct monitoring, but rely on models able to simulate physical processes. Models are not usually adopted, especially by the small and medium water utilities. It would be advisable that at least for some hazards, a “modelling team” to be shared among several water utilities is constituted to support development of water safety plans

2.2 Addressing weaknesses/bottlenecks in the implementation of the multihazard management – Water Utility Level

Some general suggestions to improve the development of water safety plans are reported here below:
1. Setting up a multidisciplinary team involving also all the institutional data providers (for example environmental data, national monitoring network for seismic phenomena, etc); the inclusion of those institutions entrusted for planning, management or emergency is also strongly advisable. Of course, the composition of such a team depends on the hazard taken into consideration, therefore it is suggested to constitute different teams in relation to specific hazards.
2. For medium and large water supply systems it is necessary to develop different water safety plans related to different subsystems. In this regard, the choice of the correct space scale is fundamental: the “subsystems” should take into account the chain of impact of hazardous events considering the propagation of impacts. If possible, it is advisable to set up internally to the water utility a team specifically devoted to the development of the water safety plans. If it is not possible (for example due to the lack of specific finance resources or to the small dimension of the WUs), it is suggested to set up consortia of several water utilities acting on neighbour territories.
3. It is necessary to consider the spatial connections of the different components of a water supply system, possibly based on structured geodatabase. This will allow to account also for the “chain of impacts”, as well as the possible superposition of impacts (multi-hazard risk assessment).
4. An explicit connection with existing external database (e.g. seismicity maps, flooding maps, etc.) can provide an added value also in view of performing the risk assessment at the local scale. It can strongly support the assessments of the “probability of occurrence” of specific hazards.

5. Tools adopted for risk analysis by the water utilities can be very useful, firstly to propose a common scheme of analysis to all the water utilities at national and transnational scale to foster exchanges of information among water utilities and toward Institutions entrusted for controls (i.e. in Italy: National Institute of Health - Istituto Superiore di Sanità). However, in order to be actually adopted on a national or transnational scale, an official endorsement by the national control Institutions is mandatory and this is currently missing.
6. Use of models to analyse direct monitoring data is strongly advisable and, in some cases, absolutely necessary. It would be advisable that at least for some hazards, a "modelling team" to be shared among several water utilities is constituted to support development of water safety plans.
Some further suggestions can be given to support the development of water safety plans for specific hazards.

2.2.1 Drought

- Climate change is strongly threatening the resilience of water supply systems (mainly those ones that rely on single water resources) due to the current and future increase of drought episodes. An update analysis of the current modification of the precipitation and temperature regime appears mandatory, as some water supply systems have been dimensioned in periods of high precipitation rate. Similarly, it is necessary to take advantage from the global climatic models to assess the future P and T regimes to estimate the future impacts on the availability of water resources.
- The development of an effective water safety plan to face drought hazard implies identifying not only actual meteorological and water availability data, but also consumption and withdrawal data and information about impacts: in Italy these data are often provided (when existing) by different Institutions and, until now, there is a not a centralized database. The recent institution of Observatories on Water Uses, within District Basin Authorities, occurred in 2016, in a significant step towards an effective multilevel water governance, in line with the Italian institutional architecture. Such Observatories include not only drinkable water managers, but also water managers for other uses (irrigation, power production, etc.): the presence of all the actors appear necessary, especially in case of shared water resources.

2.2.2 Accidental pollution

- It is advisable a strong link to the environmental monitoring network of the exploited water resources (usually not entrusted to the water utilities). Database collecting real-time data should be easily accessible by the water utilities.
- For some kind of contaminations (i.e. microbiological contaminations) it is suggested to increase the frequency of monitoring by adopting real-time or quasi real-time monitoring techniques.
- Possible hazard centres identifying locations that can constitute sources of contamination (i.e. industries) are not mapped systematically. Such databases should be structured to be shared also with the water utilities and periodically updated.

2.2.3 Flooding

- The most important input data for the analysis about flood risk are provided by flood hazard maps, which are not always developed for all the Italian territory, and also when they are available, are seldom included in the water safety plans.

Traditionally, the information of the extension of the flooded areas during past events were derived by fragmentary ground/remote data (e.g. pictures, videos, direct testimonies, indications derived from videos recorded during helicopter flights, etc.), therefore uncertainty can affect the identified area. Nowadays, the use of the high-resolution satellite data can represent a significant improvement for flooded areas identification also integrating different satellite images.

¤ It is necessary to overlap the flood maps to the WSS infrastructure maps to perform suitable and effective flood risk analysis on the different components of the WSS. This implies the necessity to describe the water supply system on a GIS basis. Such a need has to be considered also for the other MUHA hazards.

2.2.4 Earthquake

¤ External information might not be immediately available for correctly analyzing specific events, such as e.g. the risk of contamination of water source (both SW and GW, as a secondary impact of the earthquake) and the earthquake-induced landslides (which may keep evolving for several days after the quake). In such case, the interaction with environmental and hydro-geological agencies responsible for environmental monitoring activities would be crucial.

¤ The current status of the WSS supply system infrastructures and their actual vulnerability to seismic events is often missing. This survey appears to be necessary to perform a robust risk analysis to earthquake hazard, due to infrastructural ageing (High vulnerability of infrastructure) and old design criteria.

DT.3.2.2

1. Introduction

This report summarizes in sections 2 and 3 the main outcomes of the specific activities performed by the Italian partners of the MUHA project on the Italian pilot: the Ridracoli water supply systems. These activities include the performed table top exercise coping with a drought and consequent water scarcity scenario performed on March 2022 (please refer to DT2.3.3 and DT2.3.4 for details). Such an analysis allowed providing some general suggestions to improve resiliency of water utilities to hazardous events through the development and implementation of water safety plans

In section 4 a specific analysis at the national level of the inter-institutional relationship among water utilities, Civil Protection system and water agencies. Also this analysis allowed indicating some general suggestion to improve resiliency of water supply systems through the improvement of inter-institutional procedures both in ordinary and emergency phases.

2. Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs)

The key outcomes for Improved Water Safety Plans presented in this section are an overview of two types of activities carried on the case study of Ridracoli:

- The testing of the WASSP-DSS MUHA toolbox (see DT2.2.3 and DT2.2.4) carried out with the support of three Italian water utilities: Romagna Acque – Società delle Fonti (water manager of the pilot action), SMAT – Società Metropolitana Acque Torino and VERITAS - Veneziana Energia Risorse Idriche Territorio Ambiente Servizi
- The specific experimental activities carried out on the Ridracoli water supply system, in relation to the following hazard: flooding, earthquake, drought, accidental pollution (microbiological pollution). These are specific activities designed on the Italian pilot, to improve the water safety plan of Romagna Acque - Società delle Fonti s.r.l.

We remind here that the Italian case study named “Ridracoli” refers to the multiresources-multiusers water supply system connected to the Ridracoli reservoir (Emilia-Romagna region, Northern Italy). For further details, refer to DT2.3.1

The reservoir, has a depth that can reach 82 meters and can store a maximum of 33 Mm^3 of water. The stored water is made drinkable by passing through a large drinking water treatment plant and is supplied to fifty municipalities in the provinces of Ravenna, Forlì-Cesena, Rimini and the Republic of San Marino, guaranteeing 950,000 inhabitants, as well as millions of tourists in summer, excellent water quality. The Ridracoli artificial reservoir is able to satisfy approximately 50% of Romagna's water needs and it is part of a complex water supply system characterized, at a regional level, by a very high degree of network interconnection with the possibility of differentiating and integrating supplies with multiple types of sources, depending on the different needs and situations of availability. Potentially the Ridracoli aqueduct can also distribute resources from Bologna and Modena; the water distributed with the Ridracoli reservoir as source is around 55 Mm^3 per year.

The distribution network is organized into seven main delivery areas: Area 1: Santa Sofia; Area 2a: Faenza; Area 2b: Alfonsine; Area 3a: Cesena; Area 3b: Ravenna; Area 3c: Rimini; Area 3d: Gabicce. Water needs of each area, estimated at monthly scale, are partially met by the Ridracoli reservoir, the remaining part being supplied by “local resources” (generally wells) or “alternative resources”, namely waters from an irrigation canal diverted from the Po river and made drinkable after treatment in a water purification plant (NIP2).

Based on the analyses carried out through the WPT2 activities and on the general knowledge of CNR and DPC at the national level, some general key outcomes can be drawn:

1. For medium and large water supply systems it is necessary to develop different water safety plans related to different subsystems. In this regard, the choice of the correct space scale is fundamental: the “subsystems” should consider the chain of impact of hazardous events considering the propagation of impacts. However, for the WUs this could imply developing tens of water safety plans, requiring large efforts in terms of necessary time and personnel.
2. Adding spatial data (e.g. maps with the location of infrastructures and assets, flood hazard maps, historical events flooded maps) would provide more detailed and distributed information on risk level over a complex infrastructural system, and help directly identifying suitable mitigation measures
3. In addition to point 2, it is worth stressing that in a framework of multihazard risk assessment, the use of spatial data and even more the assessment of the links both quantitative and qualitative among the different components of the system is of overall importance.
4. Some of the WSP risk analyses are based on information that should be provided by other institutions than the water utility and that are not available (or because are not produced, or because are not made available by the Institution that provided them). It is very important to develop common and accessible databases able to represent (possibly in real time or near real time) the actual qualitative and quantitative status of the exploited water resources, raw water and distributed water. As it will be outlined also in the following robust and effective interinstitutional procedures (in both ordinary and emergency phase) firstly rely on common databases acknowledged by all the public and private bodies involved in the water management.

5. Some of the information necessary for risk analysis are not simply based on direct monitoring, but rely on models able to simulate physical processes and to establish connections along the entire supply chain, from resources (and even more from climate data) to distribution. Models are not usually adopted, especially by the small and medium water utilities. It would be advisable that at least for some hazards, a "modelling team" to be shared among several water utilities is constituted to support the development of water safety plans.
6. All the hazards considered in this study need for all the steps of analysis (risk analysis, management, mitigation, etc) several competences (both technical and institutional) to draw robust and most of all effective water safety plans. It is worth stressing that the necessity of constituting multidisciplinary teams for WSPs is strongly recommended by the World Health Organization (WHO, 2009). What clearly appear from our analyses is that these multidisciplinary teams could be different in relation to the considered hazards.

Along with the general outcomes presented above, some specific outcomes from the four hazard mainly addressed in the MUHA project are presented here below:

2.1 Drought

- Climate change is strongly threatening the resilience of water supply systems (mainly those ones that rely on single water resources) due to the current and future increase of drought episodes. An update analysis of the current modification of the precipitation and temperature regime appears mandatory, as some water supply systems have been dimensioned in periods of high precipitation rate. Similarly, it is necessary to take advantage from the global climatic models to assess the future P and T regimes to estimate the future impacts on the availability of water resources.
- The development of an effective water safety plan to face drought hazard implies identifying not only actual meteorological and water availability data, but also consumption and withdrawal data and information about impacts: in Italy these data are often provided (when existing) by different Institutions and, until now, there is a not a centralized database. The recent institution of Observatories on Water Uses (OWUs), within District Basin Authorities, occurred in 2016, is a significant step towards an effective multilevel water governance, in line with the Italian institutional architecture. The OWUs are collegial bodies aiming at collecting, analysing and jointly evaluating data on meteorological variables and water availability, in support of Institutional bodies entrusted of the management of water resources. In addition to constituting a specific measure of the District Management Plans, the OWUs respond to the need to provide technical support to a new water governance, thus the considerable complexity of water resource management, understood in the broadest sense, i.e. including knowledge of infrastructure structures, the considerable diversification and interdependence of uses, the extent of withdrawals, etc.. Therefore, an innovative governance based not on the rigid division of competences, but on the sharing of information frameworks, dialogue between the parties and cooperation. Such Observatories include not only drinkable water utilities, but also water suppliers for other uses (irrigation, power production, etc.): the presence of all the actors appear necessary, especially in case of shared water resources. We think that the set up of "Observatories for water uses" similar to those ones acting in Italy is strongly advisable overall the ADRION area.

- Coping with drought and water scarcity needs to account for the entire water supply chain, from the climate data to the main distribution within a common modelling scheme shared by all the involved stakeholders. Such a modelling approach needs to be recognized and approved by all the actors for an effective and balanced water policy, based on a "what if" approach. Different hypotheses to be tested should at least include:
    - Variability (also over long time spans) of the precipitation and temperature regime
    - Related impacts on the availability of water resources
    - Management scenarios (addressing the users' water needs to different resources and/or allocating the different resources to the different users
    - Variability of water needs (at different time scale: seasonal, yearly, decadal, pluridecadal)
- Some water supply systems are multi-purposes (i.e. human consumption, irrigation, industries, hydropower production, etc.), resulting in case of drought events in a conflicting use of the shared resources. In these contexts, it is very important that all the potentially involved actors share:
    - Common dataset representing the climate regime over the same reference period; data should be also represented through common and recognized indexes;
    - Common dataset representing the water needs of each user (possibly at monthly scale);
    - Common indexes representing the current and future status of the available water resources;
    - Common tools to assess the impact of precipitation deficit on the ability of the system to meet the connected water needs.

2.2 Accidental pollution

- It is advisable a strong link to the environmental monitoring network of the exploited water resources (usually not entrusted to the water utilities). Database collecting real-time data should be easily accessible by the water utilities.
- For some kind of contaminations (i.e. microbiological contaminations) it is suggested to increase the frequency of monitoring by adopting real-time or quasi real-time monitoring techniques.
- The near real-time data provided by DNA-based advanced technologies for microbial community characterization applied to water quality monitoring can allow to promptly assess local and time-series contamination anomalies which may naturally occur at the reservoir and in the raw water, owing to e.g., accidental microbiological contamination episodes, occurrence of microbial hotspots/aggregates, algal blooms, and the spread of potential pathogenic/harmful microbial elements (e.g., fecal indicators, water-borne pathogens, invasive species, antibiotic resistance genes). Details on the adopted techniques have been provided in DT2.3.1
- The newly generated data cannot be directly used for risk assessment and evaluations associated with the identification of accidental pollution events. A key issue in view of implementing predictive models and IWSPs will be the availability of historical data for a robust evaluation of the variation patterns observed either for short or long-term periods. This will necessarily include the cross-calibration of newly-generated data with those obtained by the traditional methodological approach, as applied locally.

- Possible "hazard centers" identifying locations that can constitute sources of contamination (i.e. industries) are not mapped systematically. Such databases should be structured to be shared also with the water utilities and periodically updated.

2.3 Flooding

- Climate change is expecting to affect the future regime of floods producing fewer but more severe events. An update analysis of the modification of the precipitation and temperature regime that will affect the discharge regime is therefore mandatory to update the flood risk estimates based on past time series that will not represent the climatic condition anymore. The impacts of the modified floods regime on the water supply systems should be investigated.
- The development of an effective water safety plan to face flood risk implies overlapping the WSS components' location with the limits of the flood hazard maps or the maps depicting the limits of past flooded areas. Actually, the most important input data for the analysis about flood risk are provided just by the flood hazard maps, which unfortunately are not always developed for all the Italian territory, and also when they are available, are seldom included in the water safety plans development and update. Moreover, the information about the extension of the flooded areas during past events can be a fundamental indication. However, in the past the limits of the flooded areas were derived by fragmentary ground/remote data (e.g. pictures, videos, direct testimonies, indications derived from videos recorded during helicopter flights, etc.), therefore uncertainty can affect the outcomes. Nowadays, the use of the high-resolution satellite data can represent a significant improvement for flooded areas identification also integrating different satellite images. On this basis, overlapping the flood maps to the WSS infrastructure maps is fundamental to perform suitable and effective flood risk analysis on the different components of the WSS.
- The main advice to properly address the estimate of floods impacts on WSS components concerns the necessity of using a GIS basis where the water supply system structure and connections should be described as well as the georeferenced information about flood-prone areas. The use of a GIS tool is needed also for the other MUHA hazards analysis.
- Flood events can affect different components of the WSS in different ways impacting both on the available water quantity and quality. An approach accounting for the entire water supply chain investigation is required, from the water production to the main distribution, with a common modelling scheme shared by all the involved stakeholders. Such a modelling approach needs to be recognized and approved by all the actors for an effective emergency management. The main steps to be addressed should be:
    - Variability (also over long time spans) of the precipitation and temperature regime to assess by using rainfall-runoff models the future regime of rivers' discharge
    - Impact of the modified climatic conditions on the flood hazards maps
    - Management scenarios, addressing the management of emergency due to flooding in real-time or in nowcasting (e.g. identification of possible solutions and alternative, integrated sources, emergency activities, system restoration, etc.)

2.4 Earthquake

- Although advances in potential earthquake prediction are being performed in the scientific realm, no relevant tools or techniques for supporting decision-making for the involved institutions are currently available. There are some database available with historical information, but the main source of information is the map with local seismicity available over the whole country. This issue on the one hand suggests that emergency management in case of earthquakes is definitely a complex task; on the other hand highlights the need (and opportunity) for improving resilience in the preparedness phase.
- Evidence from the interviews highlight that many interactions among institutional and non-institutional actors occur, and are particularly needed for the implementation of the risk management measures (such as the repairs, the activation of alternative water sources and the closure of parts of the system). Most of the measures require collaboration with local/regional authorities (i.e. Municipality and Regional Authority). The need for a stronger interaction with the users is also highlighted, and this is crucial for damage assessment and service recovery.
- Effectively dealing with earthquakes requires that the whole water supply chain is analyzed and taken into account in the definition of risk management strategies and resilience-enhancing measures. In this direction, the role of neighbouring WUs and the development of agreements and forms of cooperation well before the event is crucial, as this might help providing an adequate service in the aftermath of an event and help rapidly restoring the functionality of the whole system.
- External information might not be immediately available for correctly analyzing specific events, such as e.g. the risk of contamination of water source (both SW and GW, as a secondary impact of the earthquake) and the earthquake-induced landslides (which may keep evolving for several days after the quake). In such case, the interaction with environmental and hydro-geological agencies responsible for environmental monitoring activities would be crucial.
- The current status of the WSS supply system infrastructures and their actual vulnerability to seismic events is often missing. This survey appears to be necessary to perform a robust risk analysis to earthquake hazard, due to infrastructural ageing (High vulnerability of infrastructure) and old design criteria.

3. Table Top Exercise Results to define and bridge inter –agency operation services

As part of the INTERREG ADRION MUHA (MUltiHAzard framework for water related risks management) project, a table-top exercise (TTX) was planned in the pilot area of Ridracoli, called RIWAX (RIdracoli WAter crisis eXercise) 2022, aimed at improving the interaction among the Water Authorities, the Water Utilities and civil protection systems, within the framework of the activities aimed at the protection of water resources.

The event scenario considered in the performed TTX is that of a drought event which, within a few months, causes the lowering of the hydrometric level of the Ridracoli reservoir and, consequently, the reduction of water resources for the Romagna coast.

The main objective of the exercise is to strengthen cooperation between the bodies responsible for managing water resources, supervising health and hygiene aspects with the civil protection system, in the context of a water crisis.

While the exercise document is the focus of D.T.2.3.3., a detailed description of the performed table top exercise is reported in DT2.3.4. Here, the main outcomes are summarized:

- It has been highlighted that the different activities (water management, water quality control, water regulation, civil protection, etc.) are governed by sectorial rules and procedures, in many cases not coordinated with each other. It is worth noting that the RIWAX exercise involved 11 different entities (both public and private), all entrusted by law in case of a water crisis for different roles and actions. All the involved actors usually refer only to the specific sectoral rules and procedures resulting in a need of a continuous exchange of information aiming at updating the scenarios of event and related impacts and the consequent preparation and implementation of the necessary mitigation measures.
- As a consequence of the institutional framework previously presented, it is strongly suggested the set-up of a regional technical table, as the key measure for the effective, synergistic and timely connection and coordination of all the bodies responsible for the management of water resources, water quality control, water regulation and civil protection activities. The continuous flow of information and updating of the event and impact scenarios and the link between the procedures are good practices for effective mitigation measures. The choice of the regional level to set-up the proposed "technical table" relies on the Italian institutional asset that decentralizes several competences to the regional level.
- The implementation of the mitigation measures shall be carried out in a gradual and progressive way according to the severity of the event and impact scenarios. For example, urgent measures typical of emergency civil protection activities (use of water tankers, water bags making machines, etc.) are generally adopted when water resources are strongly reduced and there are no other alternative ways of supplying water to the population. The timely and effective preparation of these measures can only take place if the Civil Protection Offices are informed in time of the evolution of the event scenario. Similarly, it is very important that the control of water quality takes place according to the event scenario (i.e. for the Ridracoli case study, in relation to the volume of water resources stored in the reservoir).
- It is suggested to set up a more efficient communication system (perhaps in addition to electronic communications) that could make it easier to receive, check, reply and manage information. This system may consist of a platform, with limited access to key actors respecting the needed requirements for security, exclusively dedicated to emergency impacting on the "Integrated Water System". The different actors involved would update the necessary information with a pre-defined frequency, sharing in this repository the necessary documentation:
    - availability of mobile purification plants, water bags making machines, water tankers (and the related status of cleaning and sanitization, if of property and relative addresses of refuelling for zone of supply);
    - any water sources/ plants normally out of service but re-activable and their qualitative-quantitative characteristics (if known);
    - lists of "strategic" users and their prioritization for supply;
    - lists of the "non-domestic" users, prioritisation of supply limitations and related quantification;
    - templates for communication.
- Moreover, it is suggested to set up a strategy of shared communication towards the citizens.

- It is necessary not only a "*reactive*" type response model, but also a more complex, comprehensive and innovative "*proactive*" model including measures to be implemented to mitigate the most critical effects. For example, the organisation of the technical evaluation activities aimed at the assessment and quantification of the water resources available in the Marecchia fan is a measure that has to be planned in advance, before the emergency, but that can lead to a beneficial reduction in the water demand for water resources, partially mitigating the actual water crisis. These measures require a thorough knowledge not only of the water supply system experiencing the crisis, but also of water systems of the surrounding areas, the needs of users, and the availability of alternative sources. It is quite clear that the knowledge of these aspects cannot be entrusted to a single subject, but has to be entrusted to several entities and stakeholders. In this context, it should be pointed out that the "bottom up" approach that guided the organisation of the exercise is more advisable with respect to a "top down" approach, due to the large number of actors potentially involved.

- The TTX carried out in the Ridracoli pilot area highlighted the general lack of mutual knowledge of the roles and competences of each participant. In this regard, the exercise was a valuable opportunity to clarify what are the areas of competence and responsibilities of each of the participants in the exercise and what activities are implemented both in ordinary and during the emergency. Moreover, the preparatory meetings allowed:

  a. To outline a shared procedure and to identify some issues that have necessarily to be addressed in a collegial way in the near future before emergencies (e.g. identification of strategic users and the municipalities impacted, communication strategy, etc.);
  b. To achieve, although in a provisional way, the sharing of tools, languages and procedures, including innovative ones: for example, the definition of thresholds for the activation of the operational phases, the homogenization of terminology, etc.

  It is worth stressing that the TTX was organized in a “light” format, as it was not a “real” exercise, as it has been performed from remote in an informal (on the contrary, an “official” exercise would lead to take decisions that in turns would necessarily have been transferred to legal acts). We strongly suggest this format that effectively foster the participation of all stakeholders and the identification of the best procedures and possible bottlenecks in managing water crisis. In fact, based on the feedback received from the participants, the exercise has resulted in a substantial refinement of the knowledge of the roles and areas of competence of the different bodies and subjects, making it faster and easier to share a procedure and exchange information. This results not only in the reduction of the gap between Water Authorities, Civil Protection and Water Utilities (the main goal of the MUHA project), but also in a significant improvement in the resilience of the water supply system to drought events.

4. Key guidelines

The key guidelines provided here are based on the outcomes of the specific activities carried out on the Ridracoli pilot (section 2 of this document), on the TTX exercise results and on the overall analysis at the national level described in DT3.2.3. In particular, the latter includes: a) information collected from 11 Italian water utilities through semi-structured interviews focused the key interactions with both institutional and non-institutional agents involved in building resilient water supply systems and governance structures; b) analyses of the current Italian water governance model, also through a literature analysis.

It is worth stressing that the inter-institutional relationship among water utilities, Civil Protection system and water agencies are highly complex and dynamically evolving and cannot be framed only within the relations among the three cited entities but involve many other public and private institutions, especially in a very fragmented institutional framework such as the Italian one. On the other hand, the water governance models are quite different from country to country in the ADRION area (despite the shared European Directives as common basis) and providing too binding guidelines, sized on a precise model, appears to be not useful in the context of the MUHA project.

The key point is that according to the OECD report (2011) "*The (current) water "crisis" is not a crisis of scarcity but a crisis of mismanagement, with strong public governance features. Key obstacles to improve water management are institutional fragmentation and badly managed multi-level governance. […] Water policy involves a range of public stakeholders across ministries, departments and public agencies, and between various levels of government. In addition to the policy makers, citizens, private actors, end users, investment banks, and infrastructure and service providers have a stake in the outcome*"

For this reason, more than providing specific guidelines, this section reports general but specific suggestions based on the Italian experience aimed at improving the "inter-agencies" procedures.

TOPIC	BOTTLENECK	SUGGESTIONS
Identification of institutional actors and stakeholders	Overlapping, unclear allocation of roles and responsibilities. The involved actors usually refer only to the specific sectoral rules and procedures resulting in a need of a continuous exchange of information aiming at updating the scenarios of event and related impacts and the consequent preparation and implementation of the necessary mitigation measures Transfer of numerous tasks and relevant responsibilities from central government to the regions has worsened the situation in many instances Mismatch between hydrological and administrative boundaries Difficult coordination between urban water use, agriculture, land use and energy policies. This is a very important weakness in Italian water policy. Conflict of uses are very frequent among agricultural uses – very relevant according to the used water volumes – and other uses (domestic, industrial, etc.) and also among different areas in the same catchment Limited involvement and dialogue with users	It is necessary to strengthen the existing interinstitutional coordination tables both at national, both at the river basin district level, or at the regional and / or local level. The establishment of efficient interinstitutional coordination tables allows the sharing of data and information, the continuous updating of the event and impact scenarios, the shared choice of monitoring and evaluation methodologies, the rapid exchange of information, the coordination of mitigation measures, etc Following the Italian experience, it is strongly suggested the institution of **permanent Observatories of Water Uses** (OWUs) (Osservatori Permanenti per gli Utilizzi Idrici), which in Italy are set up at each District Basin Authority (see DT3.2.3 for further details). The OWUs are collegial bodies with tasks of collection, analysis and joint evaluation of data on meteorological variables and water availability, in support of Institutional bodies competent in the management of water resources. They are constituted by all the actors potentially involved in the water management in both the ordinary and emergency phase and by stakeholders. It is an innovative governance, therefore, based not on the rigid division of competences, but on the sharing of information frameworks, dialogue between the parties and cooperation
Recognition of existent procedures	The TTX carried out in the Ridracoli pilot area highlighted the general lack of mutual knowledge of the roles and competences of each participant	Organization of "light" TTXs involving all the potential actors aiming at a) outlying a shared procedure and to identify some issues that have necessarily to be addressed

TOPIC	BOTTLENECK	SUGGESTIONS
		in a collegial way in the near future before emergencies (e.g. identification of strategic users and the municipalities impacted, communication strategy, etc.); b) achieving, albeit in a provisional way, the sharing of tools, languages and procedures, including innovative ones: for example, the definition of thresholds for the activation of the operational phases, the homogenization of terminology, etc
Emergency Planning Process,	Lack of technical capacity, staff, time, knowledge and infrastructure, resources (mainly economic)	Set-up of a regional coordination table, as the key measure for the effective, synergistic and timely connection and coordination of all the bodies responsible for the management of water resources, water quality control, water regulation and civil protection activities
Water System Information,	The several actors involved in both the ordinary and emergency management of water resources often produce "pieces" of information, not always easily available, focused on the different components of the whole water supply chain, from the resources to the distribution Lack of common information frame of reference	A thorough knowledge not only of the water supply system experiencing the crisis, but also of water systems of the surrounding areas, the needs of users, the availability of alternative sources crucial role to be attributed to the agents that perform environmental monitoring activities, particularly as far as water quality issues are concerned (e.g. in Italy ARPA, ISS, ISPRA). Set up of common databases acknowledged by all the public and private bodies involved in the water management Concerning quantitative issues such database should include: •Common dataset representing the climate regime over the same reference period; data should be also represented through common and recognized indexes; •Common dataset representing the water needs of each user (possibly at monthly scale) •Common indexes representing the current and future status of the available water resources •Common tools to assess the impact of precipitation deficit on the ability of the system to meet the connected water needs Concerning qualitative issues such database should include past data and real time (or near-real time) monitoring of: • the quality status of the exploited surface and ground water bodies • the quality status of the raw water • the quality of the distributed water • Updated list of possible "hazard centers" identifying locations that can constitute sources of contamination
ICS Integration and Organization, Operations,	Some water supply systems are multi-purposes (i.e. human consumption, irrigation, industries, hydropower production, etc.), resulting in case of hazardous events in a conflicting use of the shared resources.	Set-up of a regional coordination table, as the key measure for the effective, synergistic and timely connection and coordination of all the bodies responsible for the management of water resources, water quality control, water regulation and civil protection activities Set up of a more efficient communication system (perhaps in addition to electronic communications) that could make it easier to receive, check, reply and manage information.This system may consist of a platform with limited access to key actors, exclusively dedicated to emergency impacting on the "Integrated Water System" (refer to section 3 of this document) Set up of shared database concerning quantitative issues

TOPIC	BOTTLENECK	SUGGESTIONS
		• Common dataset representing the climate regime over the same reference period; data should be also represented through common and recognized indexes; • Common dataset representing the water needs of each user (possibly at monthly scale) • Common indexes representing the current and future status of the available water resources • Common tools to assess the impact of precipitation deficit on the ability of the system to meet the connected water needs
Communication Procedures	Lack of citizen concern about water policy and low involvement of water users association Very limited interaction occurs with the users, which are currently not directly involved/consulted although their role could be considered highly relevant	To set up a strategy of shared communication towards the citizens. Such a strategy should be defined in advance as part of the emergency procedures and shared with the population in not emergency times. To set up shared templates for communication
Restoration and Recovery Activities	Lack of structured decision-making processes and limited availability of scientifically-sound tools and methods for the selection of measures and strategies for recovery	Development of documents with examples, best practices, guidelines, lessons learned from past events to support decision-making processes.

5. Conclusions

Section 3 is devoted to a summary of the outcomes of the activities performed by the Italian partners (CNR and DPC) on the Ridracoli pilot sites to improve the resiliency of water supply system, so focusing on the water utility level.

Section 4 is fully dedicated to provide key guidelines at the institutional and inter-institutional level.

6. References

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DT.3.2.3

Introduction

Cooperation among Water Utilities, Civil Protection and Water Authorities is of utmost importance to ensure the resilience of the water supply, severely affected both by the effects of climate change and by numerous factors that contribute to the vulnerability of water supply systems in a given area over time. Therefore, along with analysing the technical and infrastructural issues that contribute to system resilience, particular attention needs to be given to the role of coordination and effective communication between the different entities somehow involved in water management problems. In many cases, as highlighted by national and European studies, water crises are caused not so much by a real lack of water resources, but by governance and policy weaknesses related to management errors, lack of or weak planning, coordination difficulties, lack of reporting tools, etc.

In this framework, the present report will propose an overview of the role of governance issues in the resilience of water supply systems performing a multi-level analysis. First, the critical issues that historically affect the Italian water sector and its efficiency will be briefly outlined: these include typically infrastructural factors (network losses, age of the infrastructure, etc.), which in turn are often related to the lack of solid governance of the water sector. Second, the main aspects of governance of the water resource in the national territory will be examined along with the main gaps and weaknesses, such as difficulties of coordination and policy making, the lack of a clear strategy, etc. This section will also take into consideration the results of some interviews carried out with some Water Utilities, aimed at highlighting the complex framework of relations between them and the different entities having different responsibilities in the field of water resources management.

Finally, considering also the results of the Table-Top Exercise (TTX) carried out as part of the MUHA project, some recommendations are proposed to optimize the governance structures with the aim of enhancing the resilience of water supply services. These measures do not only concern the governance of the water sector, but also aim at strengthening relevant plans and programs of interventions, which in turn have an impact on improving the resilience of the water supply.

Resilient water supply: the challenges

The analysis of water management issues stems from the consideration that in recent years, Italy has experienced several extreme climatic events, in terms of temperatures reached as well as rainfall scarcity. This has caused widespread changes in hydrological regimes, the failure to recharge water resources (snowpack, glaciers, aquifers, lakes) and an increasing demand for water for different uses. The past development of Italy heavily in the XX century relied on the abundance of water the resource, as evidenced by the rapid and massive industrialization at the beginning of the last century, based above all on the exploitation of the so-called "white gold" for hydroelectric production purposes, mostly through the construction of hydroelectric basins and regulated lakes in the Alpine and pre-Alpine arc. However, in the last 20 years, both in the North and in the South, the population and the various productive sectors had to face increasingly frequent droughts and water crises, even in areas that previously had rarely been affected by criticalities. A relevant example is the recent water crises that have affected the Po basin (Figure 1) and in particular the area of the large regulated pre-alpine lakes (Lake Maggiore, Lake Como, Lake Garda, Lake Iseo) where the water resource has always been abundant, but also the drought events of 2017 that involved Lake Bracciano, which has always been a water resource for Rome.

Figure 1 The Oglio river during the 2006 drought. Source: Province of Mantova.

The multiplicity of uses and the subsequent onset of conflicts among the various sectors (agricultural, energy, drinking water, industrial) along with the impact of the regulations on the environmental flow, have brought out the contradictions of existing planning and in particular of the allocation of water resources. The impact on the territory and the consequences of water and energy policy in our country have been often neglected in their complexity (Giupponi & Fassio, 2007).

Despite the progresses made in the last century, the Italian water sector continues to be characterized by numerous weaknesses such as: obsolete infrastructural network (60% of the distribution network is over 30 years old and 25% over 50 years old), unequal distribution of the resource, ageing of the infrastructures and low renovation rates, high losses from the network, high management fragmentation, lack of purification plants, considerable waste, etc. (Duro & Losavio, 2009; Gilardoni & Marangoni, 2004; Gilardoni, 2018).

Water crises in Italy are mostly characterized by the high difficulty of accessing water rather than by the limited resource availability. Furthermore, the infrastructural and management inadequacies were also originated by gaps in planning, by the scarcity of available public funds (further limited due to the public finance crisis that has affected the country since the 1990s) and by the scarce income from water tariffs, which are currently among the lowest in Europe (Massarutto, 2008).

Additionally, the constant increase in demand for water globally makes the resource even more scarce and strategic, ultimately exacerbating water crises. Italy is one of the countries with the highest pumping rate in Europe, both in absolute terms with over 9 billion m^3 of water withdrawn every year for civil use (1st country of the European Union), and in relative terms, with 152 m^3 of water withdrawn for drinking use per inhabitant per year (2nd country of the European Union, after Greece) (The European House – Ambrosetti, 2022). Drinking water withdrawals remain high since drinking water is used for purposes that would not require it (for example, irrigation of gardens, washing streets and cars, activities that account for more than 1/3 of Italians' domestic consumption). Furthermore, water infrastructures are exposed to natural disasters (see e.g. Figure 2) which in some cases (e.g. floods, landslides, droughts, forest fires, etc.) are becoming more frequent with climate change.

Figure 2. A water pipeline damaged after a flood in Catania Plain, Oct. 2018. Source: DPC Archive.

The main issues water utilities are interested in, i.e. water quality as well as the efficiency of water systems, are also the included in the main goals of the UN 2030 Agenda. In particular, the SDG 6 objective of the United Nations policy document draws attention to the global water crisis, emphasizing the importance of "*guaranteeing the availability and sustainable management of water and sanitation for all*".

The water resilience of a water system (whatever the sector involved) represents (and measures) its ability to limit the impacts of external stress factors and to adapt to changes.

Water certainly represents a valuable raw material whose use is fundamental in various social and economic industrial areas (domestic and civil uses, agricultural irrigation, food production, manufacturing companies, thermal and cooling cycles, energy production). The factors that limit the availability of water resources are not exclusively linked to meteorological phenomena and prolonged drought periods. The demographic increase and the simultaneous increasing energy needs are also external factors that contribute to limiting the water availability of a territory. Similarly, the coexistence within a geographical area of multiple stakeholders leads to intra-territorial competition for the use and exploitation of safer water supply sources.

Lastly, the importance of maintaining the quality standards of water supply sources should not be forgotten. Diffuse pollution of rivers and aquifers also represents a limiting factor for access to water, in particular for the drinking water sector: in other words, despite having water available, many resources cannot be exploited due to the deterioration of quality.

An analysis of the management structures of water resources in Italy performed by the Water Service Divide highlighted significant differences among the various Italian territories (especially between the north and south of the country) in the water service sector, and the consequent degree of user's satisfaction:

- A significant part of the water service is still managed through local authorities (lack of full implementation of the so-called Galli Law);
- In some areas there is a lack of local regulators (EGATO or ATO) able to identify the real needs of the service;
- Gap in the effectiveness of water service supply: in Calabria and Sicily, water is not supplied on a regular basis to, respectively, 38% and 22% of families (Utilitalia, 2021);
- Uneven distribution of water on the territory, i.e. territories characterized by natural scarcity of resources for which it is necessary to activate effective transfer mechanisms from neighbouring areas;
- Uneven ability to treat wastewater.
- Complex authorization processes for hydraulic works;
- High soil sealing which prevents both the ability to manage rain flows and the ability to recover.

Water resilience assessments, undertaken by various stakeholders in water-stressed areas, are necessary and arise from the awareness of an uncertain future, where increasingly frequent intense weather events will certainly play a fundamental role in the global economy.

Promoting a cultural change regarding water consumption, through increased communication with end users to immediately activate awareness and encourage virtuous behaviour, is therefore the best strategy for a more responsible, sustainable and inclusive development.

Last but not least, the Covid-19 pandemic has also become an element of further pressure on the management of water resources, highlighting the need to have a more sustainable and resilient economic, social and environmental system. The OMS reports (OMS, 2020), in fact, identify some indirect effects that the authorities must monitor by updating, if necessary, the prevention models of the water safety plans: in fact, increases in local consumption in synergy with drought events can lead to restrictions on water supply and service shifts in some areas, with risky health-related impacts.

In the National Recovery and Resilience Plan (PNRR) there are some areas of intervention directly related to the water resource in the component "Protection and enhancement of the water resource and the territory". The funds attributable to policy actions for a more efficient and sustainable management of water resources in Italy are approximately € 7.8 billion: € 2.5 billion for flood risk management and hydrogeological risk reduction, € 2 billion for security of water supply, € 900 million for the reduction of losses in the distribution networks, including digitization and monitoring of the same, € 800 million for the resilience of the irrigation system, € 600 million for the construction of sewers and purification plants, € 500 million for the monitoring and forecasting of climate change and € 400 million for the restoration of marine habitats.

Governance issues

Overview

In this paragraph, we highlight the complexity of water governance in Italy, as resulted after the most recent institutional reforms. As pointed out in an OECD study (which does not refer specifically to the Italian case) "*The current water "crisis" is not a crisis of scarcity but a crisis of mismanagement, with strong public governance features. Key obstacles to improve water management are institutional fragmentation and badly managed multi-level governance. […] Water policy involves a range of public stakeholders across ministries, departments and public agencies, and between various levels of government. In addition to the policy makers, citizens, private actors, end users, investment banks, and infrastructure and service providers have a stake in the outcome*" (OECD, 2011). This quotation from a study of the Organization for Economic Co-operation and Development highlights the importance of the institutional framework on the water management and, in particular, the key role of government at various levels, along with civil society and private sector, to guarantee effective water governance.

Nowadays, the term governance is generally used beyond its meaning of government "to encompass all the mechanisms, processes, relationships and institutions citizens and groups use to articulate their interests and exercise their rights and obligations" (OECD, 2011). As Rossi and Benedini (2020) pointed out, the term should be distinguished from water management, as the latter refers directly to the operational activities for meeting specific targets in the water services, while water governance refers to the set of administrative systems and focuses on formal and informal institutions as well as on organizational structures and their active performance in terms of legitimacy to govern, including also transparency in the decision-making process, accountability of the responsible bodies and the inclusiveness of stakeholders. However, in practice there is a blur border between these two terms.

The Italian institutional setting of policy making, planning, design, operation and control of systems for water resource management and soil conservation is very complex, due to a historic process which has developed specific bodies for regulating and managing each specific sector, often supported also by a scientific community and by a sectorial approach (e.g. taking into account only agricultural or hydraulic engineering views) unable to produce real coordination. Multiple actors play a role in water policy design, regulation and implementation across ministries, public agencies and levels of government, thereby generating sectoral fragmentation with a high impact at the territorial level (OECD, 2011).

The Italian legislative framework (Greco 1983; E.C. 2000; Rossi and Ancarani 2002; Maglia and Galotto 2009, Rossi and Benedini 2020) has contributed to this complexity. The transfer of numerous tasks and relevant responsibilities from central government to the administrative regions has worsened the situation. This process began in the '70s of the last century and experienced a significant acceleration with the constitutional reform occurred at the beginning of this century. Besides the difficulties of communication at national level among the ministries, new difficulties have arisen between national and subnational organizations, particularly between state and regions and at regional level between region and local bodies. The reform of the water legislation, driven partially by European Directives, did not improve the confusing situation concerning the roles and responsibilities created by the overlapping of sectorial acts.

Water governance in Italy follows the multilevel governance adopted by the EU legislation. Many studies show the extraordinary complexity of the Italian institutional fragmentation of water governance both at national and subnational levels (Rossi & Benedini, 2020). In order to examine the weaknesses of the system, it seems appropriate to review the analysis carried out in an OECD study (OECD, 2011), made to evaluate the governance challenges of water policy in Italy. The evaluation was based on a list of sever proxy indicators chosen for the analysis of governance challenges in OECD countries (Table 1).

Multi-level governance gaps	Proxy indicator
Policy	Overlapping, unclear allocation of roles and responsibilities
Administrative	Mismatch between hydrological and administrative boundaries
Information	Asymmetries of information between central and subnational governments
Capacity	Lack of technical capacity, staff, time, knowledge and infrastructure
Funding	Unstable or insufficient revenues of subnational government to effectively implement water policies
Objectives	Competition between different organizations
Accountability	Lack of citizen concern about water policy and low involvement of water users association

Table 1 - Multi level governance gaps in water policy. Source: OECD (2011).

According to the responses of Italy to the 2011 OECD Survey on water governance, 5 out of 7 gaps have been identified as important or very important for Italy, namely: policy, administrative, information, capacity, and accountability.

The main obstacles to horizontal coordination in water policy making at central level which can be considered very important are the following: (i) interference of lobbies, (ii) difficult implementation of central decisions at local level, (iii) difficulties related to implementation and (iv) lack of citizen concern with regard to water policy.

The difficult implementation of central decisions at local level and difficulties related to implementation are very often due to the lack of technical and administrative skilled personnel. The technical and administrative gap is still one of the most important challenge in OECD countries – especially at the sub-national level – because of the lack of staff, time, technological expertise and innovative water processes (OECD, 2011).

Other important bottlenecks have been identified: (v) overlapping, unclear, non-existing allocation of roles, (vi) absence of reference information frame, (vii) lack of high political commitment and leadership, (viii) lack of institutional incentives for cooperation, (ix) mismatch between ministerial funding and administrative responsibilities, (x) absence of strategic planning and sequencing and (xi) absence of monitoring and evaluation of outcomes.

The weakness of the administrative process is very relevant in order to explain the difficulties of the planning activities, but also – until recent times – the lack of high political commitment and leadership. Optimization of water governance has not gained the attention of politicians for many reasons:

- First of all, water governance is very technical and is not so easy to address from a political point of view.
- Secondly, public discussion in Italy about water was largely dominated by private versus public debate, which shadows much more important issues: lack of coordination among institutions, weakness of planning, need of climate change adaptation policy, resilience of water supply systems, etc.

However, it is worth noting that in the Italian plan related to RRF (Resilience and Recovery Fund) of the Next Generation EU, called PNRR ("Piano Nazionale di Ripresa e Resilienza", National Plan for Recovery and Resilience), large funds were assigned for the upgrading, completion and extraordinary maintenance of primary water infrastructures, for the reduction of network losses, for the increase of the resilience of the irrigation agro-system and for the improvement of sewerage and purification processes.

Many barriers have been identified also in vertical coordination in water policy making and in coordination and capacity challenges. The most important barriers include asymmetries of information between urban and rural areas, mismatch between hydro and administrative boundaries, insufficient financial resources, over-fragmentation of subnational responsibilities and lack of synergies between policy fields at local level. Although the evaluation seems too severe, as it does not consider the historic reasons partially explaining the overlapping of some roles, most of the reported gaps in 2011 unfortunately persist today, in spite of the legislative reforms of the last years (OECD, 2011; Rossi & Benedini, 2020). Most of the difficulties continue to hinder the achievement of the objectives of a better water resources management and an effective soil protection. The fragmentation of responsibility at the national level and the difficulty of coordination between central and regional governments have not been overcome yet. The appeal to the Constitutional Court is very frequent in resolving the conflicts among Regions and State, being reflected into delays in the implementation of laws and measures. In addition, the over-fragmentation of responsibilities at local level has negative impacts on the performance of services as well as on a timely implementation of water works. The most severe deficiency is perhaps the delay in the functioning of the District Authorities, established in 2006 and which was supposed to operate according to Law 221/2015. These delays have likely contributed to reduce the quality of the planning provisions required by the European Directives, which have been prepared by the old National River Basin Authorities (Rossi & Benedini, 2020).

The reform of the municipal water services in Italy (Law 36/1994, the so-called Galli Law) introduces the definition of Ambiti Territoriali Ottimali (ATO – Optimal Territorial Entities), so as to eliminate the extreme fragmentation of water services: the aim was to promote horizontal integration, with only one operator for each ATO, and to have scale economies. Furthermore, the reform provides for the vertical integration of the different water services (potable water, sanitation and waste water treatment plant - WWTP) into a single Integrated Water Service (scope economies) and states for a unified fee system for each ATO: tariffs have to allow for full cost recovery (capex and opex), thus anticipating the provision of the WFD, European Water Framework Directive (EC 2000/60), and highlighting the industrial character of water services. Unfortunately, the reform process was not completed and many areas, especially in Southern Regions, have a very high management fragmentation (Gilardoni & Marangoni, 2004; Gilardoni, 2018; Mazzei et al., 2017).

The modification to the Optimal Territorial Areas, introduced by the Law 42/2010, which has transferred to the regions the responsibility to define the boundaries of the OTAs and the rules to entrust the Integrated Water Service to management companies, contributed to add new difficulties in implementing the reform of the municipal water services and increased the fragmentation of the regulation rules among in case of inter-regional water management (Rossi & Benedini, 2020).

Furthermore, considerable difficulties arise from the uneasy coordination between urban water use, agriculture, land use and energy policies. This is a very important weakness in Italian water policy. Conflict of uses are very frequent among agricultural uses

– very relevant according to the used water volumes – and other uses (domestic, industrial, etc.) and also among different areas in the same catchment (e.g. Po basin). Positive results have been obtained by the Institute for Environment Protection and Research (ISPRA) and of Water Research Institute (IRSA) in their advisor role for Ministry for Environment Land and Sea, particularly to homogenize the working rules of subnational authorities and regional bodies responsible for hydrometeorological monitoring and for sharing available water resources during droughts events (Mariani et al., 2018). The action of the Authority for Electric Energy Gas and Water Systems (AEEGSI), today Authority for Regulation Energy Networks and Environment (ARERA), has significantly improved the surveillance on the municipal water services through new criteria and methods established for management of the supply, sewage and wastewater treatment in particular for the tariff computation and quality service performance.

Evidence from interviews

The analysis of the governance structures required for a resilient water supply has been performed also based on a bottom-up approach, i.e. relying on the evidence from a set of individual semi-structured interviews carried out by IRSA-CNR and DPC with selected water utilities. Among the information collected through the interviews, emphasis has been given to the analysis of the key interactions with both institutional and non-institutional agents involved in building resilient water supply systems and governance structures.

The inter-institutional relationship among water utilities, Civil Protection system and water agencies are highly complex and dynamically evolving and cannot be framed only within the relations among the three cited entities but involve many other public and private institutions.

Five complete interviews have been conducted with WUs located in Italy, and specifically: three with *large* Water Utilities (1 located in central Italy and 2 located in Northern Italy) and two with *small* water utilities (both located in the Northern Italy). Data and information collected during the interviews have been anonymized to protect potentially sensitive information and the main results have been included in the D.T.1.2.4. Six additional interviews have been also performed with selected Italian water utilities partially within MUHA project and partially within a research agreement (ongoing) between IRSA-CNR and DPC. These interviews were mainly oriented to better understand technical procedures and measures for drinking water supply under emergency but provided also relevant insights into the governance system behind emergency water supply including lessons learned from past events. Table 2 provides a summary of the key agents the water utilities need to interact with (mainly under emergency but also 'ordinary' conditions) to guarantee a resilient water supply service. A qualitative strength of the interaction in different phases has been also attributed by the analysts based on the evidence from the interviews. Similarly, the following Figure 3 provides a graphical summary of such interactions. The different 'strength' of such interactions is identified with a different thickness of the arrow, and the interaction with another agent is characterized in terms of 'task' to be performed to increase resilience of WSS in case of hazards. A description/summary is provided afterwards.

Acronym	Full name	Main role	Level of interaction - preparedness	Task (preparedness)	Level of interaction in emergency	Task (emergency)
ISS	National Institute of Health	Research, control and technical scientific advice on public health. Provides guidelines for WSP	✓✓	Information on risks / risk matrix preparation Guidelines and training		
ARPA	Regional Agency for the Protection of the Environment	Environmental monitoring and assessment (e.g. water quality and hazards)	✓✓✓	Information on environmental hazards Information on water quality	✓	Information on environmental hazards Information on water quality
SNPA - ISPRA	National System of Environmental Protection - National Institute for Environmental Protection and Research	Multiple roles, including hydrological analysis and water pollution.	✓	Information on water quality		
CP	Civil Protection System	Civil Protection System encompassing all levels, from the National to the municipal one	✓✓	Definition of protocols and procedures Identification of mitigation measures	✓✓✓	Implementation of protocols Activation of alternative water sources EM measures
ISTAT	National Institute for Statistic	Collects, analyses and structures historical data (e.g. environmental pressures)	✓	Environmental data and statistics		
AdB	Hydrographic District basin Authority	Management of water, soil and the environment at river basin level	✓✓	Information of water quantity and availability	✓✓	Info on alternative water sources
ASL	Local health Agency	Local responsibility and management for public health	✓✓	Hazard characterization (quality)	✓	Monitoring effectiveness of measures
ATO - BC	Optimal Territorial Units and Basin Council	Coordination of public services, such as water supply, at (sub)regional level	✓	Approval of measures/interventions		
REG	Regional Administration	Multiple roles, including e.g. civil protection activities	✓✓	Hazard characterization Record of events	✓✓	Info on alternative water sources Implementation of mitigation measures
PROV	Province	Coordination among municipalities at sub-regional level. They may also support hazard analysis and	✓✓	Preparation of civil protection plan (operation continuity)		

Acronym	Full name	Main role	Level of interaction - preparedness	Task (preparedness)	Level of interaction in emergency	Task (emergency)
		intervention selection				
MUN	Municipality	The major is the local civil protection authority	✓✓	Preparation of civil protection plan (operation continuity)	✓✓✓	Infrastructural repairs Interconnections WSS
ARERA	National regulating agency far energy, networks and the environment	Regulatory and supervisory activities in the sectors of electricity, natural gas, water services, waste cycle and district heating	✓	Service regulation (e.g. tariff)		
OTHER WUs			✓✓	Identification of mitigation measures Best practices Information on WSS Coordination on WSP	✓✓	Activation of alternative water sources Implementation of mitigation measures Mutual support
RES	Research bodies and institutions		✓✓	Identification of mitigation measures Best practices Information on water quantity/quality		
USERS	Users	Require/use water and might provide a feedback on water quality/level of service	✓	Information on service levels	✓	Information on service levels

Table 2 - List of key agents interacting with water utilities in building resilient water supply, as identified during the interviews, and strength of interaction.

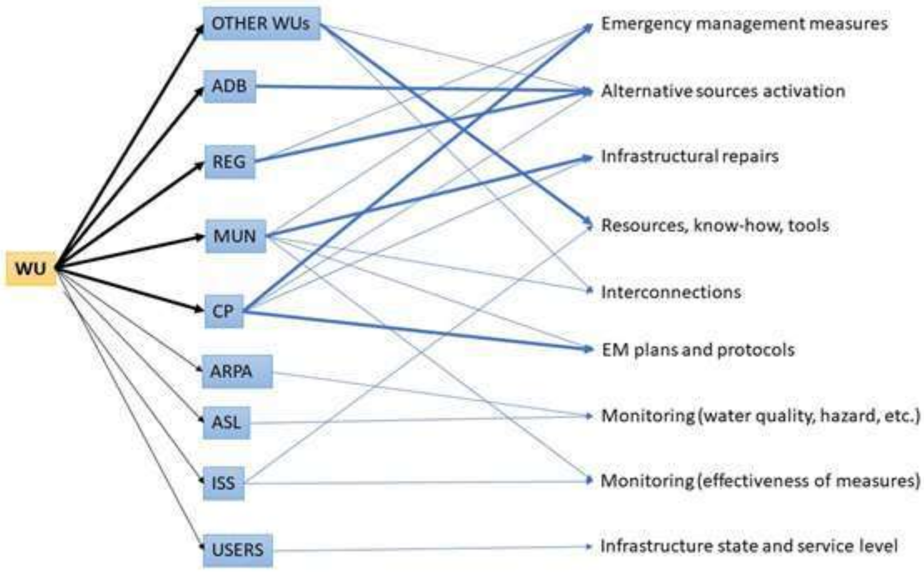

Figure 3 Graphical summary of the institutional relations that directly involve the WU level. The main interactions and relations between the agents that contribute to build the resilience of water supply with specific tasks are described. The focus is on the EM phase.

The present paragraph summarizes the main evidence from the interviews performed with the WUs on the key interactions that occur and that may contribute water supply resilience. Although this summary cannot be considered exhaustive, it provides an interesting view from the practical/operational perspective, as is mainly based on the evidence from past ‘real’ experience.

In the preparedness phase, strong interaction typically occurs with other WUs. Such interactions might be either formal (e.g. with the development of a ‘Consortium’ among several WUs or with mutual/bilateral agreements) or informal, and mainly aimed at enhancing coordination and data/information sharing on hazards and other events. This also has positive impacts in the emergency management phase, as the existence of formal relationships gives additional possibilities such as the activation of emergency/alternative water sources and the exchange of resources, vehicles, personnel etc.

A key role is played by the Regional Administration, as it contributes in the preparedness phase providing information on hazards and specific local conditions (e.g. potential pressures and sources of potential contamination events), as well as (in some cases) on past events. It becomes crucial in the emergency management as it provides info on the potential availability, state and activation of alternative water resources, ultimately interacting in the phase when specific (infrastructural) mitigation measures needs to be implemented. The role of District Basin Authorities is central, particularly in the preparedness phase, as they act as “information providers” on both quality and quantity issues related to drinking water supply, due to their key role of collecting and eventually organizing data coming from different databases. A role is also played by ATO (which is responsible for approving the plan of intervention/measures, which are identified in the WSP).

Interactions with ISS and ARPA also occur, and mainly take place in the preparedness phase. Both institutions are mainly involved in water quality issues, and contribute providing respectively: i) guidelines and training; ii) information on environmental hazards (relevant or water quality). The ASL is also directly involved in providing information on water quality and potential hazards for health. Such institutions are also involved in monitoring activities once the mitigation measures are implemented.

The interaction with Civil Protection is crucial in both phases, particularly at Regional Level, and mainly oriented to the definition of mitigation measures and protocols of action, which are ultimately 'validated' by the Basin Council. The role of CP in emergency management is fundamental, as it provides direct support (facilitating the implementation of mitigation measures) to emergency water supply. In this direction, the interaction with the Municipality is also relevant, as the Mayor is the local authority for Civil protection. The interaction with municipality is also highly relevant as far as the procedures related to the development of new infrastructure are needed (e.g. for changes in land use).

A relevant role has been also assigned to research institutions, as they provide studies and best practices that may drive the selection of suitable mitigation measures and inform decisions.

The interviews performed highlighted that a high level of complexity characterizes the inter-institutional relations related to water governance, and this directly affects the resilience of water supply systems. Although such results cannot be directly generalized at the national level, due to the complexity of the Italian system, a few remarks can be done based on the key concepts pointed out by the interviewees.

- A crucial role is attributed to the agents that perform environmental monitoring activities, particularly as far as water quality issues are concerned (e.g. ARPA, ISS, ISPRA). Such agents produce pieces of information that are important for the hazard analysis and risk matrix preparation, as well as for understanding (and monitoring) emergency conditions and effectiveness of mitigation actions.
- A key interaction occurs with Civil Protection authorities (at different levels) particularly oriented to the definition of protocols of action in case of an emergency. The interaction with CP authorities happens also in case a major emergency occurs.
- The interaction among with WUs is definitely enhancing resilience, being either autonomous or structured (e.g. through consortia). This helps sharing knowledge, information, best practices but also resources, vehicles, tools and equipment to be used in emergency conditions.

Starting from the evidence of the interviews, some gaps and weaknesses were also highlighted:

- Very limited interaction occurs with the users, which are currently not directly involved/consulted although their role could be considered highly relevant e.g. for water quality assessment and monitoring.
- An increased coordination is required with ARPA and ASL (mainly for water quality information exchange), as well as with the Municipality (responsible for emergency management activities) and with the District Basin Authorities (for both water quality and quantity issues).
- An improved coordination among WUs should be fostered, as it would allow sharing skills and know-how but also increasing the flexibility in water resources management (e.g. with agreements on mutual support).
- An improved cooperation with the CP is also suggested to enhance the definition of protocols and procedures. A stronger interaction between the Civil Protection System and the water utilities could be possibly based on shared information

platforms, which could foster the integration and coherence between plans and information.

- Finally, the problem of identifying a fast communication flow among agents in case of accidental pollution events potentially impacting on the quality of resources has been remarked (for example well clusters in case of accidental spillage).

Recommendations for optimal governance structures for resilient water supply

During the activities of the MUHA project, the critical issues concerning the cooperation between the Water Utilities, the Water Authorities and the Civil Protection Authorities have already been partially examined, also in the context of the organization and implementation of the Table-Top Exercise (TTX) (see D.T.2.3.3 and D.T.2.3.4 for further information).

Based on the activities carried out to date, some useful indications and recommendations can be proposed to improve resilience of the water supply systems, both in emergency conditions and in ordinary conditions.

First of all, given the significant analytical capacity of Bodies and Institutions, however, often referring only to institutional activities and the presence of numerous sector-based procedures, often fragmented and inconsistent with each other, it is necessary to strengthen the existing interinstitutional coordination tables both at national, both at the river basin district level, or at the regional and / or local level. The establishment of efficient interinstitutional coordination tables allows the sharing of data and information, the continuous updating of the event and impact scenarios, the shared choice of monitoring and evaluation methodologies, the rapid exchange of information, the coordination of mitigation measures, etc.

To achieve this strategic objective, the Ministry of Environment has promoted the establishment, in July 2016, of the permanent **Observatories of Water Uses** (OWUs) (Osservatori Permanenti per gli Utilizzi Idrici), at each District Basin Authority (Figure 4).

Figure 4 Meeting of the Po River District Basin Observatory of Water Uses. Source: Po River District Basin Authority.

The OWUs are collegial bodies with tasks of collection, analysis and joint evaluation of data on meteorological variables and water availability, in support of Institutional bodies competent in the management of water resources. It is constituted by all the key actors (both public and private) involved at the different levels and with different roles in the water governance. In addition to constituting a specific measure of the District Management Plans, the OWUs address the need to provide technical support to a new water governance, which takes into account the considerable complexity of water resource management, understood in a broadest sense, i.e. including knowledge of infrastructures, the considerable diversification and interdependence of uses, the extent of withdrawals, etc. Therefore, an innovative governance based not on the rigid division of competences, but on the sharing of information frameworks, dialogue between the parties and cooperation (Carlo & Colaizzi, 2019; Zucaro et al., 2017).

The OWUs are the "participatory body" for the sharing of available information by the competent actors who, having taken note of the expected scenarios, plan and implement the interventions, activities and measures aimed at the prevention and mitigation of water crises. If implemented with the necessary timeliness, these actions allow to considerably reduce the impacts of drought and water crises and other crises resulting in a reduction of the available water for different uses.

It should also be taken into account that the OWUs are a measure of the Water Management Plans of the River Basin Districts and that their establishment has been recognized by the European Commission as a useful element for the improvement of the application, on the Italian territory, of the Water Framework Directive 2000/60/EC (Checcucci, 2017). In addition, it should be considered that the establishment of the OWUs also responds to the request of the National Strategy for Adaptation to Climate Change, adopted by the Directorate Decree of the Ministry of Environment n. 86 of June 16, 2015 to provide an effective participatory approach in activities to cope with the effects of climate change.

The OWUs also operate as a control room for the forecasting and management of water scarcity and drought events, ensuring an adequate flow of information, necessary for the identification of alarm levels, its evolution, ongoing withdrawals, and for the definition of the most appropriate actions for the proactive management of scarcity events. The activities of the OWUs are obviously set according to the various management scenarios and hydrological severity, according to a criterion of proportionality and efficiency.

The activities of the OWUs are basically aimed at the monitoring of meteorological variables (precipitation, temperature, etc.) and water availability: volumes stored in reservoirs or regulated lakes, outflows of the water network, extension of snow cover, water equivalent of snow, flow rates from wells and springs, piezometric levels, etc. Usually the time evolution of these indicators is compared with the historical reference averages or with the values assumed by these indicators during significant water scarcity events.

This measure is highly effective both in the preparedness phase and during the emergency management phase, when the Observatories are transformed into real control rooms for activities aimed at mitigating drought. The rationale that led to the establishment of the Observatories was to create a permanent collegial structure to support decisions, which ordinarily collects, processes and shares data and information on the trend of the meteoclimatic variables (rainfall, temperature, etc.) and water availability, useful for making transparent, technically and scientifically based decisions. Furthermore, with the establishment of the Observatories, a decisive step was taken in the direction of overcoming the "reactive" emergency logic that had characterized so far the management of water crises.

The Observatories also constitute the privileged seats to foster exchanges between the scientific community and those who are responsible for implementing the policies. The establishment and organization of the Observatories has already been discussed in the context of D.T.1.1.4, to which reference should be made for further details.

It is obviously necessary that the Water Utilities can be part, directly or indirectly, of the Observatories, and that they can benefit from the significant information flow that is established in the Observatories and / or in the context of regional coordination tables.

As it has also been demonstrated in the context of the TTX, the effective deployment of measures to prevent and mitigate water crises, often not without consequences from a political point of view, takes place according to the severity of the event and impact scenarios, whose timely knowledge and awareness on the part of the actors is essential.

The establishment of a **technical coordination table**, both at regional and district level, is a key measure also for the purposes of mutual knowledge of the roles, activities and powers of the numerous bodies in various capacities responsible for the management of water resources, for the control of water quality, water regulation, civil protection activities, etc.

In this regard, the **continuous dialogue with the stakeholders** is crucial to acquire data and information useful for assessing the “boundary conditions” of a hazardous event in terms of uses, water needs, critical factors, even temporary ones, possible conflicts of uses, impact scenarios, etc. Stakeholders may include associations representing irrigation operators, water utilities trade associations, representatives of the agricultural and industrial world, regulatory agencies, etc. These groups must be involved from the onset and continuously so that there is a clear and effective management and planning of water scarcity, for example resulting from drought. Failure to involve stakeholders can prevent real progress in planning and exacerbate any existing conflict, in particular among users (drinking water, irrigation, industrial, hydroelectricity, etc.) and among different territories of a hydrographic basin.

In general, the generalized lack of procedures aimed at coordination between the different Bodies constitutes one of the weaknesses of the system and, for this reason, **the role of the district basin Authorities must be strengthened**, which constitute the framework to foster the agreement and concertation between the institutions involved in the protection, use and governance of the resources of the territorial system, in line with sustainable social, economic and environmental development.

The reform of the District Basin Authorities implemented in 2015 constitutes a fundamental moment in the process of reducing the fragmentation of decision-making bodies, which represents one of the weaknesses of the governance of the water sector.

At the district level, the District Authority has the following main responsibilities: (i) drawing the district plan and the plans required by the European Directives and the plans for actions, (ii) checking the coherence between the objectives of the district plan and the measures of planning and programming at European, national, regional and local levels on soil defence, fight to desertification, water resources protection and management and (iii) analysing the impacts of human activities on surface and groundwater resources as well as an economic analysis of water uses.

According to the modifications of Law 221/2015 to the Environmental Code, the District Authority is formed by the following bodies (Rossi & Benedini, 2020):

The **Institutional Conference**, including the presidents of the regions which belong to the district, the Minister for Environment Land and Sea, the Minister of Infrastructures and Transport, the Chief of the Department of Civil Protection and also the Minister for Agriculture, Food and Forest Policies and Tourism and the Minister for Goods and Cultural Activities, if the topics to be discussed require their intervention. The main undertaking of the Conference is to deliberate the “Statute”, to draw up and to adopt the planning tools (including the District Water Management Plan and the Flood Risk Management Plan (required by the European Directives). In addition, the Conference has responsibility of drawing up the Hydrogeological Asset Plans and the Extraordinary Plans for areas under high risk (except for Autonomous Regions). It is entrusted with the protocols of agreements for water inter-basin transfers.

The **General Secretary**, who provides the necessary actions for the functioning of the Authority, for implementing the directives of the Operative Conference and the data collection.

The **Operative Conference**, in addition to the representatives of the public administrations, which are already members of the Institutional Conference, including also the representatives from agricultural organizations and from the Association of Land Reclamation Consortia (ANBI). Experts (without voting rights) may be included to give advice on the plans and on the programs to be carried out.

The **Technical Operative Secretary**.

According to the Law 221/2105, in Italy the following districts have been defined: (1) Eastern Alps, (2) Po valley, (3) Northern Apennines, (4) Central Apennines, (5) Southern Apennines, (6) Sardinia and (7) Sicily (Figure 5).

Figure 5 Map of the Italian Hydrographic District, after law n. 221/2015. Source: Website of the Italian Institute for the Protection and Environmental Research (ISPRA - https://www.isprambiente.gov.it/it).

Recently, a tool for citizen participation has been introduced through the River and/or Lake Contract, which can contribute to the definition and implementation of the district plan in the fields of protection and management of water resources, development of river basin and defence from hydraulic risk, as regulated by Article 59 of Law 221/2015.

Accurate basin planning is one of the most urgent measures to be taken, also due to the universal use of water and the consequent scarce use in resorting to sector planning alone. Basin planning includes in some cases specific documents aimed at managing water crises, often resulting from drought.

In this regard, it is worth citing the case of the Drought Management Plan (DMP) of the Po basin, made up of attachment 3 to the Water Balance Plan of the Hydrographic District of the River Po (link: http: //www.adbpo .it / PBI / Plan_adopted / Attachment3_Piano_Gestione_siccita_07_12_2016.pdf).

The DMP is requested by the European Commission as a priority action to reduce the impacts of drought events, also in the perspective of climate change. The DMP is the key element to ensure a proactive approach to managing drought risk, which means:

- study the situation: learning about the climate and its variability, through the use of scientific and shared parameters; assessing the use of the water resource;
- hypothesizing possible scenarios for reducing water availability and identifying the most vulnerable components of the system;
- assessing the negative impacts on socio-economic and environmental systems;
- identifying and planning the actions and countermeasures to be implemented in case of drought, to reduce negative impacts;
- identifying the necessary measures to recover damage after the dry event.

The DMP for the Po River Hydrographic District is based:

- on the monitoring of meteorological-climatic and water availability indicators shared and recognized at national and European level: Standardized Precipitation Index (SPI), Standard Runoff Index (SRI) or Standardized Flow Index (SFI), Surface Water Supply Index (SWSI), RUN Method, FAPAR, Fraction of Absorbed Photosynthetically Active Radiation, Groundwater level (H), SSPI: Standardized SnowPack Index, Soil moisture, WEI +, Water Exploitation Index Plus;
- on the definition of four possible scenarios of water severity (non-critical scenario, low, medium and high water severity) corresponding to different Operational Phases and protocols on the activities to be carried out .
- on impact and vulnerability studies, which impact study analyse the damage resulting from drought, the vulnerability study searches for specific causes.

The choice of measures to be implemented for the mitigation of drought events is sized according to the severity of the different scenarios (Pereira et al., 2009; Rossi et al., 1995; Rossi, 2000; Rossi et al., 2007). In general, the measures and interventions to be implemented are related to the types mentioned above, but must be chosen according to the type of hydrographic basin, hydrological variables, users, etc. Therefore, each District and Region Basin Authority selects the measures to be implemented according to their specific characteristics and methodology for the identification of thresholds for the activation of measures.

A very interesting approach is carried out by the Po River District Basin Authority and by local actors for regional and minor basins, with the participation of universities and local administration. The key to definition of measures is impact and vulnerability assessment (Musolino et al., 2019). The main tool adopted in the Po valley District, called "Sicc-Idrometro" ("Drou[ght]-hydrometer"), is a shared visualization tool of the impacts of low flow periods on river discharge, developed for the entire basin. It consists of a thematic map of the whole rivers in which, at every reference cross-section, the major impacts are represented versus discharge value, in order to make the effects of water management (effects of upstream withdrawals or release, etc.) clear to all the upstream and downstream users. Based on "Sicc-Idrometro", draft set of actions to be carried out at each local node during real-time management is identified, to be submitted for discussion during the meetings of the Observatory of water uses (Figure 6).

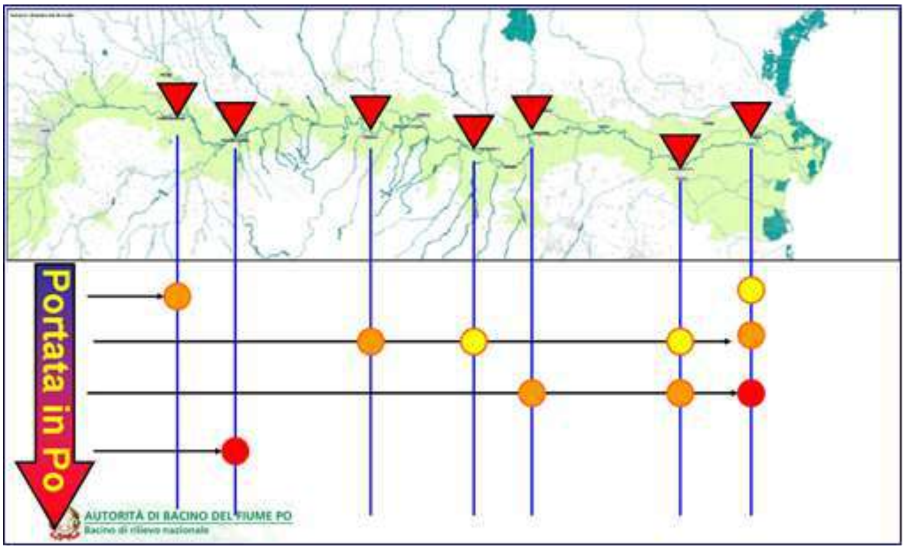

Figure 6. Schematic representation of the "Sicc-Idrometro". The writing in the red arrow stands for "Discharge in the Po River" (Source: Po River District Basin Authority).

For example, if the Po River discharge at the Delta is less than 600 m^3/s, then the sea water intrusion occurs and, consequently, difficulties for irrigation.

It is worth noting that "Sicc-idrometro" is not a top-down tool, but is a result of a prolonged dialogue between Po River District Basin Authority and the stakeholders. It is a result of participative process. The added value of this tool is that links discharge values to impacts, and, in turn, impacts to mitigation measures that must be defined "a priori" and not during the crisis. This is a real example of implementation of a proactive approach instead of a reactive approach.

The Observatory has the task, using the cognitive frameworks made available by the Early Warning DEWS-Po system and by the competent Regional Agencies, to define the level of water severity in place and promote the corresponding actions.

Generally speaking, a drought management plan should consider some key points, including (Wilhite et al., 1999; Wilhite, 2005):

- purpose and role of state or regional government in drought mitigation and response efforts;
- scope of the plan;
- most drought-prone areas of the state or region;
- historical impacts of drought;
- historical response to drought;
- most vulnerable economic and social sectors;

- role of the plan in resolving conflict between water users and other vulnerable groups during periods of shortage;
- current trends (e.g., land and water use, population growth) that may increase/decrease vulnerability and conflicts in the future;
- resources (human and economic) that the state is willing to commit to the planning process;
- legal and social implications of the plan; and
- principal environmental concerns caused by drought.

The plan aims at assessing drought conditions, developing mitigation actions and programs to reduce drought risk in advance, and developing response options that minimize economic stress, environmental losses, and social hardships during drought (Wilhite et al., 1999).

A drought management plan, and water scarcity in general, must however also include the possibility of a civil protection plan aimed at guaranteeing the minimum water supply for drinking water supply: these plans, unfortunately not very widespread, include emergency measures aimed at mitigating the impact of water crises on the population. These plans therefore provide for the use of means and devices such as, for example, water tankers, water bags making machines, provisional pipes, aimed at allowing the population to have a minimum daily quantity of water for indispensable needs. It is important to underline that these measures only allow to reduce the discomfort for the population and not to intervene in a structural and definitive way on the factors that originated the water crisis: for this reason, it is essential that, once the emergency has been overcome, structural interventions aimed at improving the efficiency and strengthening of water supply systems are properly planned.

The role of early warning systems is central in the activities of the Observatories, such as, for example, the early warning systems for drought (Drought Early Warning Systems - DEWS) (Rossi, 2003) which, as mentioned above, must refer to weather and climate indicators and water availability, shared and recognized at national and European level. The authority and credibility of early warning systems is measured in fact on the unanimous recognition by the users of the reliability, adequacy, and representativeness of the indicators.

As seen during the TTX, this knowledge is particularly relevant for the purposes of a timely preparation and implementation of mitigation measures. In this regard, the regular and periodic organization of exercises involving all the different actors who can intervene for the purpose of a better resilience of the water supply systems constitutes a powerful tool for identifying weaknesses, operations for improvement, necessity to acquire further information, etc. For example, the need to identify in time the so-called "strategic users", in many cases not yet carried out, constitutes at the same time the recognition of a weakness in the system and the identification of a possibility for improvement in preparedness.

In the specific case of the exercise performed in the framework of the MUHA project - but also extendible to other cases - it should be noted that the exercise allowed to outline not only a significant "reactive" type of response model but a more complex, comprehensive and innovative "proactive" type model. It also includes measures to be implemented to mitigate the most critical effects: for example, the prior organization of technical assessment activities aimed at ascertaining and quantifying alternative water resources constitutes a measure that must necessarily be planned before the emergency, but which can lead to a reduction of pressure to available water resources in the Ridracoli basin, partially mitigating the ongoing water crisis.

These measures require in-depth knowledge not only of the water supply systems, but also of those of the neighbouring areas, of the users' water needs, of the possibilities of addressing the needs to alternative sources. It is quite clear that the knowledge of these aspects cannot be entrusted to a single subject, but must be considered attributable to a plurality of Bodies and stakeholders. In this context, it should be noted that the "bottom up" methodological approach adopted for the organization of the exercise appears preferable instead of a "top down" approach due to the existing conflict of uses and the management issues, as well as the numerous actors in various capacities in charge for water management.

However, the model adopted cannot be considered valid for all cases but must necessarily be suitably differentiated according to the types of WSS. The supply system in question has the peculiarity of being dedicated exclusively to drinking water users; other situations present a multiplicity of different users that must be duly taken into consideration, especially in conditions of "attention" and "early warning".

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b. Slovenia

Introduction

Climate change response implies the resilience of the water systems and necessary modifications to infrastructure design practices, investment analysis processes, and policy decisions regarding financing and disaster risk management. A mainly proactive, than a reactive, set of actions combining preparedness, emergency responses, efficient operations, and both near and longer-term measures are stressed as a challenge for water utilities. Flexibility and adaptability in strategies and plans contribute to resilience building as uncertainty in future conditions pressure to response to new information over time.

According to the Water Global Practice of the World Bank Group, improvement of water utilities' climate resilience goes through three phases: a. knowing the system, b. identifying vulnerabilities and c. choosing actions. Knowing the system starts with participatory work in which an extensive team (including planners, operators, other stakeholders) identifies the problem and critical elements of the system and the potential threats that may affect these elements, the consequences of elements failure, the performance objectives and the available solutions. This scoping identifies tools, data, and models to be used in the subsequent phases. Identification of vulnerabilities requires stress-tests in the water system over a range of plausible futures and assesses its performance under different conditions. Analysts also identify options that reduce vulnerability and improve the performance of both the system as a whole and of critical elements over the same range of futures. The whole process results in the organization of the pre mentioned options into potential robust, flexible strategies and examination of the trade-offs among them in meeting the resilience objectives (World Bank Group, 2018).

In this context, the present report including deliverables of the Activity 3.2 of the MUHA project, intends to cover key issues regarding water safety planning mechanism oriented to the improvement of service resilience under a multi hazard management risk approach. For this purpose, the report is structured on the identification of the key bottlenecks for the implementation of services related to the water utilities safety planning requirements, on the basis of information stemming from water safety and emergency response mechanism (mapping of the institutional structure and inter dependencies of agencies involved), SWOT analysis outcomes performed at both national and water utility's level, as well as the findings of the testing phase carried out using the water safety planning tool (risk assessment component) developed under the MUHA project (MUHA tool box) in the pilot activity of the Municipal Water & Sewerage Company of Larissa (PP11).

Furthermore, a report on the Key guidelines for the improvement of inter-agency operation services, on the basis of the Incident Command System (ICS) organization, in the field of water supply resilience is included. In this report, except for the above mentioned elements, information stemming from evaluation of a Table Top Exercises conducted in the water utility's area, simulating an earthquake emergency incident with the activation of the key agencies involved according to the response mechanism, is also considered. Finally and based on the aforementioned points, an effort on drawing the key recommendations dealing with the improvement (optimization) of governance structures at local level for resilient water supply is made.

D.T3.2.1. Report on key bottlenecks for the implementation of services and their requirements - Slovenia

As the revised Drinking Water Directive (98/83/EC), adopted in Dec 2020, is not yet transposed into Slovenian legislation, all existing practices aiming at the drinking water safety are still more or less related to HACCP protocols. There is draft of the Decree on Drinking Water from 2017, but was not officially adopted. In this document the term “Načrt za zagotavljanje varnosti pitne vode” which translation would be similar to “Plan on assuring safety of drinking water” can be found. This can be taken as an attempt to establish the new approach of water safety in the country, but it also can be seen just as an improved version of HACCP and not as holistically taken WSP. Mentioned document is concerning more or less just on the health approach of water safety (with HACCP critical control points) and is not dealing with any probabilities, or even mentioning the standard SIST EN 15975. If the standard is taken in concern by the utilities it is by the municipality documents – Technical guidance for specific municipal utility or as a good practice from utility employee personnel.

According to the mentioned draft of the new Decree (which was not officially published) the National Institute for Public Health and National Laboratory for Health, Environment and Food were organizing the workshops on this thematic. Few Utilities already started to improve their HACCPs in the documents named as “Načrt za zagotavljanje varnosti pitne vode”.

According to The WHO Status Report on Water Safety plan from 2017 in Slovenia at least 10 WSP have been implemented, none of them in the rural area. In the feedbacks from the questionnaires from the utilities, three out of four utilities stated that they already have Water Safety Plans.

The main conclusion after a general overview on water safety the priority would certainly be to first transpose the Drinking Water Directive (98/83/EC) to Slovenian legislation, so the rules for the WSP would be clearly defined. Also the regulation with a specific emphasis on regulation of reporting the events would be really welcomed.

Despite the fact that there is no regulation concerning implementation of WSP there are a few water utilities who already started establishing those documents. This is seen as very positive as shows there is a common sense that HACCPs documents for establishing safe and uninterrupted water supply is not enough. Those documents in general are good foundation for WSPs. We still have to acknowledge that the difference among small (rural) and big water utilities is pretty big.

2.1 Evaluation of the toolbox in making of PA Water Utility WSP

General comments (link to WPT2 reports)

- *Is the reporting structure of the toolbox useful for the development of WSP?*

While the toolbox is useful and well addressing the components, hazards and consequences, the relation to the implemented measures (existing measures, planned measures) is not fully elaborated. It was acknowledged that this is extremely demanding task, which is probably beyond the scope of the MUHA project, but is recognized as an important way forward in the development of the comprehensive tool supporting the implementation of the EU directive.

Translation to national language is important for the further dissemination of the toolbox among all water utilities in Slovenia. The translation process would open another important dimension of cross-country harmonization and exchange of information on probabilities on hazards in trans-national context.

- *Is there any specific report that is not exported from the MUHA Toolbox? Can you recommend any (e.g. near misses recording)?*

The toolbox was identified as significant leap forward in the implementation of the new EU Drinking Water directive. With the overall transposition of the directive in Slovenia lagging behind it was difficult to assess which additional modules or reports might be in additional to existing content necessary for the MUHA toolbox. Therefore, the Slovenian stakeholders are not fully acknowledged regarding the requirements arising from the recast directive.

- *Which kind of information included in the MUHA Toolbox is considered as the most useful for the development of the WSP?*

Overall assessment of the toolbox was warmly welcomed by the target users. There are several arguments supporting this, defining their usefulness:

- The toolbox provides the educational framework as well as standardization framework for the water utilities. The standardization is currently in Slovenia at low level and the water utilities are left to large extent on their own when developing the water safety plans (currently developed on the level of HACCP assessment and procedures/measures).
- Most useful information is embedded in the concept of standardization of the ontological framework of risk management of overall domain of water supply system management and risks related to the operation of water supply systems. The knowledge on the risks is usually dispersed among different specialties and sectors and difficult to integrate and harmonize. Further work on the standardization and even improved ontological description of all dimensions is recommended.
- Close link to national legislation would be appreciated – while the toolbox and the MUHA project is clearly supporting the implementation of the EU Drinking Water directive, closer and more explicit connection to the governing processes defined by the national legislation would provide additional functionality to the toolbox.

- *Are there additional information/data you started collecting after the use of MUHA toolbox? why?*

The necessity for additional collection was related mainly to the components of the water supply system. This is related to the development of the hydraulic model, which is recognized as extremely demanding in relation to the component information. For the purpose of the IWSP development and the toolbox use the large set of potential components was at the first stage quite dazzeling.
Next component relative to the MUHA toolbox was probability of the occurrence of the hazards, which is quite demanding. Analysis of the consequences of the occurred events are due to the relatively simple concept of the water supply system pretty much straightforward. Nevertheless, with the development of the hydraulic model the understanding the consequences of the failure consequences will be significantly improved.

- *Which do you think should be the MUHA toolbox re-evaluation period?*

Important issue in any supporting system (software) development should be also its maintenance and periodical review. Re-evaluation is part of the maintenance process, which should be defined. While the MUHA project is recognized as a knowledge development process, verification of the tools and network development, it is quite clear now that due to its importance better defined maintenance process of the toolbox should be quite rapidly developed.
While further development by nationally responsible institutions (national agencies) is clearly an option, it is was recognized that close transnational cooperation should also be envisaged and part of the toolbox maintenance and re-evaluation.

- *Which do you think (in your case) is the appropriate time frame for the revision or update of the WSP?*

During the discussion it was recognized that for the transnational revision might be appropriate period once a year, which is also a general reporting cycle for several reporting and systems. This would encompass the findings and changes performed on the toolbox and its classification and defined interconnections among components-hazards-consequences (and measures).

- *Are there "components" of your water supply system not considered or partially considered by the MUHA toolbox? If so, which ones?*

There are no "components" of our water supply system that the MUHA tool does not consider.

- *Is the MUHA toolbox comprehensive of all the hazards potentially impacting on the analysed water supply system (WSS)? Can you indicate possible hazardous events not included in the toolbox?*

MUHA toolbox is comprehensive enough and we have not noticed any possible hazardous events missing.

"Drought" hazard

Drought hazard was not addressed in Kamnik Water supply system (Kamnik PA).

"Flooding" hazard

Different components can be correctly evaluated through MUHA toolbox on a simplified way – enabling identification of hazards and risks. For detailed quantification additional studies are needed (e.g. flood modeling) including detailed georeferenced spatial data. Development of hydraulic model increases the knowledge of the adaptive capacity of the system in case of floods.

The MUHA toolbox covers several hazardous events related to floods and there was some difficulty assessing them due to the lack of internal information.

External data like official flood and erosion maps are available, but not for the area of the whole system of Kamnik water supply. With the help of this information areas with higher flood risk are determined.

The input data to the MUHA toolbox are mostly based on experts' opinion and experience regarding past events (data related to the probability of hazardous events) or based on measured information, like water flow, levels and pressure.

The civil protection unit plays no specific role in preparation of water safety plan, but is of course still part of it. The tasks related to the crisis management (addressing also the standard EN 15975 Part 1 Crisis management (06/2011)) are also in line with the module 8 of Water safety plan manual (WHO, 2009), where the water utility is instructed to prepare management procedures, including emergency response plans. Improvement of coping capacity cooperation leads to proper and timely response in case of all hazards.

Ministry of Health together with Ministry of the Environment and Spatial Planning must first transpose the Drinking Water Directive (98/83/EC) to Slovenian legislation, where also the specific institutions related to preparation of WSP would be defined. Outcomes of the MUHA project could contribute to this process.

"Accidental pollution" hazard

Different components can be correctly evaluated through MUHA toolbox on a simplified way – enabling identification of hazards and risks. For detailed quantification additional studies are needed (e.g. DPSIR, groundwater model) including detailed georeferenced spatial data. Approach to accidental pollution in Kamnik includes identification of all threats with e.g. DPSIR analysis. Assessment of the impact on water resources included using 2D groundwater model for Iverje groundwater source with different scenarios. Development of hydraulic model also increases the knowledge of the adaptive capacity of the system in case of accidental pollution.

The MUHA toolbox covers several hazardous events related to accidental pollution and there was some difficulty assessing them due to the lack of internal information.

External data is available on data portal Atlas okolja, where the different data regarding the potential pollution sources could be find (SEVESO locations, IED locations, emissions to water from industrial plants, roads – traffic). With the help of this information areas with higher accidental pollution risks are determined.

The input data to the MUHA toolbox are mostly based on experts' opinion (data related to the probability of hazardous events) or based on measured information, like water flow, levels and pressure.

The civil protection unit plays no specific role in preparation of water safety plan, but is of course still part of it. The tasks related to the crisis management (addressing also the standard EN 15975 Part 1 Crisis management (06/2011)) are also in line with the module 8 of Water safety plan manual (WHO, 2009), where the water utility is instructed to prepare management procedures, including emergency response plans. Improvement of coping capacity cooperation leads to proper and timely response in case of all hazards.

Ministry of Health together with Ministry of the Environment and Spatial Planning must first transpose the Drinking Water Directive (98/83/EC) to Slovenian legislation, where also the specific institutions related to preparation of WSP would be defined. Outcomes of the MUHA project could contribute to this process.

“Earthquake” hazard

Different components can be correctly evaluated through MUHA toolbox on a simplified way – enabling identification of hazards and risks. For detailed quantification additional studies are needed including detailed georeferenced spatial data. For determining the earthquake risk, an earthquake hazard map (ARSO, 2001) and records of past events were studied, and potential weak spots determined. National earthquake rapid response system (URSZS POTROG, 2019) was used for help with assessment of the consequences of the earthquakes on buildings and people. Development of hydraulic model also increases the knowledge of the adaptive capacity of the system in case of earthquake.

The MUHA toolbox covers several hazardous events related to earthquake and there was some difficulty assessing them due to the lack of internal information.

External data is available on data portal Atlas okolja, where the data regarding earthquake risk could be find (earthquake hazard map). With the help of this information components with higher earthquake risk are determined.

The input data to the MUHA toolbox are mostly based on experts’ opinion (data related to the probability of hazardous events) or based on measured information, like water flow, levels and pressure.

The civil protection unit plays no specific role in preparation of water safety plan, but is of course still part of it. The tasks related to the crisis management (addressing also the standard EN 15975 Part 1 Crisis management (06/2011)) are also in line with the module 8 of Water safety plan manual (WHO, 2009), where the water utility is instructed to prepare management procedures, including emergency response plans. Improvement of coping capacity cooperation leads to proper and timely response in case of all hazards.

Ministry of Health together with Ministry of the Environment and Spatial Planning must first transpose the Drinking Water Directive (98/83/EC) to Slovenian legislation, where also the specific institutions related to preparation of WSP would be defined. Outcomes of the MUHA project could contribute to this process.

2.2 Evaluation of PA goals fulfillment

The Kamnik pilot action goals are as described multiple, covering a broad scale of goals, recognizing also the complex reality of the water supply system management. Primary goal – the implementation and learned lessons in using the MUHA toolbox in the development of the improved water safety plans was fulfilled. In relation to this it is also recognized limitation in the available human resources at the water utilities, especially small water utilities. This strategic goal was supported by more specific goals: measurement campaign of defining the discharges in the key points of the water supply system supporting the development of the hydraulic model, which is also part of the MUHA pilot action. This is closely linked to the purchase, installation and full integration of the MUHA equipment for the headquarters of the Kamnik Civil Protection and represents the support elements of the Civil Protection HQ (operations, planning, logistics, administration and support). In the MUHA project this is developing a closed link between the part 1 and part 2 of the EN 15975 defined procedures. With the final stage of the pilot action – hydraulic model in the closing stage we can assess that almost all main goals are achieved. With the recognized impact developed also with the dissemination activities of the MUHA project the developments are also quite widely recognized in Slovenia.

2.3 Addressing weaknesses/bottlenecks in the implementation of the multihazard management – Water Utility Level

Although water utilities in Slovenia are required to have a plan for case of water scarcity and an alternative source in case of droughts and pollution of water sources, few do so. This is connected to various reasons – mostly that this issue has been transferred to the local community level. Therefore, local communities have to find solutions inside their own territory which is usually hardly possible. Ideally, they would find common solution for multiple local communities from the same "region", but this is always connected to financial obligations and good cooperation of neighbouring municipalities. So it would be necessary to transfer this issues to national level.

Monitoring at the local level is also lacking as most water utilities consider it unnecessary as they do not face water shortages frequently. Water scarcity is a problem mostly in Slovenian Istria and in the north-eastern part of Slovenia during the summer tourist season. The solution would be a forecasting model to define hydrological water deficit, which would be the basis for decisions regarding the measures for different phases of water deficit.

A big weakness at the national level is the lack of legislation that includes mitigation and adaptation to climate change. This poses a threat at the local level. Another weakness is also that there is a large number of small water utilities. In the once adopted operational program, the merging of functions has already been adopted. The measure is politically problematic, so it is put on hold.

In most cases when flood event impacts the water supply system, the water intake has increased turbidity and with that increased raw water treatment might be necessary. As a consequence, provision of drinking water of adequate quality might be affected if the treatment (i.e. ultrafiltration) is not adequate. This issue usually affects the WSS with intake from karstic springs.

Other (chain) events related to floods can also happen:

- pumping stations get flooded – flood proof pumping stations are needed;
- erosion around the water supply main where the pipes are positioned directly next to the river - improved planning on areas exposed to erosion;
- damages to water supply suspended on the bridges – improved planning of water supply system;
- landslide next to the drinking water reservoir causes comprehensive pipe break in the road infrastructure - improved planning on landslide areas.

Major parts of WSS in Slovenia were constructed before the implementation of EU standards – Eurocode 8 - Design of structures for earthquake resistance and even previous ones, so there is a possibility that some WSS components are not earthquake resilient.

While aged infrastructure is on one hand a weakness, this is also an opportunity. Namely aged infrastructure is currently under intensive rehabilitation investment cycle, providing an opportunity to improve overall functionality and resilience of the structures, that include also earthquake resilient construction. International partnerships and exchange of experiences as well as information sharing are a great opportunity, supporting these efforts.

Water Safety Plans and HACCP procedures are not addressing earthquakes. Therefore, a need for guidelines in that regard is crucial and should also include advice on operational inspections and inspections of infrastructure after earthquakes, enabling more rapid, effective and efficient re-establishment of water supply after earthquake events.

D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply - Slovenia

Guidelines were developed to overcome gaps and weaknesses identified with the improved water safety plans. The guidelines will be based upon the ICS (Incident Command System) theory. In addition, guidelines should be structured on the Inter-agency operation services that strongly affect the capacity of the key water services (water utilities, water authorities-local/regional level, institutions) to meet incident requirements (within the framework of the multi hazard risk analysis and management).

3.1 Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs)

All the activities were performed with an overall objective to improve some aspects of the risk management of the Kamnik water supply system and provide testing platform for the development of the overall framework for the implementation of the water safety plans.

The pilot activities adopted in the PA:

- Development of improved coping capacity, with specific focus on the equipment for the civil protection headquarters of the Kamnik Civil protection.
- Development of the hydraulic model for the Kamnik Water supply system.
- Measurements of discharges on the Kamnik Water supply system (as a sub-measure for the calibration of the hydraulic model).
- Development of the reporting system for the improved understanding of the probabilities of critical events on WSS.

All implemented activities are important step to preparation of improved water safety plan. As the revised Drinking Water Directive (98/83/EC), adopted in Dec 2020, is not yet transposed into Slovenian legislation, all existing official practices aiming at the drinking water safety are still more or less related to HACCP protocols.

Improved coping capacity cooperation can always be further improved as it was recognized also in the table top exercise held in Kamnik. With the developed procedures based upon the standard ICS (NIMS Incident Command System) protocols overall improved response in the case of any hazard could be expected. Further improvement would also be connected with user-friendly tools for managing the different headquarters and daily reports.

Hydraulic model increases the knowledge of the adaptive capacity of the system in case of all hazards, but the model can always be upgraded and improved with availability of new data (especially measured data of the system SCADA). This also means that some information regarding the adaptive capacity could change significantly.

The motivation of developed reporting system for the improved understanding of the probabilities of critical events on WSS is (1) to early identify the causes of the event and the causes of it and (2) to take measures to prevent the event from recurring under comparable conditions (systematic learning at events).

This is also the basis for probabilistic event analysis and risk analysis. The purpose of reporting and probabilistic evaluation is not punishment of water supply system operators, but significantly improved risk management process. We recognize a need to establish national incident and disaster systems, to transpose Directive 2019/1937 and to establish an international exchange of probability data on events occurring on the water supply systems. Unfortunately, the standards defining the risk management and asset management are not supported in a way that would enable the collaborative exchange of the probability statistics of incidents, accidents and near-misses, while on the other hand EU is addressing the importance of similar reporting also by the EU Whistleblower protection directive (2019/1937). We recognize this gap and necessity to systematically address it.

Important issue is also transposition of the revised EU Drinking water directive into Slovenian and local (municipality of Kamnik) legislation. Only the transposed legislation will provide a firm background to the implementation of the Water Safety Plans.

3.2 Table Top Exercise Results to define and bridge inter –agency operation services

Civil protection in Slovenia is organized at the local, regional and state level, and connects the resources and capabilities of participants, operational forces and citizens into a single unit to reduce the risk of disasters, provide a rapid and optimal response to threats and dangers and mitigate the consequences of major accidents and disasters.

The role of the municipalities in the Slovenian civil protections is very important. The system doctrine is based on the stepwise, bottom-up engagement and related assistance. Municipal civil protection headquarters is the first to activate in almost any disaster, and by experience often manages the disasters of notable proportions. Municipalities also carry costs of any incident – intervention, unless regional or state level rescue and protection plans are activated.

On a local level the mayor may decide that several planning bodies in the area of the municipality draw up a joint protection and rescue plan for an individual accident or several different accidents together.

Following the status of civil protection external assistance in the case of failure of water supply all emergency planning documents are focused on external assistance to local population aiming at the delivery of water in the case of failure of water supply system.

Civil protection being in this case external assistance to the population does not have any relations to procedures aiming at the identification of the causes for the disaster.

In the case of water supply emergencies, each water utility has their own operational plans in which the protocol of dealing with hazards is described.

The protocol, documentation, forms is different, but Water utilities try to follow the norm EN 15 975.

There is no unified way of executing listed tasks in Slovenia but the closest reference structure is the activation of municipality/regional/state level civil protection headquarters.

While for the water supply emergencies there is no state level planning framework (protection and rescue plans), but there is some planning framework on the regional and especially on the local level (municipalities / water utility). Moreover, there is a lack of stakeholder cooperation (especially municipality – water supply department, civil protection department and/or HQ of municipality and water utility) in preparation of emergency response plans. To overcome this issue, complex TTXs with all involved stakeholders for different hazardous events, where shortcomings in action procedures are identified, should be organized. In this way the planned response procedures could be verified and improved. Nevertheless, a development of guidelines, defining how to prepare a contingency management plans for water supply system at the country level is one of the important recommendations.

In the case of minor events, when the situation is controlled by individuals (owners or operators of water supply systems) or organizations, the intervention of forces for Protection and rescue plan is usually not necessary.

Activation of forces for Protection and rescue plan is also not necessary when regular intervention services (infrastructure maintainers) and firefighters are sufficient.

3.3 Key guidelines

1) <u>- Improved inter-agency cooperation</u>

<u>Scope of the guidelines for the improved inter-agency cooperation:</u>

Main scope is improved cooperation among water utilities and municipalities (water supply department and civil protection department and/or HQ of municipality) as key institutions defined also by the EN 15975. Another set of institutions should be also part of this process – Slovenian Water Agency (Direkcija za vode RS), State level (Ministry of Environment and Spatial Planning, Ministry of Health), Ministry of Defense – Administation for Civil Protection).

<u>Emergency Planning Process:</u>

For the water supply emergencies there is no state level planning framework (protection and rescue plans), but there is some planning framework on the regional and especially on the local level (municipalities / water utility). Emergency planning process should therefore be:

1) Defined and described in the form of guidelines;
2) Tested and provided as an example (pilot cases elaborations);
3) Related to a broad set of existing procedures (i.g. River Basin Management Plans, following Water Framework Directive, permitting procedures, supervision procedures)
4) Should be verified in the table top and combined exercises,
5) Should be regularly revised and updated.

In this way the planning process would be comprehensively addressed.

Water Supply System Information Management:

Water supply system information management is to certain extent adequately addressed in Slovenia. Drinking water protection zones are defined already for several decades, water supply systems are spatially defined (INSPIRE DIRECTIVE), there is state level annual reporting on key performance indicators of WSS, water quality indicators and water quality processes (HACCP) are centrally managed on the state level.

On the other hand it could be recognized that the emergency management of the water supply system should be improved as most of the existing information are based on the annual reporting, and cannot address the crisis on the water supply.

For the purpose of civil protection the spatial information of all core water supply components (capture, pumping stations, transport pipes) could be better maintained and accessible. The hydraulic model (under development in the MUHA project) will significantly contribute to the efficiency and effectiveness of the response.

In the case of the drinking water supply, a database on the availability of spare parts should be set up.

Communication Procedures (Command Chain)

Setting-up stakeholder cooperation (especially municipality – water supply department, civil protection department and/or HQ of municipality and water utility) for the preparation of emergency response plans during the preparatory stage should be improved. The importance of TT-exercises was recognized during the TTX in Kamnik. It was strongly recommended to organize TT-exrcises more regularly in order to develop, improve and check the communication among all institutions and individuals involved in the response.

2) Importance of the organization of complex TTXs

Scope:

Recognized important scope is more regular organization of complex TTXs, with all involved stakeholders for different hazardous events occurring on water supply systems (including water sources).

Emergency Planning Process:

The training and exercises are very important for all participants, as they are more confident in the event of an accident. In each exercise, deficiencies can be identified and therefore corrected after the exercise. Planning process is extremely important for the organization of the TTX in order to develop adequate scenario of events, master scenario event list, role of the participants, narrator and observers, evaluation process and other components of the TTX

Water Supply System Information Management:

The water supply system information management on all levels (utility, municipality, state services) should support the simulation of events in order to verify their functioning for the purpose of the TTX. This would enable "real world" scenario evaluation during the TTX and post-analysis, thus maximizing the positive outputs of the TXX.

Communication Procedures (Command Chain) and TT-exercises

Setting-up stakeholder cooperation (especially municipality – water supply department, civil protection department and/or HQ of municipality and water utility) for the preparation of emergency response plans is the main challenge. Adequate stakeholder cooperation *cooperation of headquarter (MACS – Multi Angecy Coordination System, SACS – Single Agency Coordination System) is essential challenge of the management of span of control, situational awareness and chain of command.

To overcome this issue complex TTXs with all involved stakeholders for different hazardous events, enable identification of shortcomings in the procedures, and propose improvements.

3) **Transposition and implementation of the revised Drinking Water Directive (2020/2184)**

Clear definition of the scope of the provided guidelines/requirements

The Transposition and implementation of the revised Drinking Water Directive is obligatory process by all EU Member states. The transposition process should be closed by January 2023. The process is probably delayed in Slovenia, as the drafts of the national transposition and analysis of the changes is not published for the public consultation yet.

Emergency Planning Process

National guidelines should be prepared defining the emergency planning process, and upgrade of current guidelines and procedures, which should be fully aligned with the EN 15975. Current procedures which are based on the implementation of HACCP procedures are not adequate and do not meet the revised EU Drinking water directive.

The emergency planning process should be after the adoption of the guidelines communicated with all the users (water utilities) and other stakeholders in the process, together with the EU suggested mechanism of micro-certificates.

Water Supply System Information Management

Overall management of the information on water supply systems should be improved, enabling better decision making process on all level and different responsibilities. The use of the water supply system information management should be enabled for: water rights management and links to RBMPs, water abstraction taxation, water losses management, benchmarking process, contingency management, strategic investment management, optimization process, risk management and other tasks. Some components of the water supply system information management are already set in place (i.e. Inspire directive, reporting of the public water utilities, water quality management), but should be improved with better analysis of the reported data, and measures which would be induced by the data.

ICS Integration and Organization, Operations

Part of the improved implementation of the Part I of the EN 15975 is clear definition of the organization and process defined for the response stage in the case of any extraordinary events on the WSS (beyond the SOPs – Standard operational procedures). The decision making process, which includes among other also management of the span of control, situational awareness, documentation process, chain of command with defined sovereignty of the institutions involved in the typically multi-agency response, usually follows the US-NEMA defined procedures based upon the – Incident Command System (ICS) theory and procedures.

The implementation of the procedures in the contingency plans and the exercises (TTX, combined) are essential for the efficient and effective ICS procedures.

Communication Procedures (Command Chain)

The communication procedures are one of the procedures, which are defined by the ICS theory, and is especially important in the typically multi-agency response. The communication pathways should be clearly defined and again verified in the TTX and practical exercises.

Restoration and Recovery Activities

Recovery activities are important component of the disaster management cycle (preparedness – response - recovery), but often overlooked as the media attention and political priorities decrease after the closure of the response stage (immediate intervention on the water supply systems). Hence, the restoration and recovery process after the emergency on water supply systems should be closely managed and monitored, with predefined procedures, responsabilities and financial/human resources.

D.T3.2.3. Local application: recommendations for optimal governance structures for resilient water supply - Slovenia

Competence relative to the water supply domain in the Republic of Slovenia is shared among several ministries and legislation. The portfolio of following ministries defines key functional, operational components of water supply:

- Ministry of Health – drinking water quality
- Ministry of Environment and Spatial Planning – regulations regarding the water supply service, drinking water protection zones, water pricing and relative full cost recovery
- Ministry of Defence – civil protection and operation of water supply under specific conditions, water for firefighting from water supply systems.

Other ministries and governmental offices have a minor role, which is in specific occasions of importance: Ministry of Agriculture Forestry and Food (relative to the implementation of Nitrate directive and agricultural practice on water protection zones); Ministry of Finance (indirectly following the costs of service), Statistical office of the Republic of Slovenia (reporting to EUROSTAT).

There is no central body to coordinate the three key ministries.

The civil protection mechanism relative to the operation of water supply systems is defined by the Protection Against Natural and Other Disasters Act (Zakon o varstvu pred naravnimi in druigimi nesrečami[1]).

Protection against natural and other disasters is provided by:

- residents of the Republic of Slovenia as individuals;
- residents, voluntarily organized into associations, professional associations and other non-governmental organizations engaged in activities important for protection against natural and other disasters;
- public rescue services;
- companies, institutes and other organizations;
- local communities and
- state

Protection against natural and other disasters is a uniform subsystem of national security of the state, which is coordinated and connected with other subsystems of national security; at the level of local communities, regions and the state.

<u>Local communities as basic entities of democratic governance on local level</u>

The competencies of municipalities are determined by Article 37 of the Protection against Natural and Other Disasters Act (94/126). Certain powers are also set out in the Fire Protection Act and the Drowning Protection Act.

Municipalities cooperate with each other in the performance of tasks of protection against natural and other disasters, and for this purpose they may pool funds and form joint services for the performance of common matters of protection against natural and other disasters.

Municipalities adopt their programs and plans for protection against natural and other disasters in accordance with the national program.

The role of the municipalities in the Slovenian civil protections is very important. The system doctrine is based on the stepwise, bottom-up engagement and related assistance. Municipal civil protection headquarters is the first to activate in almost any disaster, and by experience often manages the disasters of notable proportions. Municipalities also carry costs of any incident – intervention, unless regional or state level rescue and protection plans are activated.

<u>Regional level</u>

Slovenia has no regional level authorities. Only state level and municipal level are present. Regionalization is present in the form of state branch offices which ensure distributed presence of state level administration closer to the end-users. Regions are also defined in non-uniform way:

- Statistical regions are most official regions, as they are reported on the NUTS3 level, used also by the EUROSTAT, there are 12 statistical regions;
- 13 Regional branch offices of the Administration of the RS for Civil Protection and Disaster Relief

[1] Zakon o varstvu pred naravnimi in druigimi nesrečami
http://pisrs.si/Pis.web/pregledPredpisa?id=ZAKO364

- 58 Administrative regional branch offices of the MJU – (Ministry of Public Administration)
- 8 Regional branch offices of Slovenian Water Agency (water management, protection of water resources, permitting procedures).
- 9 Regional branch units of the National Institute for Public Health.

Necessity for improved definition of regions, together with their political, executive and financial mandate and was in Slovenia recognized and addressed several times, but so far without success.

Regional branch offices of the Administration of the RS for Civil Protection and Disaster Relief have a function of 112 call centres, coordination centres, operate the regional civil protection headquarters, and provide planning process for the region.

<u>State level</u>

Civil protection is organized at the local, regional and state level, and connects the resources and capabilities of participants, operational forces and citizens into a single unit to reduce the risk of disasters, provide a rapid and optimal response to threats and dangers and mitigate the consequences of major accidents and disasters.

Standard operating procedures in Slovenia are defined as annexes to rescue and protection plans some outstanding SOPs are:

- SOP-s(regional) in case of large-scale traffic accident,
- SOP (regional) in the case of airplane accident
- SOP between the Administration of the Republic of Slovenia for Protection and Rescue and the State Administration for Protection and Rescue of the Republic of Croatia

In the event of any disaster or other threat, local capacity is activated first, and if local civil protection forces are unable to cope with the magnitude of the threat, then regional or, if necessary, state resources are activated.

Water supply is not addressed in the framework of civil protection activities, with exception of the EU legislation addressing critical infrastructure and national transposition of this legislation.

Planning tasks and development of contingency management plans are defined on the basis of procedure, which is shown on the following figure:

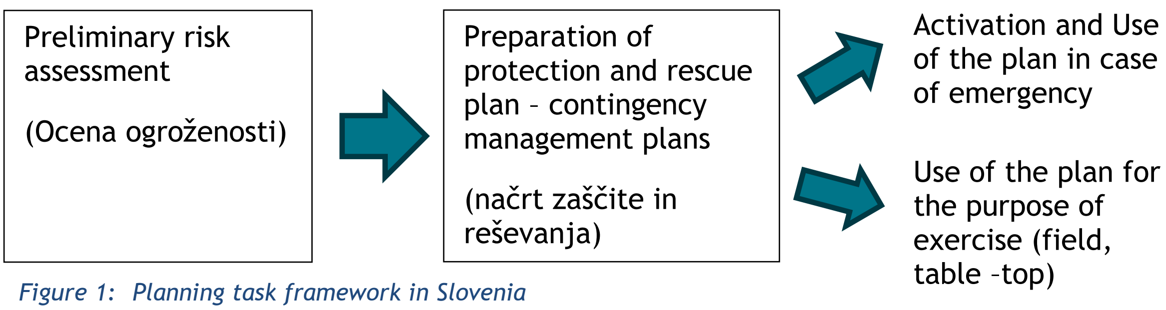

Figure 1: Planning task framework in Slovenia

Preliminary risks assessments and protection and rescue plans are defined at the country level, regional level and local level (municipality protection and rescue plans). Protection Against Natural and Other Disasters Act.

More detailed methodology for the preliminary risk assessment is defined by the Instructions on the preparation of risk assessments[2] (Official Gazette of the Republic of Slovenia, No. 39/95).

The threat assessment due to natural and other hazards must include data and assessments on:

- sources of hazards;
- possible causes of the accident;
- the probability of an accident;
- type, forms and level of threat;
- the accident development and possible extent of the accident;
- endangered inhabitants, animals, property and cultural heritage;
- the probable consequences of the accident;
- the probability of a chain accident;
- the possibility of predicting an accident.

In general Slovenian legislation follows the definitions relative to risk management defined by the ISO 31000 Risk management — Principles and guidelines and ISO 31010 Risk management — Risk assessment techniques.

On the national level preliminary risk assessments are developed for following disasters[3]:

- Earthquake
- Forest fire
- Floods
- Nuclear and radiological disaster,
- Infectous diseases – human
- Infectious diseases – zootia
- Railroad accident
- Airplain accident
- Sleed

Disasters addressing water supply are not encompassed in the Slovenian legislation. However out of 13 regional branch offices of the URSZR two (Slovenj Gradec and Kranj) have actually developed preliminary assessments and regional plans for emergency water supply.

Public water supply as a priority service is mentioned in several other, or almost all public protection and rescue plans (earthquake, floods, sleed) recognizing public water supply as important priority. Other stipulations but to pay a special attention or re-establish supply of drinking water as a priority are not defined.

These preliminary risk assessments developed on the national level define the priorities for regional level and local communities regarding the preparation of the local community

[2] Instructions on the preparation of risk assessments (39/95) http://www.pisrs.si/Pis.web/pregledPredpisa?id=NAVO242

[3] Pravilnik o načinu izdelave izjave o varnosti z oceno tveganja https://www.uradni-list.si/glasilo-uradni-list-rs/vsebina/24734

level/region level preliminary risk assessments and local community/regional level protection and rescue plans.

On the other hand, preliminary flood risk assessment is prepared a published on the national level. Based upon the closer analysis of the published preliminary flood risk assessment several inconsistencies could be identified, basically originating from the use and interpretation of flood hazard modelling results used for the preparation of this analysis.

While state level plans are present for key disasters that might occur in Slovenia. Incidents related to the drinking water supply are not defined on a state level plan. Two regional branch offices have emergency water supply in their response planning documents: Slovenj Gradec (January 2018[4]) and Kranj (November 2019[5]).

Following are the main components of the regional emergency water supply planning document:

- **Premises of the plan** – assumptions of the plan for emergency water supply in Gorenjska region (Kranj) is only a drought (water scarsity). The emergency document for Koroška region has a wider set of possible reasons for water supply crisis:
    - Drought,
    - Water supply system malfunction,
    - Water pollution
    - Unmanaged water losses
- **Drinking water supply systems** – analysis of the drinking water supply systems with the description of the role of different institutions, especially:
    - Water utilities operating public water supply systems in the region;
    - NIJZ – Nacionalni inštitut za javno zdravje (National Institute of Public Health);
    - NLZOH - Nacionalni laboratorij za zdravje, okolje in hrano (National laboratory of healts, environment and food);
    - Zadravstveni inšpektorat RS (Health Inspectorate);
    - UVHVVR – Uprava za varno hrano, veterinarstvo in varstvo rastlin (Food Safety, Veterinary and Plant Protection Administration);
    - Inšpektorat RS za kmetijstvo, gozdarstvo, lovstvo in ribištvo (Inspectorate of the RS for agriculture, forestry, hunting and fisheries).
    - Police

Regional emergency plan envisages that local communities prepare the preparedness and response plan for emergency water supply for the specific local community. Water utitlites also have to prepare the emergency management procedures for water supply (načrt dejavnosti).

The gaps (in terms of structure, communication, collection of data, reporting, post event analysis, consensus on important decisions).

The main recognized gaps are:

- Absence of the transposition of the EU legislation (Drinking water directive, EN 15975) in the Slovenian legislation. Implementation of risk assessment, based upon

[4] Regijski načrt zaščite in reševanja - oskrba s pitno vodo v Koroški regiji, verzija 2.0, URSZR 2018
[5] Regijski načrt oskrbe z vodo za Gorenjsko regijo, URSZR ver 2019

the Water Safety Plans is not announced yet in Slovenia. Missing are also guidelines on the development of contingency plans and crisis management following this directive/standard.

- Missing integration of emergency situation on the water supply systems in Slovenian assessment of hazards and absence of guidelines for emergency procedures on water supply systems, which could be further on elaborated on the level of each individual municipality/water utility.
- Information management on water supply systems is not adequate, not enabling analysis and overview of the status of water supply systems in Slovenia enabling cross-agency data exchange and analysis, data/information verification and validation and induction of measures based upon the analysed data/information.
- Planning and execution of TT-exercises on water supply system is not obligatory (in regular intervals), beside that the Incident Command System procedural framework (which would enable efficient and effective multiagency response) is not implemented in Slovenia.
- Large number of water utilities in Slovenia (approx. 110 utlitites for 2,1 mio. inhabitants) induce that there are also many extremely small water utilities, which have a problem with the knowledge base and human resources for these specific tasks. In many cases, the tasks related to hazard/risk management are not fully implemented.
- There is no systematic framework for the performance of the recovery measures after the water supply system emergencies.

<u>**Proposal of corrective and preventive actions**</u>

The proposed corrective and preventive actions directly address the gaps identified above:

- Absence of the transposition of the EU legislation: the responsible ministries (Environment, Defence, Health) should harmonize and transpose the revised EU directive in the national legislation, together with the defined technical papers, and educative materials.
- Integration of emergency situation management on the water supply systems with the developed guidance notes and verified procedures, including performance of the TTX exercises, verifying the developed contingency plans.
- Improved information management on water supply systems, upgrading the current information management based upon the EU INSPIRE directive, EU drinking water directive enabling improved decision making process on different levels and different institutions with the validation and verification of the reported data/information and strong analytical framework.
- Planning and execution of TT-exercises on water supply system.
- Reduced number of the water utilities enabling optimization of the human resources and the performance capacity of the tasks assigned to the water utilitites.
- Development of systematic recovery measures after the water supply system emergencies with clearly defined role of all involved institutions.

c. Croatia

Introduction

General statement regarding the specific deliverables.

This report summarizes the outcomes from the testing phase of the MUHA toolbox WASSP-DSS on the Croatian pilot sites (the Water Utility of Zadar and the Water utility of Istria) focused on the four project hazards (drought, flooding, accidental pollution). In order to link the WPT2 to the WPT3 activities, feedback is structured according to the guidelines provided by UTH (WPT3 leader).

The pilot activities (D.T.2.2.4.) are getting the crucial data for testing the MUHA Toolbox (D.T.1.3.1 – D.T. 1.3.4). The problems are identified, and the water utilities possible issues might be solved and adjusted the components of the tool. Evaluation of pilot activities aims to verify whether objectives defined for the pilot phase are met and to propose recommendations on how to improve water safety plans with the MUHA Toolbox before it will be launched on a full scale. The process involves reviewing the MUHA Toolbox activities and evaluating whether they enabled the goals to be achieved.

D.T3.2.1. Report on key bottlenecks for the implementation of services and their requirements - "Croatia"

Identification of gaps and weaknesses identified in WPs T1 and T2 and implemented specific tools developed in T3.1 with recommendations drafting the necessary solutions.

Based on the results from the national consultations carried out under DT1.1.1. describe Water Safety Plans development & implementation status (providing feedback for the progress – if applicable).

Point out the issues of your concern stem from the consultation main outputs that will be under consideration within the activity 3.2.

NOTE: WSPs' implementation status is the basis for the PPs experience and their ability to identify key bottlenecks in terms of water services requirements under the MUHA project perspective.

Based on the information reported in D.T2.2.4.- Evaluation reports for each pilot action - MUHA Toolbox- identify the capabilities provided by the toolbox in your case (advantages and disadvantages with respect to water service requirements, indentified gaps), focus on the aspects in the following paragraphs 2.1 &2.2

2.1. Description of the pilot sites

Golubinka pilot site

The catchment area of Golubinka spring is highly vulnerable, with limited groundwater source. It is part of a wider karst catchment called Bokanjac-Poličnik, located in Zadar county in northern Dalmatia. During the summer periods and hydrological minimum, the impact of droughts is becoming more intense, and the need for drinking water is increasing due to tourist activities. In some parts of this coastal area, the need for water is growing. Pumping large amounts of water for drinking water supply reduces the amount of fresh water in the ground, which facilitates the penetration of seawater into the aquifer.

The main Pilot Action goals are to:

- determine hydrogeological dynamics of the aquifer as the basis for the water safty plans,
- determine groundwater origin, amount of water in the aquifer, water quality etc.
- define the zone of fresh and saltwater mixing in the catchment area of the Golubinka spring.

To accomplish the goals geophysical surveys were carried out by geoelectric tomography to determine the zone of fresh and saltwater mixing. Hydrogeological dynamics of the aquifer, groundwater origin, and water quality are determined by monthly monitoring and interpreting of measurements - both in situ and laboratory e.g. physicochemical parameters, hydrochemical parameters, stable isotopes, and trace metal concentrations. The interpretation of the aquifer in the area of the Golubinka spring will be contributed by aerial images made by an unmanned aerial vehicle equipped with a thermal camera based on which the discharge zones of underground freshwater sources will be located so the amount of water in the aquifer can be determined.

The Water Utility of Istria

Water utility of Istria covers around 2/3 of the area of Istria Region in Croatia with around 70000 installed customer water meters. It has almost 2400 km of pipelines, 95 reservoirs and 42 pumping stations, supplying water intended for human consumption to 98.000 permanent inhabitants, as well as one 200.000 of tourists in summer for approximately 12 Mm3/Y.

The Pilot Action focus on the development of a mathematical (hydraulic) model of the water supply system which was used for simulating the various hazardous scenarios, their impact on the water distribution as well the simulation of the optimal measures to be taken, all based on the proposals for harmonizing Civil Protection Mechanisms to Water Safety Plans defined in WP1.

2.1 Evaluation of the toolbox in making of PA Water Utility WSP

Evaluation of the toolbox in making of PA Water Utility WSP (missing parts/additional information, reporting requirements, difficulties in the use of the tool-implementation bottlenecks and reliability issues. Consider difficulties in the use of the tool-implementation, bottlenecks and reliability issues, reevaluation requirements will also be assessed and included.

In this context, structure your analysis on the following:

<u>General comments (link to WPT2 reports)</u>

- Is the reporting structure of the toolbox useful for the development of WSP?
- Is there any specific report that is not exported from the MUHA Toolbox? Can you recommend any (e.g. near misses recording)?
- Which kind of information included in the MUHA Toolbox is considered as the most useful for the development of the WSP?
- Are there additional information/data you started collecting after the use of MUHA toolbox? Why?
  Collecting of the additional information/data has started. For improving the situation in the Water Supply of Zadar which is in a close relationship with relevant components

which are described in the MUHA Toolbox, the process of collecting information focuses on the information of the legal and illegal landfills of the catchments.

- Which do you think should be the MUHA toolbox re-evaluation period?
- Which do you think (in your case) is the appropriate time frame for the revision or update of the WSP?
- Are there “components” of your water supply system not considered or partially considered by the MUHA toolbox? If so, which ones?
- Is the MUHA toolbox comprehensive of all the hazards potentially impacting on the analysed water supply system (WSS)? Can you indicate possible hazardous events not included in the toolbox?

Feedback from pilot site Golubinka (the Water Utility of Zadar):

1.) The main advantage of the Toolkit for WAter Safety Planning Procedures Decision Support System (WASPP – DSS) is that it covers a lot of components that are essential and crucial for hazard management of the water supply system. It enables the management of hazards and risks in a simpler way. Therefore, it allows the implementation of the Water Safety plans to be more accessible. To conclude, with the development of the finalization version of the Toolkit, a lot of time will be saved in the process of implementing and improving water safety plans.

2.) The specific reports were included in the MUHA Toolbox. The scheme of MUHA Toolbox should be available earlier to the external audience, that there is more time for implementing further improvements. For the MUHA Toolbox, it is important to consider the possibility of improving certain measures at the time of the hazard itself, ie when it occurs. This means improving the supervision and management system, implementing an early warning system, drafting plans and protocols in the event of a particular hazard (for example droughts, accidental pollutions, floods, and earthquakes, etc). Some of these were included in the section “Operational Monitoring” and “Water supply incident tool”. The MUHA Toolbox should include some of the possible benefits for the Water Supply System which could help to improve Water Safety Plans as well as the situation in the water utilities. Those benefits are related to the design of the early warning system (how to react in a situation when a hazard occurs) and which measures are most important to consider when designing such a system.

3.) The most useful information from MUHA Toolbox is included in the System Assessment – Modul 2 Describe the water supply system, Modul 3 Identify the hazards and assess the risks, and Modul 4 named Determine and validate control measures, reassess and prioritize the risks. The relevant information is in close relationship with the catchment and information for risk assessment of the catchments.

4.) Upon completion of the project, water utilities will be able to use the MUHA toolbox. The re-evaluation period should not be questioned yet. The MUHA toolbox should be used for some time to provide input for possible changes. The developed components of the System Assessment will be tested in the real-time scenario for defined hazardous events. The best practices to define the re-evaluation period of the MUHA Toolbox will be dedicated to the continued testing of the tool components. In this way, water utilities which are most affected by different hazards will be able to define which components and measures need to be precisely modified and improved.

5.) The appropriate time frame for the revision or update of the Water Safety Plans was defined by national legislation in each country. The revision of Water Safety Plans should be performed in case of incidents, unforeseen events, or some changes in the catchment or water supply system, regardless of the time frame.

6.) Components of the hazardous events such as droughts, floods, earthquakes and accidental pollutions are considered in the MUHA Toolbox.
7.) The MUHA Toolbox is comprehensive of the addressed hazards.

Feedback from Water utility of Istria

Based on the testing which IVB done on Toolbox, the opinion is that in general the toolbox can be used as a useful tool in generating of the WSP, particularly in defining the module 3 of the WSP where Key actions include identifying the hazards and hazardous events and assessment of risk with when no control is in place.
The supermarket concept of picking the hazardous events is the most useful component of the toolbox, which is a real time saver for anyone who is involved in the process of making the WSP. Our evaluation is that the components significantly shorten the time needed for identifying the hazardous events, if quantified probably by several weeks when spiking on systems such as WU IVB. The potential of the tool is in the possibility of expanding and filling the developed database with new hazards and in such way filling the shelves of the “supermarket” concept. Furthermore, if the toolbox could be expanded with the possibility of hazard reporting, especially with the hazard which have a low occurrence, there could be a better evaluation of the risk assessment. With filling of WSP’s Module 3 component the further development of the toolbox could also address the Module 4 component which identifies the controls (existing control measures) and validate the effectiveness of the controls, reassess risk, takin into account the effectiveness of existing controls and prioritize all the identified risks. As a conclusion we think that the Toolbox is highly applicable as a help tool in making of the Water Utility WSP which significantly reduce the time of the whole WSP process so we can recommend its use to other Water utility companies.

Feedback on the question above by IVB:

1.) The hazardous events database.

2.) We didn’t start collecting any additional data after the toolbox use. The data that we already had were enough in the process of Toolbox usage.

3.) We don’t have any suggestions.

4.) The reliability of the inputted data concerning the probability of the hazard occurrence was 80% estimated and 20% calculated based on the occurrence frequency of the hazard that already occurred in the WU system.

5.) The re-evaluation period should be at least one year.

6.) At least one year but depending of the amount of usage and new data input, it can take even a shorter time.

Regarding questions above the feedback is given from pilot sites for 4 hazards (drought, flooding, accidental pollution and earthquakes):

1.) Possible risks can be estimated using the MUHA tool, but the exact defined value should be tested over a period of time.
2.) and 3.) the water utility of Zadar and Istria – hazardous events for drought, accidental pollutions, floods and earthquakes are considered by the Toolbox.
4.) *The water utility of Zadar:* Regarding the reliability of the input data, all the applicable components were included in the Section System Assessment. The main estimates of the probability of the occurrence of a hazardous event are assessed based

on past experience and predictions of what could happen or what will have a negative impact on the catchment. The measurable input data are the laboratory results of physicochemical and microbiological analyses. Other data that are measured and monitored daily are flows, pressures, and levels.

The water utility of Istria: The reliability of the inputted data concerning the probability of the hazard occurrence was 80% estimated and 20% calculated based on the occurrence frequency of the hazard that already occurred in the WU system.

5.) The Civil Protection System Act (Official Gazette 82/15, 118/18, 31/20) regulates the system and operation of civil protection; rights and obligations of state administration bodies, local and regional self-government units, legal and natural persons; training for the needs of the civil protection system; civil protection financing; administrative and inspection supervision over the implementation of this Act and other issues important for the civil protection system. Civil protection is organized at the local, regional and state level, and connects the resources and capabilities of participants, operational forces and citizens into a single unit to reduce the risk of disasters, provide a rapid and optimal response to threats and dangers and mitigate the consequences of major accidents and disasters. The operational forces of the civil protection system are: Civil Protection Headquarters, Firefighting Operational Forces, Operational Forces of the Croatian Red Cross, Operational Forces of the Croatian Mountain Rescue Service, Associations, Units and commissioners of civil protection, Site coordinators and Legal entities in the civil protection system. Instructions for citizens were given by Civil Protection Headquarters (how to prepare for the accident itself, why it was caused, how to act after the accident etc. The Civil Protection System is not in charge for improving water safety plans.

6.) Institution such us Hrvtaski zavod za javno zdravstvo (eng. Croatian institute of public health) plays a specific role for developing a water safety plan for addressed hazards. They defined the specific obligations for improving Water Safety plans in Croatia.

2.2 Evaluation of PA goals fulfillment

Considering the information reported in paragraph 2.1, point out the contribution of the MUHA toolbox to the fulfillment of your goals. Except for the usefulness of the toolbox provide information on the other parties/actors (at the external environment of the Water Utility-) that are directly involved in the Water Safety Plan development and implementation (e.g. Institutions/organizations, regulatory or civil protection authorities).

NOTE: Based on the information reported in WP1 fo focus on the stakeholders that directly related to the water services management (Water Utility level) under multi hazard risk analysis and management.

Feedback from pilot site Golubinka (the water utility of Zadar):

Considering the evaluation of the actual implementation of methods and measures with an interpretation of tested practices of the MUHA toolbox for improved water safety plans and resilience of drinking water supply, expected pilot action activities were fulfilled and ongoing activities will be implemented on the pilot site. The main focus of the current pilot activities and future research is to continue pilot investigations and collect all relevant information for a better understanding of the catchment area and to improve water safety plans. Accomplishments of the activities are related to proposing improvement measures of Water Safety Plans and they are mostly based on data collection, audit, and improvement options of the developed tool. The connection of pilot action outcomes and MUHA project objections are in a close relationship with identifying what resources are needed to improve the Water Safety Plans and situations in the water utilities. On the other hand, activities related directly to testing MUHA Toolbox could be improved in the future by changing or adding some important features for implementation pilot activities. For the water utility of Zadar, the main goal of the developed tool is focused on the System Assessment – Modul 2 Describe the water supply system, Modul 3 Identify the hazards and assess the risks, and Modul 4 Determine and validate control measures, reassess and prioritize the risks. The collection of information is mostly similar to risk assessment in the catchment area. Accordingly, MUHA Toolbox will be useful for improving water safety plans and the revision of water safety plans should be done in case of incidents, unforeseen events, or some changes to the water supply system.

Feedback from water utility of Istria

Pilot action current state

The WU Istarski vodovod Pilot Action is at its end. If the latest budget change suggestion will be approved, it is planned that IVB implement a functional radio system which will be a backup system in the case of communication failure due to the MUHA hazards.

Pilot action accomplishment

As mentioned before the PA consist of four parts:

1. Computer equipment acquisition
2. Hydraulic modelling software
3. Development of hydraulic model of IVB WSS
4. Development of Water safety plan

After fulfilling the planned parts, IVB was able to get a functional water supply hydraulic model which was used as along the MUHA DSS Toolbox in the developing of the Water safety plan.

Pilot action outcomes

The implemented PA activities resulted in the input data which were used in the WASSP-DSS MUHA toolbox which resulted in faster and better WSP. During the elaboration of tasks and data gathering, several vulnerabilities of the Water supply system were detected and taken in consideration when making the WSP.

The PA activities produced the scenario analysis of each individual hazard addressed by MUHA project which resulted with the selection of optimal measures in case of hazard occurrence. These measures were later implemented as part of WSP and will be tested in the field with the tabletop exercise for accidental pollution scenario.

2.3 Addressing weaknesses/bottlenecks in the implementation of the multihazard management – Water Utility Level

After identified bottlenecks in the pilots (WP T2) and in general (WP T1) the main key services that are still missing will be identified and descripted (planning, logistics, public communication, interagency cooperation service, communication/messaging section, situation service) and their linkage.

Based on DT3.1.1, DT3.1.2, DT3.1.3, DT3.1.4, from SWOT analysis at Water Utility Level, determine the weaknesses and gaps in terms of services requirements. The outcomes of the SWOT analysis will be the baseline to extend your analysis in order to include possible inter-services and interdependencies (if applicable) in overcoming the weaknesses of Water Utilities. Use the results of consultations with stakeholders (water operators, agencies etc) on the deliverables of Activity 3.1. and provide recommendations to address the issues of your high concern (identify good practices – if applicable-).

NOTE: Please mind that the above requested information should go a step further from basic reports of previous deliverables, facilitating the scope of action planning and strategy development. In this context try to stay in line with the simplicity, clearness and applicability of the guidelines will be produced within WP3.

Regarding the SWOT analysis at the Water Utility Level based on the D.T.3.1.1., D.T.3.1.2, D.T.3.1.3. and D.T.3.1.4. the determined weaknesses and gaps are:

Droughts

- growing water demand in the summer periods (growing population, increasing agricultural demand etc.) due to the amount of water for water supply is reduced, the reason for which is the occurrence of drought
- longer periods of drought, which lead to a lack of available fresh water and thus to an inability to meet the increased water demand, can lead to water crises

Accidental pollutions

- lack of skilled staff in small WU
- lack of technical and financial resources in small WU and
- poor water supply maintenance in some smaller WU

Floods

- not awarded enough of the existence of residual flood risks and the inability to ensure full flood protection
- lack of technical resources in small WU
- in some places old infrastructure
- not enough activities to monitor the functionality of flood defences systems, and their maintenance

Earthquakes:

- no official list of the impact of the earthquake on drinking water sources or water supply networks
- an impact of earthquakes on the infrastructure (for example, older water supply pipes, - damage to pipes or a possibility of corrosion)
- possible changes of the chemical composition of the water and turbidity (sand in the water) due to the consequences of liquefaction
- turbidity of water in water wells (for example, the water in the public water supply system may not be satisfactory for a long time; a recommended measure: boiling drinking water)
- possibility of elevation of heavy metals' concentration in waters affected by the earthquake and presence of dominant ions in groundwater for up to a year after the earthquake

D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply - "Croatia"

Guidelines to overcome gaps and weaknesses identified with the improved water safety plans. The guidelines will be based upon the ICS (Incident Command System) theory. In addition, guidelines should be structured on the Inter-agency operation services that strongly affect the capacity of the key water services (water utilities, water authorities-local/regional level, institutions) to meet incident requirements (within the framework of the mutli hazard risk analysis and management).

HACCP (Hazard Analysis and Critical Control Points) is a professional, rational and systematic approach to the analysis and management of biological, chemical and physical hazards throughout the production process of water for human consumption. For all water utilities in Croatia, it is obligatory to introduce the HACCP system, which identify critical control points, critical limits and preventive measures in all phases of technological processes of production and distribution of water for human consumption. From 01.01.2024., all water utilities will be obligatory to do Water Safety Plans which also replace HACCAP system. In Croatia, till now, only 2 water utilities implemented WSP respecting the guidelines given by the Institute of Public Health.

3.1 Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs)

To this end, input from DT 2.3.1 Validation of implemented Improved Water Safety Plans (IWSPs) and implemented measures in PAs will be used. Information regarding the overall evaluation on the efficiency and effectiveness of implemented IWSPs and measures performed in PAs within the MUHA project will be the basis for drafting the guidelines.

DT 2.3.1. – it is not done yet. Partners need to agree on the date.

3.2 Table Top Exercise Results to define and bridge inter –agency operation services

Given that Table Top Exercises support bridging the gap between Civil Protection Authorities and other water cycle managers (Water Authorities) and service providers (Water Utilities), information reported in DT2.3.4 Reports on the performed table-top exercises can also be used by the 5 PPs of Pilot Actions that will perform TTEs.

Only few PA did the table top exercise.

Guidelines for report need to be discussed between Work package leaders of T2 and T3.

3.3 Key guidelines

Based on the paragraphs 3.1 and 3.2 proceed to the guidelines for the improvement of inter agency operation services toward the resilient of water supply.

Guidelines should be structured (at least) on the following points:

- Clear definition of the scope of the provided guidelines/requirements,
- Emergency Planning Process,
- Water System Information,
- ICS Integration and Organization, Operations,
- Communication Procedures (Command Chain),
- Restoration and Recovery Activities.

Guidelines should be focused on ICS Integration and organization, where inter agency services plays a crucial role.

NOTE: Internal consultations/structured personal interviews within water services of PPs are proposed in order to identify substantial dimensions like goals and sub goals of the entities oriented to the enhancement of water supply resilience (planning and finance are among the most fundamental factors that should be included). Consultation/interviews procedures could be implemented for drafting recommendations regarding the core elements of the ICS: management ("Command" at the Field Level), Operations, Planning/Intelligence, Logistics and Finance/Administration.

D.T3.2.3. Local application: recommendations for optimal governance structures for resilient water supply - “Croatia”

This deliverable will analyse status of the governance structures necessary for resilient water supply and suggest feasible implementation options.

- <u>Input from DT1.2.4 - Report on the cross-institutional procedure & D.T1.1.3 - Report on status of Civil Protection Response Mechanisms – water related plans and procedures</u>

  - **Provide the entire scheme (STRUCTURE/FLOW CHART) of institutional relations at these levels of governance that directly reach the water utility level, interactions and relations between the parties involved necessary to build the resilient of water supply.**

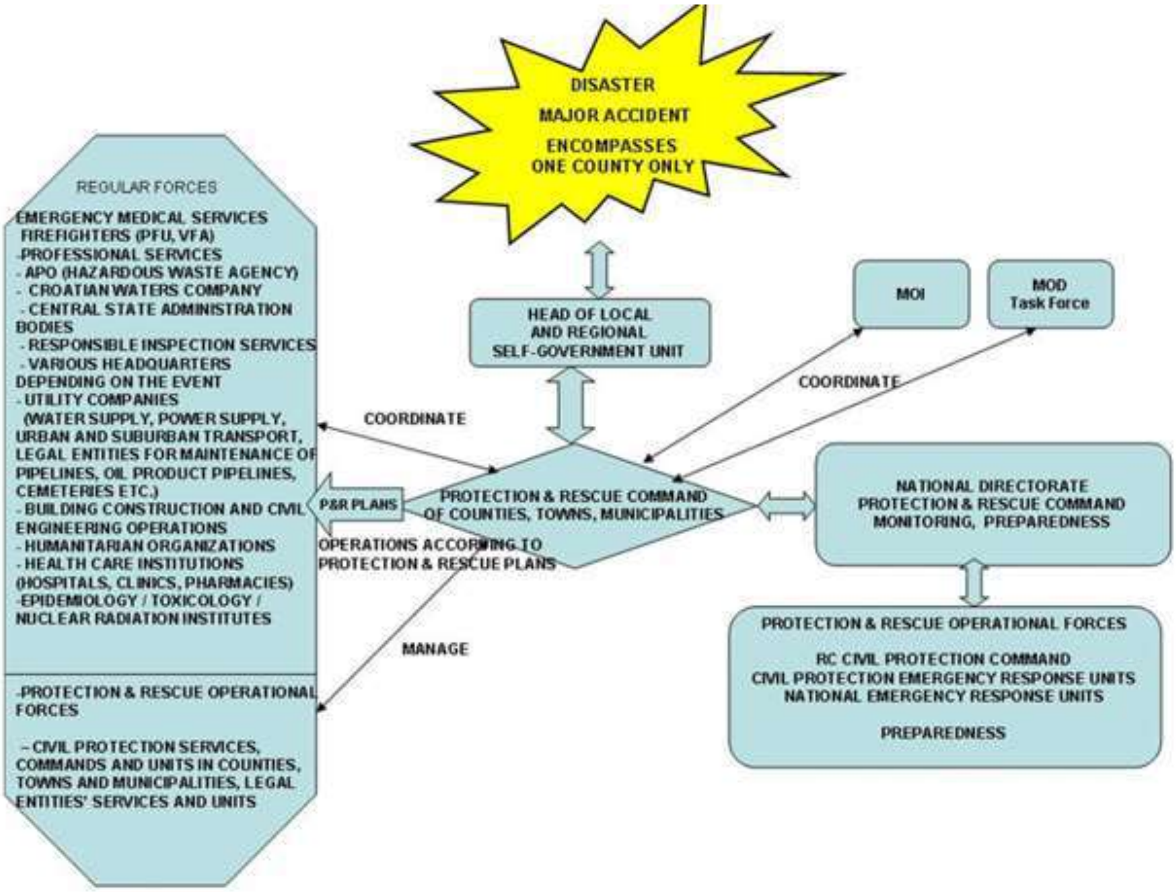

Figure 1: Example of the structure of the national civil protection system (Croatia)

  - **Have all institutions involved developed and issued management plans (addressing measures for accidental pollution, flooding, drought and failure of critical**

infrastructure due to earthquakes). Do they include in their plans measures for resilient water supply .

Legislation important for the civil protection:

National level

In accordance with the common legal practice in Croatia all relevant legislation is published in the official gazette and is considered to be national level legislation, while ministerial level would consist of internal regulations that are numerous in every government body (for instance the regulations on internal organisation etc.).

- Civil Protection System Act (Official Gazette 82/15, 118/18, 31/20),
- Act on Protection against Natural Disasters (OG 73/97, 174/04)
- Protection and Rescue Plan for the Territory of the Republic of Croatia (OG 96/10)
- Fire-Fighting Act (OG 125/19)
- Decree on the composition and structure of civil protection units (OG 27/17)
- Decree on holders, content, and procedures of preparation of planning documents in civil protection and the way of informing the public in the procedure of their adoption (OG 49/17)
- Decree on the composition of the headquarters, the manner of work and the conditions for the appointment of the chief, deputy chief and members of the civil protection headquarters (OG 37/16, 47/16)
- Decree on the organization, staffing and equipment of civil protection units and alert units (OG 111/07)
- Republic of Croatia Threat Assessment
- Republic of Croatia Protection and Rescue Plan.
- Rules on the methodology for making threat assessments and protection and rescue plans and a score of other acts and supporting legislation
- Strategy of National Security
- Strategy of Defence
- Rules on the composition of the Headquarters Staff, the manner of work and the conditions for the appointment of the Chief, Deputy Chief and members of the Civil Protection Staff
- Risk Assessment of disaster for Republic of Croatia

Regional level

- Republic of Croatia Constitution
- Act on Local and Regional Self-Government
- Risk assessment for each county + City of Zagreb
- Civil protection action plan – each County + City of Zagreb

Local level

- Republic of Croatia Constitution, Act on Local and Regional Self-Government.
- Risk assessment for each City and Municipality
- Civil protection action plan of each municipality

Public sector

- Legal entity risk assessment
- Operational action plans

Volunteers

Protection and Rescue Act, supporting legislation governing the rights and obligations of volunteers in protection and rescue, agreements on protection and rescue cooperation.

NGOs

- Act on Croatian Red Cross
- Act on Croatian Mountain Rescue Service

In the event of any disaster or other threat, local capacity is activated first, and if local civil protection forces are unable to cope with the magnitude of the threat, then regional or, if necessary, state resources are activated. When a major accident and/or catastrophe is declared, and the capabilities and resources of the operational forces of the civil protection system are not sufficient, the Armed Forces of the Republic of Croatia and the Police are activated at the proposal of the Ministry of the Interior affairs.

- **Define the gaps (in terms of structure, communication, collection of data, reporting, post event analysis, consensus on important decisions).**

  In Croatia, water utilities are operational force of civil protection. They act if civil protection (headquarters) calls them. They need to have operational plans if they use hazardous substances. Beside operational plan, they need to perform field exercise on the location where they have hazardous substances every two years. There is lack of communications between all the actors. There is lack of information about data, reporting, post event analysis, consensus on important decisions.

- **Propose corrective and preventive actions**

The stages in the civil protection system are: Prevention, Preparation and Response.

Preventive activities in the civil protection system are carried out by participants and operational forces of the civil protection system and citizens within regular activities to reduce risks, threats and dangers to life and health of citizens, material goods and the environment from all kinds of natural and technical disasters. They include:

• special research relevant to disaster risk assessment and reduction, natural process development forecasts and standards of materials, technical and operational solutions of interest to reduce vulnerability
• raising the awareness of citizens, vulnerable and special target social groups about dangers and protection measures and the use of the number 112
• raising children on specific content based on existing or special programs
• space use planning
• defining and applying special technical rules in construction, industry, transport and other areas that increase the vulnerability of communities
• specific strategies, assessments, action plans and programs
• implementation of international documents in the field of disaster risk reduction
• supporting sustainable development policies and measures to manage identified risks
• public information and cooperation in the media.

Based on the information in the early warning system on the possibility of a major accident, the readiness in the civil protection system is declared by the executive body of the local and regional self-government unit. Readiness in the civil protection system is declared by the Minister on the base of information in the early warning system about the possibility of a catastrophe. Preparedness focuses on the preparation of equipment and procedures for use after the occurrence of an accident. Preparedness measures can take many forms, including the construction of shelters, the installation of alarm devices, the creation of back-up essential services (eg electricity, water, sewerage), and the exercise of evacuation plans. Two simple measures can help prepare an individual for event survival or evacuation if necessary. Supply equipment for crisis situations can be prepared for evacuation, while supply supplies can be created for the purpose of hiding in the shelter.

Authorities often advocate the preparation of survival equipment such as "72-hour equipment." It can include food, medicine, batteries, candles, and money.
The response begins with the activation of participants in the civil protection system from the civil sector, continues with the declaration of a major accident and disaster, implementation of civil protection measures and the participation of the Armed Forces of the Republic of Croatia and the Police in eliminating the consequences of major accidents and disasters. implementation of measures within the regular competence of government bodies at the local, regional, and state level.
NOTE: To deal with the aforementioned aspects, paragraph 3.2 and 3.3 should also be the basis for drafting of recommendations. Special focus on mapping of the key players, inter agency services and operational capabilities/gaps is proposed in order recommendations to be structured on a practical/feasible basis.
To increase the robustness of the DT3.2.3, information stemming from focus group discussions/personal (structured) interviews related to governance structures could be used.
Conclusions

Please provide conclusions incorporating key messages for the country (priorities). Focus on guidelines and recommendations on a water utility level.

In Croatia, water utilities are only operational force of civil protection system. This means they act according to orders of civil protection service (headquarter). They aren't authorized for organization of table top exercise and other way od prevention (beside the area in which they work). They don't have updated data regarding stuff, updated information on available staff, machinery, or other necessary things which they can use in hazardous event (except their own). It is necessary to better connect civil protection and water utilities and give feedback regarding important matter in case of hazardous events.

d. Greece

General statement regarding the specific deliverables.

Climate change response implies the resilience of the water systems and necessary modifications to infrastructure design practices, investment analysis processes, and policy decisions regarding financing and disaster risk management. A mainly proactive, than a reactive, set of actions combining preparedness, emergency responses, efficient operations, and both near and longer-term measures are stressed as a challenge for water utilities. Flexibility and adaptability in strategies and plans contribute to resilience building as uncertainty in future conditions pressure to response to new information over time.

According to the Water Global Practice of the World Bank Group, improvement of water utilities' climate resilience goes through three phases: a. knowing the system, b. identifying vulnerabilities and c. choosing actions. Knowing the system starts with participatory work in which an extensive team (including planners, operators, other stakeholders) identifies the problem and critical elements of the system and the potential threats that may affect these elements, the consequences of elements failure, the performance objectives and the available solutions. This scoping identifies tools, data, and models to be used in the subsequent phases. Identification of vulnerabilities requires stress-tests in the water system over a range of plausible futures and assesses its performance under different conditions. Analysts also identify options that reduce vulnerability and improve the performance of both the system as a whole and of critical elements over the same range of futures. The whole process results in the organization of the pre mentioned options into potential robust, flexible strategies and examination of the trade-offs among them in meeting the resilience objectives (World Bank Group, 2018).

In this context, the present report including deliverables of the Activity 3.2 of the MUHA project, intends to cover key issues regarding water safety planning mechanism oriented to the improvement of service resilience under a multi hazard management risk approach. For this purpose, the report is structured on the identification of the key bottlenecks for the implementation of services related to the water utilities safety planning requirements, on the basis of information stemming from water safety and emergency response mechanism (mapping of the institutional structure and inter dependencies of agencies involved), SWOT analysis outcomes performed at both national and water utility's level, as well as the findings of the testing phase carried out using the water safety planning tool (risk assessment component) developed under the MUHA project (MUHA tool box) in the pilot activity of the Municipal Water & Sewerage Company of Larissa (PP11).

Furthermore, a report on the Key guidelines for the improvement of inter-agency operation services, on the basis of the Incident Command System (ICS) organization, in the field of water supply resilience is included. In this report, except for the above mentioned elements, information stemming from evaluation of a Table Top Exercises conducted in the water utility's area, simulating an earthquake emergency incident with the activation of the key agencies involved according to the response mechanism, is also considered. Finally and based on the aforementioned points, an effort on drawing the key recommendations dealing with the improvement (optimization) of governance structures at local level for resilient water supply is made.

D.T3.2.1. Report on key bottlenecks for the implementation of services and their requirements - "Greece"

According to the survey carried out by the University of Thessaly (with the contribution of the Hellenic Association of Water Utilities – EDEYA) within the framework of DT1.1.1 REPORT ON NATIONAL CONSULTATIONS ON WATER SUPPLY SAFETY MECHANISMS, the implementation status of Water Safety Plans for the twenty three (23) water utilities responded to the questioner released (*Section 2.3.2 Level of Implementation & Appendix 1*), approximately 22% of water utilities participated in the survey (five (5) out of twenty three (23)) was at the phase of development of the WSPs, while a percentage of approximately 43% (ten (10) out of twenty three (23)) was preparing the tendering procedures to proceed to the development of the WSPs, Figure 3. WATER SAFETY PLANS' IMPLEMENTATION STATUS (UTH, 2020).

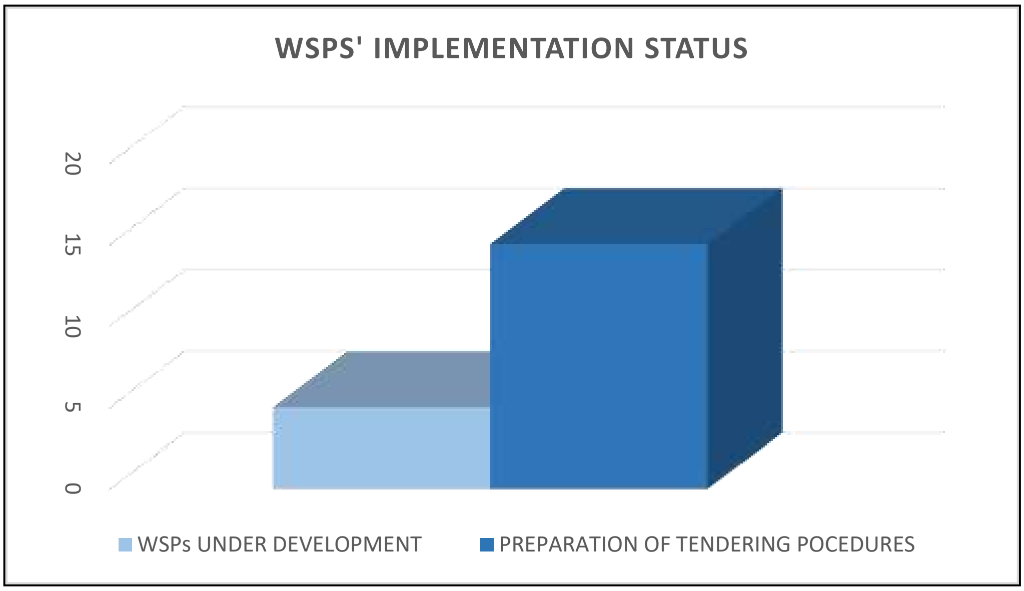

Figure 2. WATER SAFETY PLANS' IMPLEMENTATION STATUS (*Source: UTH, 2020*)

Based on the aforementioned data collected in the WP T1 in October 2020, the progress in the implementation status of WSPs in Greece could be drawn through the information collected by the Municipal Water & Sewerage Company of Larissa -DEYAL (in cooperation with the Hellenic Association of Municipal Water and Sewerage Companies abbreviated E.D.E.Y.A.) within the framework of the MUHA Project Webinar, carried out in February 2022. In this context, from the total number of 122 Municipal Water Utilities in Greece – Members of the EDEYA – to whom related questionnaire was addressed, sixty seven (67) responded to the survey out of which forty six (46) are in the development phase (a percentage of approximately 69%), as it is shown in Figure 3. WATER SAFETY PLANS' IMPLEMENTATION STATUS (DEYAL, 2022).

As regards the Municipal Water & Sewerage Company of Larissa (DEYAL), the development of the Water Safety Plan is in progress within the framework of the MUHA project.

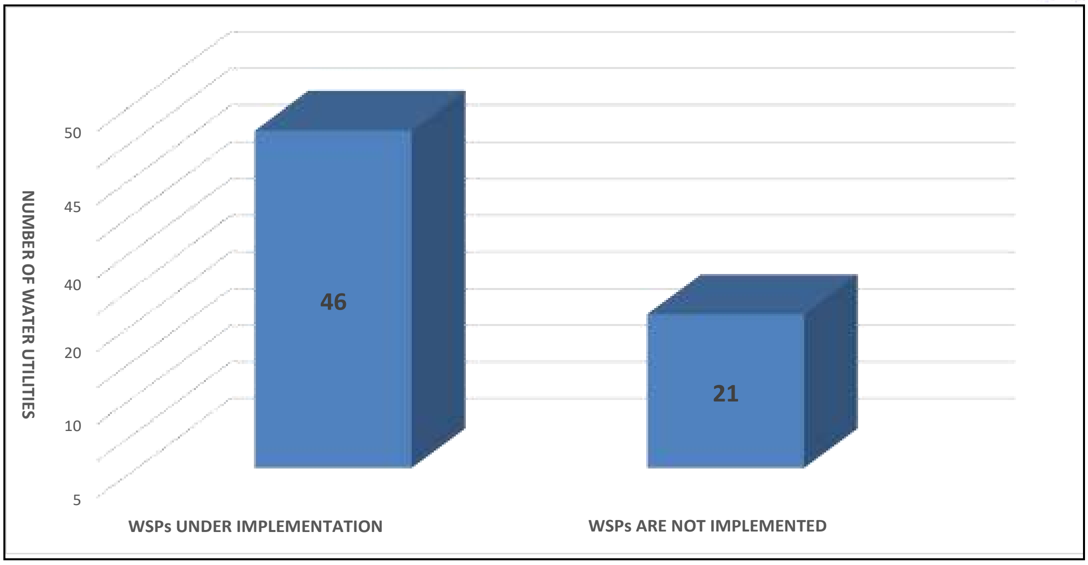

Figure3. WATER SAFETY PLANS' IMPLEMENTATION STATUS (Source: DEYAL, 2022)

Comparing information collected at both stages of MUHA project, the key messages stem from the increase in the number of Water Utilities involved in these procedures that reflects the increasing concern of water operators in water safety issues, as they become more familiar with legislative and planning requirements as long as they are gradually becoming more mature in the utilization of available financial tools in order to improve their performance and meet water sector challenges.

At a later stage, following the guidelines provided by the WP3 Lead Partner (University of Thessaly-PP7) and for the purpose of the Activity 3.2 deliverables, the Water & Sewerage Company of Larissa proceeded to the conduction of a consultation procedure specifically oriented to Water Safety Planning and inter – agency cooperation topics. The target group consisted of Municipal Water Utilities that the task of the development of Water Safety Plans is on board or completed and namely, Municipal Water Utility of Chania (Crete), Municipal Water Utility of Serres (Central Macedonia), Municipal Water Utility of Kozani (Western Macedonia) and Municipal Water Utility of Messolonghi (Western Greece).

Consultation procedure was carried out in April 2022 through the distribution of a structured questionnaire divided into two thematic sections: A. Water Safety Plan and B. Cooperation – Communication with the involved agencies (*see ANEX I QUESTIONAIRE*). Questionnaire's subject matters concerned utilities' requirements related to the hazards coped with and their management, water safety plans towards meeting service requirements, risk assessment approaches, key aspects on which Improved Safety Plans focus, operational monitoring of implemented measures, constraints and bottlenecks at each water safety planning phase and their correlation with internal characteristics or the hallmarks of the entities involved (external environment), as well as difficulties in inter - agency cooperation.

Following the processing of the descriptive answers collected under the consultation with the aforementioned water utilities the key aspects could be presented as follows

- **Water Utilities' requirements related to risks observed and their management** (risks in water systems' components – causes and vulnerability, impacts, risks related to operational and management procedures etc.):

Hazard risks in water systems observed in the whole water supply chain from water intake points to consumer tap and namely at water abstraction, treatment, storage, distribution and consuming stages. Generative causes with respect to water supply stages related to

- ➢ Infrastructures' accessibility (mainly at abstractions points), land uses and activities (intense agricultural/livestock activity) close to water intake points that pressure aquifers status. Hazard risk differ depending on the geological background of the water body in which each water intake is located and it is necessary to prepare special hydrogeological studies to determine protection zones of all water points.

  High vulnerability of water abstraction stage is observed in case of karstic aquifers, as they can be burdened by pressures/loads exerted at very long distances from the water intake point.

- ➢ Infrastructures' condition, materials, aging of the networks, uncompleted network components' constructions (mainly after network failures), operating processes and inadequate cleaning of external and internal networks.
- ➢ Vulnerability of individual water abstraction areas/points to flood events.
- ➢ At the treatment stage, hazard risk is related mainly to disinfection failure due to power outages as well as damage to chlorination devices. Risk stemming from malfunction/absence of security at disinfection devices and fires/explosion incidents are also noted.
- ➢ Vulnerability of systems' components at water storage stage concerns mainly the condition of the storage tanks (insufficient maintenance) or requirements for construction of new tanks, as well as risks arisen by inadequate security from unauthorized access.
- ➢ At the distribution – consumption stage pollution risk is related to pipes materials (asbestos cement pipes) that potentially affect the quality of drinking water. In addition, inadequate installation of shut-off valves and non-return valves resulting in an occasional increase in the risk of contamination /pollution from an accident (breakage, piping leakage, arbitrary connection).

A common place of water service providers' requirements is the implementation of a detailed hazard assessment plan of existing operating conditions and procedures and an integrated management approach, which includes all stages of water management, from the catchment to the consumer tap. This process is reflected in the WSPs that aim to systematize and organize practices that have been developed and used for production, supply, treatment and distribution to the consumer. In this context the key objectives of the plan include minimizing source contamination/pollution, reduction or elimination of contamination through treatment, and timely prevention of contamination during storage, distribution, and consumption.

- **Water Safety Planning to meet water utility requirements** including hazards of natural disasters/ pressures related to floods, drought, accidental pollution and earthquake incidents:

- ➢ The WSP adequately addresses the aforementioned requirements as the risk is determined at each stage following studying the prevailing conditions, such as geological factors, location and condition of infrastructures, pressures from man-made and natural environment, infrastructure failures, results of physicochemical and microbiological analyses of water, etc. WSP incorporates the risks of emergencies and natural disasters such as floods, earthquakes, etc.

The above is mentioned by all the participants in consultation procedure except for one case where earthquake hazard has not been included in the water safety planning.

In addition, it is highlighted that WSP constitutes an effective tool under the conditionality of proper risk assessment and ensuring its constant implementation. To this end meeting staffing requirements is a prerequisite.

- **Risk analysis and assessment approaches within the WSP:** outcomes of the consultation process shows that water utilities implement

➢ The semi-quantitative methodological approach, according which the frequency of occurrence of the hazard is estimated on a five-point scale and the severity of the hazard impacts is estimated on a five-point scale too. Risk assessment is derived on the basis of these estimations.

➢ The qualitative approach which is based on the experience of the WSP team and “expert’s judgment”.

Water operators support this approach on the argument that it has significant advantages when used by experienced in WSP teams as it appears to provide flexibility in the identification of Critical Control Points and in the implementation of existing control measures.

In addition, the contribution of utility’s experience in networks operation and predictions of potential problems occurrence, as well as the reliability of the network surveying are pointed out.

➢ The combination of semi – quantitative and qualitative methods approach.

It is also argued that qualitative approach may be proved of high effectiveness when applied by experienced work team in the implementation of WSP, while the semi-quantitative method leads to safer conclusions when the development and implementation of a WSP is carried out by people with no previous experience.

It was stressed that in any case, in risk assessment, in order to determine the frequency, intensity and impacts of each hazard, both the information collected during the description of the Water Supply Network of water supply zone of interest, as well as available literature references to any impact of hazards on the safety & health of Consumers should be co-estimated.

- **Key points that the Improved Water Safety Plan (IWSP) is focused on:** The IWSP includes proposals and measures to monitor critical points. For each measure, monitoring parameters, their values and the way towards their successful monitoring are determined. Any suggestions for taking new control measures in an Improvement Plan must be thoroughly investigated considering financial efficiency, sustainability, effectiveness and improvement of resources management (human resources included). Additionally, implementation of new measures adopted should be performed under strict supervision, avoiding new risks’ insertion to the water supply system.

  It is noted that for some of the participated (in consultation) utilities IWSP has not been in place.

- **Identification of the key issues cropped up from the operational monitoring of measures’ implementation:** Water utilities pointed out that the key issues raised by the monitoring of the measures concern the necessity for implementation of new works, supplies of new materials, new installation etc. In this context, utilities deal with financial and human resources constraints. Increasing in monitoring water quality parameters and the frequency of sampling may entail "pressures" on water utilities (due to limited resources). This is strongly related to the initiation of proposed measures' implementation (in short/medium term).

Human resources availability and management is also stressed as a necessary condition for the effective implementation of WSPs. More specific, utilities emphasize in proper work allocation, effective coordination, necessity of review-evaluation with regard to operational monitoring improvement, as well as high level administration's support at the implementation phase. These aspects are considered substantial as from the efficient function of WSP team will emerge (in a systematic and prioritized way) the proposals for investments, improvement of the infrastructures and the operational practices subjected to the Water Safety Planning.

- **Difficulties/ problems that water utilities faced at each water safety planning stage up to the completion of the Plans' development (prioritization of the problems based on the severity and difficulty in coping with):**

  Water utilities commonly recognize that the development of a WSP is a complex process in which many parameters are involved. For correctness and completeness purposes, of the WSP system, an extensive analysis of the prevailing conditions in the examined water supply zones is required. In this context, increased data/information availability requirements concerning individual functions of the water utility entails high organizational (management) and operational demands. A well organized internal cooperation (work allocation and communication flow) among the different departments of the utility (depending on its size) constitutes a prerequisite for Plans' implementation continuity. This is commonly phrased as of high difficulty by water operators (participants in the consultation). In this context, the adoption of a well organized sequence of standardized procedures appears to be a necessity.

  Despite the aforementioned issues raised by the utilities, it should be noted that in some cases operators consider these difficulties as a challenge or opportunity to improve the procedures regarding collection, recording, process and communication of data/information concerning water systems of their responsibility. .

  In addition, operational capacity building issues, including staff expertise, exchange of experience and know how taking into account national even international applied practices, are also substantial to meet the aforementioned demands. These elements create difficulties in terms of human and financial resources availability and management.

  Furthermore, the cooperation with the agencies involved is also a dimension of high significance for the successful implementation of the WSP (inter agency cooperation and external communication flow).

  WSP is a dynamic system that is being modernized and must always be fully relevant to the risks posed by water, technological developments regarding equipment and compliant with the current legislation. To this end, adequate funding of the WSP system is a crucial factor for its success and simultaneously constitutes its difficulty.

- **The pre described difficulties/ problems that are attributed to internal characteristics of the Water Utility (weaknesses/ deficiencies) and to other involved agencies (indirectly and directly):** At this point, water utilities highlighted that internal weaknesses that are depended on the size of the utility, are mainly due to the understaffing conditions (staff recruitment difficulties) and the absence of registries (data bases) in which failures are recorded, e.g. water supply system failures and water quality incidents, hazardous events etc. As far as external impact factors water utilities focused on the cooperation weaknesses with the agencies involved (e.g. water directorates, etc.) and the availability of the adequate funding sources (financial instruments) for investments.

- **Suggestions for dealing with the aforementioned difficulties/problems based on the water operators' experience:** Dealing with problems that already observed or may be emerged is oriented to

- The development of a data basis for recording monitoring of failures (regarding infrastructure and water quality) which will be linked to the GIS map data for spatial and temporal recording and troubleshooting.

- The improvement of cooperation and communication flow among the various departments of the water utility.

- The ensuring financial tools to fund the required infrastructure works and supplies concerning water safety planning mechanism.

  Despite the fact that the development of the Water Safety Plan is funded in the framework of Operational Programs of EU Structural Funds, Recovery Fund etc for WSP's implementation requirements there are not relevant provisions for funding.

  However, in some cases water utilities incorporate the water safety planning investment needs into their investment plan as a part of projects that are eligible for funding within financial tools in place.

- The continuous education / training of the members of the WSP Team. In addition, training in water safety and proper use of drinking water issues should be in place for all water utility's staff members.

- **Key issues arising from the cooperation of water utilities with other agencies - organizations, regional & local authorities- points for improvement:** Legislative framework does not provide for cooperation among the agencies involved in water management for the implementation of the WSPs. Cooperation is actually at the discretion of each water utility. However, water utilities recognize that inter agency cooperation through the involvement of Water Directorates, Regional Directorates of Public Health (Department of Environmental Hygiene and Sanitary Control), Civil Protection etc. at the implementation of the WSPs is necessary towards the increase of operational effectiveness.

  In this framework, it is proposed the WSP team to function at two levels: internally in the water utility to cover operational requirements on a daily basis and externally involving the aforementioned agencies. The proposed enlarged WSP team may be convened at least annually prior to the review of the WSP by the municipal water utilities.

  A positive contribution to the improvement and mitigation of existing difficulties could be achieved by the regular evaluation of the effectiveness of the WSP, which could be performed by both internal and external inspections, as well as by monitoring consumer satisfaction concerning water service provided. Internal Audits of the WSP could be assisted by at least two inspectors (in a rotation scheme) so as not to be directly involved in the activity/ department to be inspected, while they will be able to recognize all discrepancies and their risks of the system impartially.

To sum up, it could be concluded that consultation process performed with the above mentioned selected municipal water utilities has a substantial contribution to the confirmation of the shortcomings/bottlenecks indentified under the Activity 3.1, as well as to increasing the robustness of recommendations/proposals and guidelines phrased within Activity 3.2. of the Muha project.

Evaluation of the toolbox in making of PA Water Utility WSP

Within the pilot activity testing phase performed by the the Municipal Water & Sewerage Company of Larissa, MUHA toolbox capabilities with respect to service requirements could be drawn as follows.

MUHA toolbox provides an online tool for the risk assessment, covering a very wide range of hazardous events. The toolbox can be used by water utility operators in order them to indentify the most critical components with high risk and plan the respective mitigation measures. In this context, risk assessment process can be repeated after the measures' implementation in order water utilities to evaluate the risks related to the specific hazards.

The user-friendly interface allows the user to select the components of the water supply system studied. For each component there is an extensive and very detailed list with hazardous events for which the user has to assess the probability of occurrence and the severity in order to finally evaluate the risk. The MUHA toolbox provides the user with statistical graphs regarding the hazards and their severity and the risks assessed. These features make the toolbox quite useful as it enables the user to perform a thorough risk assessment supporting the development and implementation of the Water Safety Plan.

Statistical data related to the possibility of occurrence of the hazard, the severity of consequences and the risk assessed are very useful to the water utility operators as consolidated results will be provided facilitating corrective actions 'planning. Other kind of reports could be also useful, as for example the near misses recording, provided that further analyses are used to back the results.

An important aspect regarding the usefulness of information for the development of the WSPs could be considered that the MUHA toolbox except for the hazards related to the water quality also covers hazards related to water availability and quantity, including water losses and leakages. The latter is a crucial point which is also addressed in the revised EU Drinking Water Directive 2020/2184 "on the quality of water intended for human consumption". In addition, the MUHA toolbox includes hazardous events in the internal piping systems (in line with the EU Drinking Water Directive requirements), organizational and other hazards. Thus, the MUHA toolbox can be used not only by water utilities but also by other organizations, such as organizations responsible for the water basins management, etc.

Reliability of the toolbox results is strongly depended on the reliability of the input data stressing the importance of data and hazardous events 'recording by the water utility. A relevant issue is referred to the water operators practises in the collection of information/data after the toolbox use. As regards the Water Utility of Larissa (DEYAL), even if it has not started collecting additional information or data for the moment, it is evident and accepted by the water utility that it is necessary to establish a system to collect all the related data in one registry which will be available to the water utility. Although DEYAL gathers and keeps records of pollution events (accidental or not), it is necessary to have one common registry for all kind of failures. For example, except of the data related to water supply and distribution failures, it is necessary to collect in a standardized manner data related to water quality, such as events where the water analyses provided results of increased values or values exceeding the limits, etc. In addition, this registry should also include data for all the components of the system. This registry can be mapped in the GIS to have an overview of all failures or accidental pollution events in the whole water supply system, from the catchment to the consumers' taps. The registry can include the following data: name of event and location, time of the event, causes of the event, consequences of the event, and measures taken to tackle the failure.

As far as MUHA toolbox re-evaluation requirements is concerned, once the MUHA toolbox is used for risk assessment, it can be used again in specific time periods. World Health Organization defines the re-evaluation period in one year. However, when extreme or unforeseen events take place, the re-evaluation is necessary. Risk assessment time periods are also related to the revision /update of water safety plans that should be performed in case of extreme and unforeseen incidents, or when there are significant changes in the water supply system components. Under normal circumstances, the revision /update of the water safety plans can be performed once a year.

To sum up and focusing on DEYAL's pilot activity experience, in the current phase of project implementation, MUHA toolbox is appeared to be a very useful tool for the water operators providing an extensive list of hazardous events and allowing the users to perform a comprehensive risk analysis, in coherence with the World Health Organization Guidelines and EU Drinking Water Directive principles. In the future, the MUHA toolbox might be improved to include hazardous events that are not included at the current version, based on the experiences of the users.

Despite the aforementioned capabilities of the MUHA toolbox stemming from the test phase under the pilot activity, issues regarding potential difficulties in the use of the tool could be taken under consideration.

An important aspect is the reliability of the data entered into the MUHA toolboxand namely the probability of occurrence of the hazardous events and their severity. As regards the probability of occurrence of the hazardous events toolbox provides the certain choices: hazard not present, occurring every 30 years or more, occurring every 10 years, occurring annually, monthly, weekly and hazard is present but probability cannot be assessed. In this context and in order the probability of occurrence of a hazardous event to be assessed the user should use data from the water utility company or the expertise of the operators ("expert's judgement") resulting in distorted estimations.

In case of DEYAL, as it has already mentioned, systematic and standardised keeping records related to specific hazards is not performed. Consequently, hazards probability of occurrence based on both measurements and experts' judgement.

The assessment of the hazards' severity of consequences is also an issue as it is based on "experts' judgement", the tool does not provide any guidance/suggestion. Dealing with severity assessment, DEYAL proceeded to the definition of severity categories as follows:

- Severe effects: catastrophic health effects; the hazard results in serious symptoms, permanent injuries or mortality; no water supply at all for long period.
- Major effects: regulatory effects causing short- or long- term symptoms; water interruptions resulting in intermittent water supply.
- Moderate effects: temporary consequences to the health of the consumers; no serious injuries; temporary water interruptions.
- Minor effects: effect that has to do only with physical water characteristics and the hazard has no effect on the consumer's health; water supply is not interrupted for long periods.
- Minimal effects: no effect at all or insignificant effect.

To this end, the results from the water analyses can be useful in order to record when the values of specific parameters are increased or exceed the limits set.

Given the complexity of drinking water chain, possible variation of the hazard risk among system components or subcomponents also constitutes an issue. Especially in cases of large water supply systems it is necessary for the MUHA toolbox to allow the user to add components and subcomponents (within the same components) of different probability of occurrence of hazardous events or different severity of consequences. This is also the case for DEYAL.

Evaluation of the MUHA toolbox testing phase outcomes for the pilot activity of the Municipal Water & Sewerage Company of Larissa is presented bellow with respect to the MUHA hazards and namely drought, floods, accidental pollution and earthquake.

- ***Can possible risks related to the different components be correctly evaluated through the MUHA toolbox? Are you able to indicate possible lacks?***

“Drought” hazard: Possible risks related to drought can be correctly evaluated through the MUHA toolbox. MUHA toolbox allows the user to assess the risk of any hazardous event for the components which comprise the water supply system. However, these components are not specified. For example, large water supply systems take water from different water sources. As the user cannot add subcomponents for each component in MUHA toolbox, it is not easy for the user to assess the risk separately for each sub component. In the case of Larissa water supply system, water is abstracted from 3 groups of boreholes. Two groups of boreholes are located in sub-basins characterized to be in poor quantitative status and thus, facing a higher risk of drought. The current version of MUHA toolbox cannot provide this information. On the contrary, for a small water supply system (as for example the water supply system of a village), the water sources are located in the same water sub-basin and thus the risk assessment can be done for this component.

“Floods” hazard: The same stands for the flood hazard as for drought hazard. The MUHA toolbox addresses many potential hazardous events related to floods. However, when the water supply system is large then there may be components or subcomponents with higher flood risk related to others (either because of higher probability of occurrence or because of more severe consequences). In the case of DEYAL’s water supply system, there are groundwater sources located in areas identified as areas facing high flood risk, thus the probability of occurrence of a flood event is higher compared to another borehole location.

“Accidental pollution” hazard: The causes of accidental pollution hazardous events may be different in different water supply sources and in different parts of the water distribution system. For example, in the case of a water supply source which is close to agricultural, or livestock activities may face higher risk of accidental pollution compared to another water supply source. The same happens in the water distribution network. For example, the deadends of the water supply network may face higher risks of accidental pollution due to high water age values. Although the MUHA toolbox addresses various hazardous events related to accidental pollution, the use of subcomponents could be useful in order to assess the risk in a different way in different subcomponents.

“Earthquake” hazard: The MUHA toolbox allows performing a comprehensive risk assessment for possible risks related to earthquakes for various components of the water supply system as it provides an extensive list of hazardous events.

- ***Are there hazardous events (due to drought, accidental pollution, floods & earthquakes) considered by the toolbox, but not fulfilled due to the lack of internal(at the WU level) information? Which ones?***

“Drought” hazard: The Water Safety Plan elaborated by DEYAL as the pilot activity evaluates the risks based on hazardous events that have already occurred. Regarding drought is assessed as a hazardous event only if it happened in the past. On the contrary,the MUHA toolbox provides a detailed list of possible hazardous events. In this way DEYAL assessed the drought hazard as a hazardous event which is present, but its probability cannot be assessed. DEYAL monitors the water level in the boreholes but not in a regular basis.

"Floods" hazard: The MUHA toolbox covers several hazardous events related to floods. DEYAL does not record any specific information related to floods. Also, until now there is no failure to the water supply system recorded due to floods.

"Accidental pollution" hazard: The water utility registers accidental pollution events and thus internal information is available. The MUHA toolbox has a detailed list of accidental pollution hazardous events covering almost all cases faced by DEYAL so far.

"Earthquake" hazard: In most of the hazardous events of the toolbox although the hazardous event is present its probability cannot be assessed because it has never happened before. DEYAL records all failures to the water supply system related to the water supply and distribution system (e.g. pipes, valves, etc.)and to water quality. Thus, the internal information exists.

- ***Are there hazardous events (due to drought, accidental pollution, floods & earthquakes) considered by the toolbox, but not fulfilled due to the lack of external information? Which ones? From which institution?***

"Drought" hazard: The external information on drought events can be found on the Drought & Water Scarcity Plans elaborated in the context of River Basin Management Plans. However, as a registry for drought events is not in place, the external information can be improved.

"Floods" hazard: External data on the floods hazard are available at the Flood Risk Management Plans and the flood hazard maps developed for 50, 100 and 1000 years return periods. In Greece the Flood Risk Management Plans are under revision at the moment. Available data can be found at https://floods.ypeka.gr/ where maps can be downloaded, and a geoportal is available. These data are used for the development of the DEYAL Water Safety Plan and for filling in the requested data for the MUHA toolbox.

"Accidental pollution" hazard: External information related to accidental pollution is not available by any other institution in Greece. According to the Greek legislative framework the authorities responsible for drinking water quality monitoring are: (a) water services providers (first degree of responsibility); (b) Environmental Hygiene & Sanitary Control Department of the Regional Units (second degree of responsibility); and (c) the Ministry of Health. Thus, water utilities report the results of their water samplings to the Environmental Hygiene & Sanitary Control Department of the Regional Units every three months, and to the Ministry of Health once every three years for the needs of reporting to the EC (https://ec.europa.eu/environment/water/water-drink/reporting_en.html).Water quality data are also reported to the water quality monitoring platform of the Hellenic Association of the Municipal Water Supply and Sewerage Companies (EDEYA) https://ydor.edeya.gr/dashboard. The toolbox contains a long and extensive list of potential hazardous events related to accidental pollution.

"Earthquake" hazard: There is no external information related to failures to the water supply system due to earthquakes. Also, the earthquake's consequences related to water contamination or water interruption are not regularly recorded in Greece. The only available sources are scientific publications from earthquake related institutions and research teams.

- ***Can you provide information regarding the reliability of the input data (e.g. which category of the input data is estimated, calculated or measured)?***

As it has already mentioned, the input data to the MUHA toolbox are based on experts' opinion and experience regarding past events. For further information see previous paragraphs in this section on general comments. Except for the general comments regarding reliability issue and with respect to the

"Drought" hazard: the available internal and external data sources are limited. In addition, sophisticated tools such as modelling, and prediction tools are not used by water utilities in Greece. In particular, small water utilities do not have the personnel to undertake such activities. Another obstacle is that the water utilities are understaffed and thus not available to undertake more scientific activities.

"Floods" hazard: External data sources for floods exist and although DEYAL keeps records for failures in the water supply system, there is not a specific registry for failures related to floods. Flood hazard has not affected the water supply system of DEYAL in the past.

"Accidental pollution" hazard: DEYAL keeps detailed records for accidental pollution events, thus the reliability of the input data on accidental pollution is high in relation to the probability of occurrence. The use of sophisticated tools such as the hydraulic simulation model of the water network should be useful for the assessment of the impacts of such a hazard (e.g., the number of people consuming contaminated water).

"Earthquake" hazard: Regarding earthquakes, water utilities register only failures to their water supply system due to earthquakes. For example, DEYAL registered the consequences of the recent earthquake (in March 2021), the actions taken and how the problems are remediated.

- ***Does the civil protection system of your country play or would play a specific role for developing water safety plan related to the***

"Drought" hazard: Although drought is one of the hazards addressed at the General Plan of Civil Protection – "Xenokratis" General Plan-, an emergency operational plan to deal with drought and water scarcity conditions is not in place. In addition, the National Civil Protection System is not involved in the development of Water Safety Plans (WSPs), which is an obligation of the water utilities (as set in the Programmes of Measures of the River Basin Management Plans). However, the cooperation of the civil protection organization and the water utilities could be useful, especially in relation to hazards identified in the General Plan of Civil Protection, such as drought. The WSP team could include external members, such as local civil protection representatives, water users, etc.

"Floods" hazard: The National Civil Protection System is not involved in the development of WSPs. However, there are emergency operational plans to deal with floods at national, regional and municipality level ("DARDANOS" plans). The general director of DEYAL participates in the Coordinating Body for Civil Protection of the municipality. Thus, the cooperation of civil protection organizations with the water utilities is useful for the protection of public health in the case of a flood event. In particular, the WSPs teams could consist of external members including a representative of the civil protection

Accidental pollution" hazard: The National Civil Protection System is not involved in the development of WSPs. In general, the accidental water pollution is not identified as one of the disasters in the General Plan of Civil Protection in Greece.

"Earthquake" hazard: The National Civil Protection system is not involved in WSP development. However, in the case of earthquakes which are an identified disaster in the

General Plan of Civil Protection, the civil protection system could be involved in the WSP team as external members. Civil protection could play a significant role providing guidance on the activities for the protection of the infrastructure in case of an earthquake. Civil protection could also train the water operators for the emergency response actions after an earthquake event.

- ***Does any other institution of your country play or would play a specific role for developing a water safety plan related to the***

"Drought" hazard: WSPs are usually developed by water utilities. As the WSP takes into consideration all hazards from the water basin to the consumers' taps, multidisciplinary teams from various organizations and institutes related to water resources management, public health, civil protection, and stakeholders should be established. In fact, the competent authorities regarding water resources management in Greece are: (a) at national level the National Water Committee, the National Water Council, the General Secretariat for Natural Environment and Water of the Ministry of Environment and Energy; and (b) at regional level the Decentralized Administration Water Council, and the Decentralized Water Directorates. Thus, as drought is a hazard affecting multiple water users, the development of teams consisting of both water utility members and external ones is necessary.

"Floods" hazard: The competent authorities according to the Flood Risk Management Plans are: (a) at national level the National Water Committee, the National Water Council, the General Secretariat for Natural Environment and Water of the Ministry of Environment and Energy; and (b) at regional level the Decentralized Administration Water Council, and the Decentralized Water Directorates. As floods are included in the natural disasters identified in the General Plan of Civil Protection ("Xenokratis"), the former Civil Protection Secretariat has issued the document 7742/1-11-2017 "Planning and Actions of the Civil Protection for the confrontation of hazards from flood events". This document presents the responsibilities of the bodies involved in the management of flood phenomena and their coordination. The WSP teams could involve external members from organizations such as the civil protection.

"Accidental pollution" hazard: As already mentioned, the WSP teams could involve external members from organizations and institutions such as the regional Environmental Hygiene & Sanitary Control Departments, and the Ministry of Health, as contaminated drinking water could jeopardise the public health. In addition, since the elaboration and monitoring of the protection zones are important activities for the water supply sources safety, institutions such as the Regional Water Directorates and the Ministry of Environment and Energy could also be involved. These teams could involve environmental inspectors too.

"Earthquake" hazard: In Greece, there are national institutes regarding earthquakes such as the Institute of Geodynamics of the National Observatory of Athens; Geophysics Department of the Aristotle University of Thessaloniki; Geophysics-Geothermics Department of the National and Kapodistrian University of Athens; Geological Department of the University of Patras; Laboratory of Geophysics & Seismology of the Technological Educational Institute of Crete; Institute of Engineering Seismology and Earthquake Engineering; and Organization for Earthquake Planning and Protection (OASP), Ministry for Climate Crisis and Civil Protection. These institutes could participate in the development of WSPs as they could provide their expertise.

Evaluation of PA goals fulfillment

The goals of the pilot activity that has been carried out by the Municipal Water & Sewerage Company of Larissa are mainly related to: the reporting of problems faced during Water Safety Plan (WSP) development and implementation, measures taken to address identified problems, provision of guidance towards the multi-hazard management of the water supply systems, contribution of utility's experience to the implementation of the WSP in a practical and more efficient way, as well as dissemination of lessons learnt to other water utilities overcoming existing gaps and inefficiencies. In this context, specific targets of DEYAL's pilot case are referred to the addressing all the MUHA project hazards based on historical data, monitoring of water quality and hazard identification at the whole drinking water chain (from resource to consumption points), risk assessment using risk- hazard assessment matrix, as well as evaluation of measures applied, and identification of measures required to ensure water safety.

At the current phase of pilot action, the WSP is under development. Regarding the incorporation of the information system that will result in the identification of critical control points in the water supply system is also in progress. In particular, the first phase of the pilot action is concluded, and the 2nd phase is under preparation. Within the 1st phase:

- The WSP team is established, and the subgroups are identified: management subgroup, mapping, on the spot research, data recording and analysis, samplings, chemical analyses, education, management and communication subgroups.
- The water supply system consists of 9 water supply systems which represent 11 water supply zones.
- The information system, which is used to support the WSP development,is set up and seven water supply zones are prepared. For these water supply zones, their characteristics are entered in the information system and an initial risk assessment took place.
- The necessary monitoring activities are determined (number of samplings and water analyses that need to be done both at the water abstraction sites and at the consumers' taps). Samplings and water analyses will take place to complete the risk assessment process.

Taking into account the above-mentioned information concerning the goals and specific targets of the pilot action in combination with the progress status of the related activities, it is noted that evaluation of the pilot action demands at least the completion of the 2nd phase. The latter is the most important one, consisting of the determination of the critical control points and the critical limit values, and the operational monitoring actions. The 3rd and last phase includes the revision of the WSP and its validation and actions for the consumers' satisfaction assessment. Finally, the update of the WSP takes place.

In this context and considering the results of the MUHA toolbox testing phase (see Section 2.1 "Evaluation of the toolbox in making of PA Water Utility WSP" of the present report) the followings can be drawn.

- The initial risk assessment identified some vulnerable parts of the water supply system and based on the data from the samplings and the analysis, new measures will be suggested to reduce the vulnerability.

- The information system proved to be very useful as it facilitates the monitoring of the WSP implementation. MUHA toolbox used for the hazards' identification and the risk assessment.
- MUHA toolbox is a very useful tool for the water operators as it provides an extensive list of hazardous events and allows the user to perform a thorough risk assessment.
- MUHA toolbox evaluates correctly the risks related to the 4 MUHA hazards. However, for large water supply systems it is necessary to provide the user with the possibility to add subcomponents to the existing components, as the risk is different. For example, the location of the water supply sources affects their risk for drought or flood or accidental pollution due to their location.
- In the future, the MUHA toolbox can be improved to include some hazardous events that might occur which are not included at the moment, based on the experiences of the users.

Addressing weaknesses/bottlenecks in the implementation of the multihazard management – Water Utility Level

In the light of information stemming from the pilot activity in DEYAL, MUHA toolbox testing phase included (see Section 2.1. "Evaluation of the toolbox in making of PA Water Utility WSP" of the present report), the key issues concern the provided capabilities for performing a comprehensive risk assessment at drinking water systems, as well as the availability of internal and external information related to MUHA project hazards that is required for the impacts' assessment under Water Safety Planning.

The pilot activity focuses on the development of an integrated information system for the Water Safety Planning Mechanism that will cover the whole water supply system of DEYAL. Despite the fact that the pilot activity is fully in accordance with the objectives of the MUHA project the pilot actions are in progress, thus a re- evaluation process may be considered on the appropriate time of their completion. However, the pilot case of DEYAL has been planned to meet the utility's service requirements overcoming weaknesses and gaps revealed in the SWOT analysis performed within activity 3.1 of the MUHA project (see DT 3.1.1, 3.1.2, 3.1.3 & 3.1.4).

Dealing with MUHA hazards, drought/water scarcity, accidental pollution, floods & earthquakes, water utilities in Greece face the uneven spatial and temporal distribution of precipitation and water availability, temporal and spatial imbalances of water demand & over exploitation water resources, degradation of qualitative status of water resources due to pressures/pollution loads mainly from land uses & activities, flood incidents' impacts as well as earthquake hazardous events, that affect not only abstraction water bodies but also the operability and efficiency of drinking water supply systems.

Focusing on DEYAL's case, it is located in a river basin facing severe water exploitation problems and extremely high water demand for irrigation. As water utilities take measures (locally) to monitor the level of the water bodies they use for abstraction, DEYAL monitors the water level in boreholes and in the case of low water levels, alternative boreholes are used. If a water utility faces a significant problem with water supply, then intermittent water supply measures are activated. However, this is a practice decided ad hoc. In this case, the public is informed for the restrictions set.

DEYAL uses water from groundwater bodies classified in bad qualitative status, facing pollution risks, frequent accidental pollution incidents, mainly due to untreated water entering the water distribution network. However, a vulnerability plan for accidental pollution has not been developed.

With regard to flood hazard, DEYAL is affected by climate change and the vulnerability of water supply under flood event conditions. According to Preliminary Flood Risk Assessment (Ministry of Environment & Energy, 2020) Municipality of Larissa is located in a potentially high flood risk area.

According to the national classification of seismic hazards, Larissa city is also located in the medium seismic hazard zone. The region of Thessaly is tectonically active and conspicuously vulnerable to strong earthquakes. At the utility level DEYAL does not use any indicator related to severity and impacts of earthquakes on water supply infrastructure. It is noted that there are no failures reported after earthquakes in the recent years. The vulnerability of the water supply system in case of earthquake events has been assessed in an empirical way, highlighting the good condition of the networks (in terms of construction), however damages in boreholes observed caused degradation of water quality and consequently water supply interruption.

In the context of a combining analysis of bottlenecks for the implementation of services in relation to their requirements at water utility level, based on the information released in the previous paragraphs of the present report –outcomes of consultation procedures included (see Section 2.0) - and deliverables of activity 3.1 of the MUHA project, the following key aspects are set under consideration:

- **Staffing requirements.** Personnel at higher hierarchical levels in DEYAL is specialized and of long experience. However, understaffing constitutes an issue, as the utility serves a large part of population in the region.
- **Planning weaknesses.** Development and implementation of the Water Safety Plan as well as the Master Plan of the water utility are currently pending. Response measures in case of the aforementioned hazards are not addressed within an organized management plan while risk assessment tools are not in place (ad hoc decisions on measures taken on the basis of operator's experience/implementation of empirical practices).However, DEYAL has just embarked on this task in the framework of the MUHA project pilot activity, while the development of the Master Plan for drinking water supply is in progress contributing to the enhancement of water service resilience.
- **Monitoring weaknesses** concerning online monitoring of water quality inside water systems. Monitoring gaps are observed due to the lack of innovative monitoring technologies (automated sensing technologies) for real time water quality monitoring in DEYAL's water system.
- **Internal information gaps.** Although DEYAL keeps records for failures in the water supply system, there is not a specific registry for failures related to floods, while for drought events internal available information is limited. Regarding earthquakes, water utilities register only failures to their water supply system due to earthquakes. For example, DEYAL registered the consequences of the recent earthquake (in March 2021), the actions taken and how the problems are remediated.
- **Interagency Cooperation –External information.** Information related to accidental pollution is not available by any other institution in Greece. According to the Greek legislative framework the authorities responsible for drinking water quality monitoring are: water services providers (first degree of responsibility), Environmental Hygiene &

Sanitary Control Department of the Regional Units (second degree of responsibility) and the Ministry of Health. The Hellenic Association of the Municipal Water Supply and Sewerage Companies (EDEYA) has an information system for the collection of drinking water quality data that is addressed to its members (https://ydor.edeya.gr/dashboard).The external information on drought events can be found on the Drought & Water Scarcity Plans elaborated in the context of River Basin Management Plans. However, as a registry for drought events is not in place stressing the need for the improvement of the external information. With regard to earthquakes, there is no external information related to failures to the water supply system. In addition, the earthquake’s consequences related to water contamination/ water interruption are not regularly recorded. The only available sources related to earthquakes are scientific publications from institutes and research teams.

- **Interagency Cooperation – Crisis Management/Disaster event**. Under the Local (Municipal) Emergency Response Plans and Immediate/Short-Term Management of the Consequences of an Earthquake & Floods, DEYAL is responsible for the adoption of an internal regulation for civil protection. It has the obligation to assign a chief, a deputy chief and teams for civil protection. It is also obligated to carry out all the necessary actions in order to provide safe water of good quality to the citizens of the municipality in case of any disaster, in collaboration with the municipality and the regional department for civil protection and emergency planning policy.DEYAL’s internal regulation for civil protection, in terms of the water supply service provision within the area of its responsibility in case of a disaster has not been completed yet.

At national level, water companies confront the above-mentioned issues that, especially in case of small water utilities, are exacerbated by reasons related to both available technical capabilities and the geographical location of the areas of their responsibility (high potential risk related to hazards addressed). Water service providers face difficulties in the adoption of available technologies and dealing with deficiencies in their infrastructure (age and condition of the networks, inefficiencies of monitoring tools etc.) as funding limitations, low investment activity, lack of qualified staff are included in the list of constraints.

Recommendation to address the aforementioned issues could be specified as follows:

- Development of the WSP and adoption of an innovative monitoring system for real time water quality monitoring at the drinking water chain supporting water safety mechanism.
- Development of the Master Plan that provides for water supply in a long-term time frame, in which resilience in water scarcity, floods and earthquake hazards will be considered.
- Regular evaluation of the effectiveness of the WSP, which will be performed by both internal and external inspections, as well as by monitoring consumer satisfaction concerning water service provided. Internal Audits of the WSP could be assisted by at least two inspectors (in a rotation scheme) so as not to be directly involved in the activity/ department to be inspected, while they will be able to recognize all discrepancies and their risks of the system impartially.
- Development of a data base for systematic and standardised recording of hazardous incidents (including all relevant information with geospatial mapping capabilities) in order risk assessment and interventions’ planning to be supported.

- Use of integrated simulation models (for hydraulics & water quality) of the water network should support water pollution impacts assessment (e.g., the number of people consuming contaminated water).
- Adoption of an organised sequence of standardized procedures for internal cooperation (work allocation and communication flow) among the different departments of a water utility. The latter is a necessity to improve organisational inefficiencies and gaps concerning internal cooperation demands stemming from WSP's development and constant implementation.
- Further improvement of the risk assessment tool (MUHA toolbox), based on DEYAL's experience in pilot activity, will contribute to the capacity of the utility to perform a comprehensive risk analysis. Given the complexity of drinking water chain, possible variation of the hazard risk among system components or subcomponents also constitutes an issue. Especially in cases of large water supply systems it is necessary for the MUHA toolbox to allow the user to add components and subcomponents (within the same components) of different probability of occurrence of hazardous events or different severity of consequences.
- External information provided by other institutions/authorities (if any) should be incorporated in the available data at water utilities to bridge information gaps and facilitate water management at operator's level.
- Exploring the possibilities and the way of high skilled staff recruitment to meet human resources' requirements and enhance the operational capacity of the utility.
- Improvement of inter –agency operation through participation of external members in the Water Safety Plan team taken into account the hazard addressed (establishment of enlarged WSP teams). Representatives of organizations and institutions such as the regional Environmental Hygiene & Sanitary Control Departments and the Ministry of Health could be involved dealing with water quality issues. In addition, since the definition/establishment and monitoring of the protection zones are of high importance for the water supply sources safety, authorities such as the Water Directorates of Decentralised Administrations could also be participate in WSP teams, as well as Environmental Inspectors of the Ministry of Environment & Energy (*see MUHA DT 1.1.4. "Report on Multi hazard analysis - Floods and drought and emergency pollution management status –"GREECE", Section 3.1.1. Catchment Protection*).

  The Water Safety Plan Team will function at two levels: internally in the water utility to cover operational requirements on a daily basis and externally involving the aforementioned agencies. The proposed enlarged WSP team may be convened at least annually prior to the review of the WSP by the municipal water utilities.

  Within the framework of the emergency operational plans dealing with floods at national, regional and municipality level ("DARDANOS"), the General Director of DEYAL participates in the Coordinating Body for Civil Protection of the municipality. Thus, the cooperation of civil protection organizations with the water utilities is important for the protection of public health in the case of a flood event. In particular, the WSPs teams should consist of external members including a representative of the civil protection services.

  The General Secretariat of Civil Protection has developed an emergency response and immediate / short-term management plan for earthquakes (EGKELADOS) (2020). The General Secretariat for Civil Protection set the guidelines for regional and local (at municipality level) emergency response and immediate / short-term management plan for earthquakes. Civil protection could play a significant role providing guidance on the activities for the protection of the infrastructure in case of an earthquake. Civil protection could also train the water operators for the emergency response actions after an earthquake event. Therefore, the involvement of civil protection representatives in the WSP team as external members is considered of high importance.

With regard to earthquake hazard scientific research groups and interdisciplinary networks consist of Research Institutes and Universities work in earthquake phenomena in combination with disaster/crisis management. Namely, the Institute of Geodynamics of the National Observatory of Athens; Geophysics Department of the Aristotle University of Thessaloniki; Geophysics-Geothermics Department of the National and Kapodistrian University of Athens; Geological Department of the University of Patras; Laboratory of Geophysics & Seismology of the Technological Educational Institute of Crete; Institute of Engineering Seismology and Earthquake Engineering; and Organization for Earthquake Planning and Protection (OASP)could participate in the development of WSPs as they could provide their expertise.

- Development of databases at regional level for recording of incidents (and relevant information), response/mitigation measures. Therefore, water operators within the same basins, supplied by the same water bodies/systems and serve areas of the wider administrative unit (regional unit) could substantially support Water Safety Planning.
- Towards the enhancement of operational capacity of utilities on multi hazard water management, the development of regional/ local cooperation networks with the participation of institutes and interdisciplinary groups of experts could also benefit water operators to cope with their inefficiencies.

In the above mentioned forms of inter-agency cooperation the Water Directorates of the Decentralized Administrations could also provide information and their expertise as they are the primarily competent authorities for water management planning at regional level.

D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply - "name the country"

Guidelines to overcome gaps and weaknesses identified with the improved water safety plans. The guidelines will be based upon the ICS (Incident Command System) theory. In addition, guidelines should be structured on the Inter-agency operation services that strongly affect the capacity of the key water services (water utilities, water authorities-local/regional level, institutions) to meet incident requirements (within the framework of the multi-hazard risk analysis and management). It is noted that coordination between the different Bodies in ordinary conditions should also be considered.

Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs)

With regard to the Implemented Improved Water Safety Plans (IWSPs) the key issues and outcomes will be drawn in due time and after the completion of the deliverable DT 2.3.1. At the current phase and due to the fact that works concerning the development and implementation of the Water Safety Plan under the pilot action of DEYAL are in progress (Section 2.2 of the present report) the requested information is limited to the stages that have been completed.

The development of the IWSP for the pilot case showed that cooperation among the various departments of the water utility is necessary to elaborate the WSP, namely the networks' management department, the environmental department, etc. It is apparent that a common registry to gather all the data for the water supply and distribution system is necessary and it has to be shared among all departments in the water utility. Continuous funding is necessary for the implementation of the proposed measures, and human resources are needed for the monitoring of the WSP. The dedication of the water utility managers and staff is a prerequisite for implementing the WSP continuously.

During the preparation of the WSP, many data is required concerning many sub-sectors of the utility. Depending on the size of the water utility, data availability is a major concern.

One common problem is the continuous implementation and monitoring of the WSP after the completion of the study. To achieve this, the WSP should be integrated into the daily operation of the utility and become an integral part of it. This presupposes the cooperation of all water managers from different sectors of the utility. Elaborating the WSP is a complex process, requiring many parameters. Thus, an extensive analysis is required, both for the status of the water supply zones but also for the practices applied at national level. This creates difficulties, requiring combined work and data from many sub-sectors of the utility.

In addition, as WSP is a dynamic system, it must always be fully relevant to the hazards threatening water, the technological developments related to the equipment, the current legislation, as well as potential hazards that may cause threat to public health.

Table Top Exercise Results to define and bridge inter –agency operation services

Table Top Exercise has been planned on the basis of the Emergency Response and Immediate/Short Management Plan for the Consequences of the Earthquake at Municipal level, according to which DEYAL controls the supply of drinking water (supply and distribution networks, etc.) and takes measures to ensure the quality of drinking water.

Water utilities intervene upon the Mayor' order (or the notification of the Municipality's Civil Protection Office for immediate restoration of the operation of infrastructures of their competence (e.g. water supply networks) the operation of which presents difficulties or was interrupted due to earthquakes.

DEYAL is included as an independent entity in the Emergency Response plan for civil protection of the Independent Division of Civil Protection and emergency planning policy of the Region of Thessaly. The latter is responsible for monitoring, participation, coordination, planning and activation of the civil protection at the area of responsibility of the Region. Specifically, the responsibilities of the department include:

- planning and programming for the organization, preparation and mobilization of the political forces, to survive the war or to deal with emergencies in peace and their contribution to the national defence, which is ensured through the mobilization policy and civil defence;
- the suggestion for the appropriate methods of handling issues and measures of the emergency planning policy;
- coordinating and directing the actions of all services of the Region in general to achieve the requirements of emergency planning;
- the establishment of joint committees and working groups with the participation of officers of the security forces for the study and planning of various issues

related to emergency political planning, in the event of a declaration of political mobilization.

Immediately after the occurrence of a natural disaster within the administrative boundaries of the Municipality and after the first briefing, the Mayor of Larissa, in the context of its institutional role in dealing with emergencies that may result from natural disasters, communicates with its local competent services:

The Hellenic Police and the Fire Corp, the Deputy Mayors, the Presidents of the Local Communities and the president of the representative of the Water Supply Utility (DEYAL), in order to assess the effects of the natural disaster.

The Mayor of Larissa, assessing the consequences of the occurrence of the disaster, as they are shaped by the information he has collected or by more recent information following the evolution of the catastrophic phenomenon, mobilizes through the Independent Department of Civil Protection of the Municipality of Larissa, the operationally involved staff and the means of civil protection of the Municipality.

The Municipal Water Supply and Sewerage Company (DEYAL) is responsible for the control of the drinking water supply network (water source, distribution network, etc.) and for taking measures for ensuring the quality of drinking water, in accordance with the provisions *of Δ1δ/ΓΠ οικ.8565/16-11-2017 and Δ1/ΓΠοικ.53542/17-07-2019.*(Circulars - "Taking measures to ensure Public Health after severe weather and floods phenomena " of the Ministry of Health).

DEYAL has to appoint a chief and a deputy chief for civil protection. DEYAL has also formed several teams for civil protection, such as the safety team, the fire safety team, the first aid team, the disinfection team, the damages' restoration team, the detection team and the team for logistics. DEYAL has to develop and adopt a regulation of internal operation and take part in exercises for civil protection organized by the competent authorities.

The Water Supply and Sewerage Company of the Municipality of Larissa:

• Immediately disposes its human resources, equipment and means to deal with the emergency and organizes the immediate/ short-term management of the consequences of the disaster event

• Controls the supply of drinking water (water source, distribution network, etc.) and takes measures to ensure the quality of drinking water.

• Repairs problems in the water supply infrastructure and its competence networks, whichwere damaged

• Organizes crews of its employees, in order to go directly to the affected area and clean the water collection wells.

Information Flows

1.Initial alert for effects of the emergency situation

Greek police
President of Local Community
Municipal services
National EmergencyCenter

} Mayor → Civil Protection Department

Civil Protection Department Mayor

→ Deputy Mayor for Civil Protection
→ Head of Cleaning & Recycling Department
→ Head of the Green Department
→ Head of Technical Services Department
→ Head of Depot Management
→ Head of Urban Planning Department
→ Social Policy& Welfare Division
→ Municipal Police
→ **President of DEYA Larissa**
→ **Director of DEYA Larissa**
→ Presidents of Local Communities
→ Dpt of CP of the Region of Thessaly
→ GSCP
→ Volunteer Organizations

2.Mobilization of stakeholders' management of the consequences and immediate/short recovery

Mayor Deputy Mayor for Civil Protection Civil Protection Department

→ Head of Cleaning & Recycling Department
→ Head of Technical Services Department
→ **President of DEYA Larissa**
→ **Director of DEYA Larissa**
→ Director of Social Policy& Welfare
→ President of Local Community
→ Volunteer Organizations

Tabletop exercises are an effective means to practise and test response procedures, while they provide a better understanding of both internal and external environment of the water utility reflecting the status of inter agency cooperation effectiveness under the conditions of the emergency incident (scenario) simulated.

On behalf of Greek project partners a table top exercise is scheduled in May 2022, under the responsibility of DEYAL, according to the Guidelines provided under Work Package 2 (DT 2.3.3 and 2.3.4).

In this context the TTX is based on the emergency response and immediate / short-term management plan for earthquakes (EGKELADOS) following the above described scheme of emergency mechanism. Simulation scale will be local and localities involved except for DEYAL are the Region of Thessaly, Municipality of Larissa, Police, Fire Corp, Electricity Distribution Network Operator S.A., National Emergency Centre, etc. The organization responsible for planning and managing the TTX is DEYAL in cooperation with the Region of Thessaly and the Municipality of Larissa.

The objectives of the TTX include

- Testing and checking the completeness of the Emergency & Crisis Management plans as well as effectiveness of cooperation between the involved organizations.
- Testing the initial assessment phase of the disaster and the immediate response - mobilization of the involved bodies.

- Implementation of the procedures with regard to convening and operation of the Coordinating Bodies for civil protection for earthquake.
- The identification of gaps or overlaps in the roles and responsibilities of involved entities.
- The improvement of the coordination, the communication, and the management of the information between the involved departments of DEYAL (internal communication), but also of the Authorities and other entities (external communication), such as Fire Corp, Police, Civil Protection, Regional Authorities, Municipalities.
- The response of the Immediate Intervention mechanism (Call Center, Technicians, Contractor etc.).
- The identification and assessment of the required resources.
- The assessment of the overall reaction of DEYAL and the coordination of the actions of all departments.

Concerning the involved entities, at DEYAL's level the TTX Planning Group consists of the General Director of DEYAL, the Director of the Technical Services and the Director of the Environmental Services. The team leaders and the roles and responsibilities will be assigned in due time.

Focusing on inter operation services, according to the provisions of the emergency response and immediate / short-term management plan for earthquakes, "EGELADOS", Civil Protection Coordinating Bodies' composition at Regional and Municipal level are presented as follows

Municipal level: Coordinating Body for Civil Protection

- The **Mayor of Larissa** city: President
- The **Deputy Mayor of Civil Protection**, or the Mandated Civil Protection Advisor, (in case of absence, or legal impediment of the President, he replaces him)
- The **Deputy Mayor of Technical Works** of the city of Larissa
- The **Deputy Mayor of Sustainable Mobility and Smart City** of the city of Larissa
- The **Deputy Mayor of Urban Planning** of the city of Larissa
- The **Deputy Mayor of Environment** of the city of Larissa
- The **Deputy Mayor of Agricultural Development** of the city of Larissa
- **Members of the Municipal Council** designated in the coordinating body for civil protection
- The **Deputy Governor for the Regional unit** of Larissa
- The **Head of the Independent Directorate of Civil Protection of the Region** of Thessaly
- The **Head of the Independent Directorate of Civil Protection of the Decentralized Administration**
- The **Head of the Independent Department of Civil Protection of the Municipality**
- The **Commander of the Fire Services Administration of the Prefecture.**
- The **Commander of the local Fire Corp, or Fire Station.**
- The **Commander of the local Police Department.**
- The **Commanders of the Health units of the Municipality.**
- The **Commander of the local military formation, or group, or unit.**
- The **Head of the Department of Technical Services of the Municipality.**
- The **Head of the Department of Cleaning and Recycling of the Municipality.**
- The **Head of the Department of Green spaces of the Municipality.**
- The **Head of the Department of Urban Planning of the Municipality.**
- The **Head of the Department of Operational Planning of the Municipality.**
- The **Head of the Department of Social Policy of the Municipality.**
- The **General Director of DEYAL.**
- A representative of **the municipal police.**
- A representative of **Hellenic Electricity Distribution Network Operator S.A.**
- A representative of **EDAThess (natural gas)**
- A representative **of Hellenic Telecomunications Organization.**
- A representative **of the Railway organization.**
- A representative **of the hospitals.**
- A representative **of the National Emergency Center.**
- **Volunteering organizations**

Regional level: Coordinating Body for Civil Protection

- The **Regional Governor**: President
- **Regional Deputy Governor for the regional unit of Larissa**: Regional Coordinator of Civil Protection. He is the Head of the Independent Directorate of Civil Protection of the Region of Thessaly and he replaces the President in case of absence or legal impediment
- The **Mayor of Larissa** city (and other neighboring cities)
- The **Deputy Mayor of Larissa** city (and mayors of other neighboring cities)
- The **Commander of the Regional Fire Corp**
- The **General Regional Police Director**
- The **Governor of the relevant Health District**
- The **Commander of the Regional Fire Corp**
- A representative of the **National Emergency Center**
- A representative of the **Electricity Distribution Network Operator S.A.**
- The thematic **Deputy Regional Head of Civil Protection** or the Mandated Civil Protection Advisor
- The spatial **Deputy Regional Head of the Regional Unit**
- The **Commander of the local military formation or group**
- The **Heads of Divisions or Departments of Units of the relevant Region**, per case of involvement and risk category
- **Volunteering organizations**

The TTX was carried out on May 3, 2022 under the initiative and organizational responsibility of the Municipal Water & Sewerage Company of Larissa following the Guidelines issued by the General Secretariat for Civil Protection of the Hellenic Ministry for Climate Crisis & Civil Protection, Ref. No 532/23.1.2020 updated Document, (*DT 2.3.4 "Report on the performed TTX – GREECE"*).

On the basis of local implementation level, DEYAL involved representatives from Municipality of Larissa, Region of Thessaly, Civil Protection Directorate of the Decentralized Administration of Thessaly – Sterea Ellada, Independent Directorate for Civil Protection of the Region of Thessaly, Independent Department for Civil Protection of the Municipality of Larissa, Hellenic Police, Fire Department of the Regional Unit of Larissa, Municipality Police, Hellenic Electricity Distribution Network Operator S.A. and Association of the Radio Amateurs of Thessaly (volunteering organization).

For the purpose of the present report, the key aspects that have been emerged from the TTX conduction, in correlation with both the Exercise's initial objectives and the Incident Command System concept (*see Section 3.3. Key Guidelines of the present report*), could be structured on the following axes

Management (function): establishment of a command chain that it will depict clear roles and responsibilities' allocation at water utility's level. The exercise revealed that even though the high level of DEYAL's executives are fully aware of emergency response issues, there is a gap of information and activation/mobilization bottlenecks at staff members' level. This is strongly related to the lack of a contingency plan communicated to the staff members, including regularly update of the command chain, identification of primary and alternate staff for each key position and those responsible for responding to incidents. In this context, the need for the establishment of a core group for emergencies that will be on alert and they will be activated by physical presence without previous notice (on call) is stressed.

The aforementioned management aspects proposed to be addressed through the adoption of a Memorandum of Actions at the internal organizational level of DEYAL.

As far as internal organizational issues are concerned information and training of the staff members involved in emergency situations are considered substantial for the improvement of operational capacity of the utility. Generally, implementation and support of a regular cycle of information/training, exercising, equipping, evaluating of priorities and actions to respond in emergencies is needed.

Building relationships and constant communication with the involved agencies in the area of utility's responsibility included in the key issues stemmed from the TTX performed. Exchange of experience from past events among the responders concluded to the necessity of strengthening inter agency cooperation that could be established through Memoranda of Cooperation.

In the aforementioned framework, conduction of exercises (extended to full scale implementation) is pointed out as of high importance enabling the agencies involved (responders) to assess the way and the time of response during an incident simulation and supporting the effective resource management in the field.

The necessity of ensuring that all stakeholders and services will get the fullest possible information on existing best practices concerning emergency response is also listed among the key issues drawn during TTX.

Within the management function, technologies and procedures for public information are highly prioritized by the Water Utility. Namely, cooperation with the Civil Protection of the Region of Thessaly, in order the call center of the General Secretariat for Civil Protection to be used by the water utility (phone number 112 for emergencies) constitutes the solution to overcome DEYAL's call center overload under an incident situation.

Operations (function): Initial assessment of the emergency situation (during the first 24 hours after the incident when information flow is limited) was one of the key points highlighted within the TTX. The weakness of the initial conditions assessment, due to the lack of experienced personnel at critical points within the area of utility's responsibility hampers the decision making at operational level (in the field). The proper allocation of human resources (in the field), in order the real picture of the emergency situation to be communicated to the operational center of the water utility, through the implementation of assignments to local supervisors, was proposed to be addressed through a comprehensive Memorandum of Actions at internal level, as well as Memoranda of Cooperation at inter agency level (embedded in the Management function axis).

Furthermore, operation of active teams (shifts) of the services/agencies involved in the area of interest on a daily basis is proposed to support the improvement of the response time in case of an incident in the interagency coordination context.

Logistics (function): Given the significance of communication/information flow during mobile or landline networks interruptions, maintenance of the necessary equipment to deal with emergency conditions, communication equipment condition (radios), was included in the key issues during the TTX. In addition, development of alternative communication networks for use when technology-based systems have failed (even potential "face to face" communication) is proposed as an effective way of ensuring communication flow.

Planning (function): Improvement of coordination at both internal and external level (with the agencies/entities involved) is at the core of planning function. Recording the contact details of the key response partners as well as the regular update of the related information included in the list of the key aspects concerning immediate response planning under the TTX performed. Gaps in external communication with the key respondents in case of emergency incidents were recognized as one of the constraints towards coordination and resource management in the field.

Planning gaps/inefficiencies and necessity for: planning the steps in an emergency situation, development of contingency plans, identification of resources on hand and assessment additional resources needed (at both internal and external level), adoption of written procedures and instructions based on the experience and lessons learnt from past incidents were recognized through the implementation of the TTX.

Key guidelines

The **scope** of this deliverable is to address the essential aspects of the emergency response mechanism in water utilities, focusing on the improvement of inter agency operation in order the purpose of the enhancement of water systems resilience to be served. Key elements concerning preparedness, response and recovery phase are drawn in the form of guidelines for improving resilience, oriented to cooperation among the basic actors (agencies) involved in the water safety mechanism in water utilities area (local level). In this context and according to international practices, the structure indicated by the Incident Command System concerns the coupling of involved agencies actions with water utility's level.

Prior to further analysis, a brief reference to the definitions of resilience as well as the basic principles of a water utility according to the Incident Command System is considered appropriate. In this context, resiliency is generally defined as the ability of a utility's business operations to rapidly adapt and respond to internal or external changes (such as emergencies) and continue operations with limited impacts to the community and customers (Critical Infrastructure Partnership Advisory Council, 2009). Resilience is the capacity of any entity—an individual, a community, an organization, or a natural system—to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience (Rodin 2014, 3). Resilience helps integrate consideration of disasters and shocks into a broader theory of system function and change. This connection matters because extreme events will be one of the primary ways in which the effects of climate change are felt. In addition, such extreme events may help catalyze desired changes in an urban system of system function and change (World Bank, 2018).

As regards the Incident Command System organization, it provides for the key-principle functions concerning water utility's organizational structure and namely management, operations, planning, logistics and finance. **Management** refers to the command chain and is the term used to identify the regulatory or delegated authority in the field during response, while during preparedness management refers to the leadership tasks concerning implementation. **Operations** concept concerns development and implementation of strategies to carry out incident objectives, coordination of field resources, and identification of personnel or resources requirements. In the **planning** functions collection, analyzing, dissemination of information and intelligence, management of the planning process, compilation of incident Action Plans and management of technical specialists are included. **Logistics** deal with all incident resources such as transportation, communications, supplies, equipment maintenance and fueling, food, and medical services for incident personnel etc. The **Finance/Administration** function covers all financial, administrative and cost analysis aspects of the incident, including vendor contracts, recording of expenditures for personnel and equipment, keeping records of claims and providing preliminary estimates of damage costs and losses.

Within the emergency response mechanism the ICS organization is implemented at the field in order to manage field response sources under incident circumstances. The establishment of the command chain and flow constitute the basis for the system's structure. Command flow exceeds the internal organization of the water entity and it is extended to all response agencies fitting to the respective system structure of services outside the water utility and/or at higher level or responsibility (integration/inter agency operation) in accordance with the existing (legislative) framework.

The cooperation structure for risk and crisis management in drinking water supply, depicting water suppliers and competent authorities according to the European Standards (EN 15975 – part 1) is presented in Figure 3.

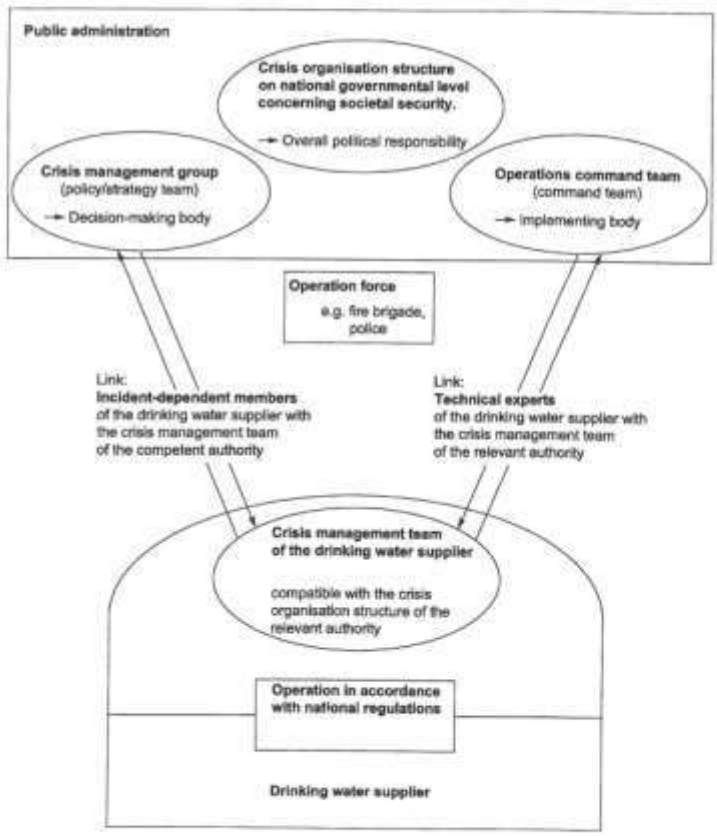

Figure 3 - Figure from the EN 15 975 -1- A cooperation structure of the crisis organizations of a drinking water supplier and the competent authorities.

The capacity of the water utility to cooperate and carry out coordinated action under an incident circumstances prerequisites a **clear mapping of the key agencies** involved in combination with the **understanding and recognition of procedures in place** (who does what and how). Therefore, the early integration of crisis management team of the water utility into the relevant authorities' crisis management system facilitates the exchange necessary information (at an early stage) and expertise contribution to both planning and response phase. Thus, decisions and measures to mitigate incident consequences enhancing the resilience of the water systems are supported.

In the framework of the **emergency planning process** and in terms of effectiveness of a plan it should be stressed the importance of the establishment of the **planning team**. Definition of roles, allocation and assignment of responsibilities, based on clarity and consistency in team's engagement, prior to an emergency incident occurs is at the core of the planning process. Emergency response roles at water utility's level should cover all the emergency actions including engineering and operations, water quality, emergency preparedness, security, safety, planning, consumer's service, administration, finance, training, and management.

Involvement of **response agencies** in the planning process is also important for water utilities as at the emergency response phase they will be activated in the field or collaborated with the utility providing assistance. Public response agencies should be considered local police, fire corp, health and environmental departments, local civil protection departments, water quality control agency and any other organizations located in the water utility's service area involved in emergencies and disasters depending on the incident. In this context, cooperation with response agencies should address key issues of the ICS (**inter agency operation**) regarding the role of water utility staff in the field (development of field management structure for both the utility's and the agencies' staff), the relationship and communication methods between field activities and any activations or preventive measures taken by the water utility's Emergency Operations Centre (EOC) or Water Utility Emergency Response.

To achieve the improvement of inter agency coordination; joint exercises by the agencies involved at the area of water of utility (local level) should be performed in a regular base (adoption of an exercise schedule). This will contribute not only to the improvement of staff skills but also to the release of useful information concerning bottlenecks and review/update needs towards the improvement of the inter agency operation. Inter agency exercises should be incorporated in the staff training policy of the water utility (as it is described below).

Except for field resources and their coordination, inter – agency cooperation that should be adopted in the emergency planning process of water utilities (preparedness phase) concern the involvement of **interdisciplinary groups of experts** as external members in the utilities' WSP teams. Scientific research groups and interdisciplinary networks consist of Research Institutes and Universities, work in certain hazardous incidents in combination with disaster/crisis management, will provide their expertise to water operators towards the improvement of resilience of water services. In this context, **water management authorities in the service area of water utilities'** should also be involved covering planning aspects related to water resources.

Vulnerability of water systems is another crucial aspect that should be addressed at the emergency planning process of water utilities. Knowledge of the utility's hazards and their consequences goes through the determination of hazards (type of incidents), probability of occurrence and their severity, allowing risk assessment, vulnerability evaluation and analysis of recommendations for improvements (identification of mitigation measures). Options that reduce vulnerability and improve the performance of both the system as a whole and of critical elements over the same range of futures should be included in the vulnerability analysis. The needs of the incident should drive the level of response required to mitigate the problem. The latter should be incorporated in a recovery plan in order system resilience to be enhanced.

Standardization of collection and management of incident Information should be adopted by the water utility to facilitate both operations and planning functions. Indicatively, incident status reports sampling and analysis results contribute to a robust risk assessment as well as to the availability of information not only internally (following ICS information flow) but also to the agencies involved (improvement of inter agency operation).

Identification of water utility's internal resources and capabilities should also be included in the planning process. What resources are on hand, what the additional resources it needs in order to meet the needs of the incident, as well as to maintain minimum operations and essential services, at this point the interdependencies with other entities (from other sectors e.g. power suppliers, chemical suppliers etc) in relation to the emergency incident consequences should be considered. In addition, alternate water resources or contingencies for temporary solutions concerning drinking water supply (e.g. bottled water, water trucks, potential agreements with other utilities etc) should be identified. A prerequisite for incident needs' fulfilment is the linkage between the above mentioned issues with a comprehensive mapping of service area and consumers (focus on critical structures such as hospitals/social care facilities) and capabilities of the utility under emergency conditions.

Water system information is the basis for the principle functions of ICS organization of the water utility, mainly planning, as well as management & operations. Identification of the key utility information concerning description of the system and system's capabilities (evaluation of emergency sources' supply included), maps of the service area, detailed drawings of the sources, water treatment plants, booster stations and distribution system, system valves and sources should be provided in the emergency plan. In the event of a disaster, it may be necessary for the water system to use an emergency source of supply. Different emergency sources of supply that could be used in a contamination or disruption of service event (backup power supplies in case of power outage and redundant facilities included).

In addition the basic system information should be standardized and available to the utility's staff in case of an emergency situation. Indicatively, the basic information could include system's ID number, system name, system address and location, population served, number of service connections, source type, treatment provided, available storage and emergency contact numbers.

ICS structure is implemented in the field targeting to the effective management at the site resources, actually to the **management of multiagency response** to an incident (**ICS Integration & organization**). Prior to an incident, roles should be established, through the planning process, with response agencies. It is advantageous for utility's personnel to understand the incident command system and learn the emergency operations protocols and procedures that will be enacted by local emergency responders (such as Fire, Police, Health Services), so they can work within the system to provide the most efficient response. In this context, local response agencies in the area of utility's jurisdiction should be indentified and the utility should build relationships with the key response managers. This ensures that in the event of a crisis all concerned already know each other and are mutually informed about each other's structures and processes as well as about the means and channels of communication (EN 15975-1:2011+A1:2015).

The level of response/intervention that is related to the command chain/inter agency operation, should be clearly defined (e.g. local level, regional level or water districts level) under emergency circumstances. Thus, the understanding of how the ICS is applied through the different levels (e.g. from local to regional level in the area of utility) facilitates coordination purposes. This is strongly related to the **communication flow** inside and outside of the water utility under emergency conditions response, while a prevention aspect should be addressed via substantial cooperation, such as establishment of inter sectoral cooperation networks (for exchange of information, tools and resources among the key stakeholders) oriented to the enhancement of preparedness status of the water utility.

Inter agency cooperation could be shaped through mutual agreements between water service providers in the wider area of a utility's jurisdiction (e.g. at regional level, or at water district level) on the basis of emergency planning and response support/assistance. That kind of networks might be encouraged through an incentive mechanism for entities to provide their contribution within the network partnership (e.g. privileges regarding access to funding instruments).

In this context, the linkage/coupling between the emergency response plans of response agencies is a crucial point for the improvement of inter agency cooperation under emergency conditions. This should be based on synergies and complementary responsibilities in the utility's area as well as the grade of intervention assigned to higher levels (local, regional etc). To this end, the participation of a representative of utility in planning teams of response agencies (and via versa) as well as in the Emergency Operational Centers of agencies at the response phase is recommended.

As it has already mentioned, identification of response roles and responsibilities at the **utility's level (organization**) should be clear. The establishment of the **command chain** and line of succession plan in order responsibilities to carried out confidently is a prerequisite for the effective implementation of Incident Command System. An incident notification flow chart clearly indentifying key staff and response partners to contact, primary and alternate staff for each key position and those responsible for responding to incidents including assignments for the key functions (management, planning, operations, logistics and finance) should be adopted.

Development of a Water Utility Emergency Operations Centre (EOC) management structure may also be included in the planning process items (depending on the magnitude of the incident) in order operations function to be supported (incident resources management, coordination with agencies/entities outside the utility). An EOC is a physical location from which support centralized emergency management is performed. An EOC Director should be established in order to manage the Operations, Planning, Logistics, Finance/Administration Sections, and related sub-functions. Furthermore, essential function carried out in EOC are setting priorities and developing Action Plans, coordination and support of all field level incident activities within the utility service area, information gathering, processing, and reporting within the utility service area and to other levels of involvement, coordination with local government and regional EOCs, as appropriate.

According to EPA Instructions for Community Water Systems (EPA Office of Water, 2019), **Internal communications** should address what, when, and how a message will be provided to utility personnel who are directly and indirectly involved in an incident. Internal communications and notification lists should outline the personnel responsible for activating communications, the order in which notification occurs, and the members of the emergency response team (as defined in the ICS structure).

Regarding **external communications**, external response partner notification list should ensure that all appropriate partners are notified. Some agencies will need to be notified immediately while others may be needed later in the incident, depending on the event. Procedures should also be established as to who should be notified, when they should be notified, and who is responsible to make the notifications from the utility. Local response partners should be engaged first. Water utility should develop a communication strategy with agencies involved in the area of its jurisdiction (depending on the event) in order inter –agency coordination to be facilitated. Moreover, communication with **critical customers** should be maintained as a part of the emergency response plan of the utility. Some of these customers may be given priority notification due to their reliance on the water supply (such as hospitals, fire department, industry etc).Generally, development of a standardized communication with the public, protocols for public notification should be incorporated in the incident management of water utilities.

Restoration and recovery activities should be considered at the planning process. **Development of utility's procedures to identify the damages** and their causes, the impacts on the provided water services, necessary restoration ensuring the minimal level of services and transition to full service recovery.

In this framework a **restoration and recovery plan** will need to be developed in preparing for any emergency addressing aspects such as return to service, level of quality of return, treatment options (including onsite treatment) and their requirements, technologies applicable, change in existing treatment, discharge/disposal options, power requirements, monitoring and analysis, human and environmental impacts, equipment and supplies, rehabilitation options and permitting requirements (permits for constructions, discharges or any other regulatory assignments might be needed). Furthermore, personnel requirements should be addressed. Determination of skill sets that are needed to start and run critical equipment, management of the ongoing day to day operations, longer –term recovery and mitigation actions should be included in a **staffing plan for the transition up to full recovery**.

The aforementioned aspects could be categorised on the basis of initial recovery and long term activities. Actually recovery activities begin during the response phase. Damage inspections, reporting, and recordkeeping is important to be carried out as soon as the plan is activated. Initial recovery activities may include notification of the competent regulatory agencies, detailed evaluations of the affected water utility facilities and prioritization of repairing, reconstruction, or replacements, restoration of telecommunications, data processing, and similar services to full operation. Assessment of losses and costs for repair and replacement, determination of any kind of financial assistance, the financial capabilities of the water utility itself, execution of agreements with vendors to meet service and supply needs, re evaluation of requirements for maintaining the emergency management organization (considering return to the normal organizational structure), including cost at the emergency and preparation phases, should also be dealt with.

Furthermore, **post event reporting** is of significant importance for the emergency planning phase including, inter alia, lessons learnt during the response phase, restoration and recovery activities. Post event reports should be accessible and available to any other agency involved under inter agency operation services.

Along with the aforementioned issues regarding recovery of the water utility's operations, public information should be carried out including information on progress status after incident conditions (to reduce anxiety and panic expressions).

In the long term recovery activities, permanent reconstructions of damaged facilities and systems and restoration of water utility's operation and services to full (pre – event) levels are subjected.

The aforementioned in combination with the vulnerability and resilience factors, point out the need of incorporation both the preparedness and rehabilitation interventions in water systems in the investment activity and in the master plan of the utility, including the aspects of alternative options for water supply. To extend narrow approaches of water safety planning to a multi hazard approach towards systems and services resilience, water safety planning mechanism should not be isolated from the long term planning of the utility.

Finally, another crucial issue concerns **staff training activities**. Development of a training plan for the staff is of the core elements of the water utility safety planning policy. Water Utility management should target to adopt a training policy that emphasizes plan implementation, emergency management, and employee health and safety. The training policy should be subjected to the overall emergency preparedness policy. In this framework, the type and the level of training activities should be indentified in correspondence to individual roles outlined in the emergency response plan.

D.T3.2.3. Local application: recommendations for optimal governance structures for resilient water supply - "name the country"

According to the OECD, water governance is defined as the "range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision makers are held accountable for water management" (OECD, 2015). Policy responses to water challenges will only be viable if they are coherent and integrated; if stakeholders are properly engaged; if well-designed regulatory frameworks are in place; if there is adequate and accessible information; and if there is sufficient capacity, integrity and transparency (OECD, 2018).

Governance reforms are required to establish adaptive and resilient urban water resource management that takes into account complexity, uncertainty and immediate and long term change. Despite the availability of technologies and knowledge required to develop resilient water resource management systems, practical implementation remains slow. Developing resilient water resource management systems is more a governance issue than a technological issue as adaptation to climate change is limited by the values, perceptions, processes and power structures within society (J. Rijke et al, 2020).

Within the activity 3.2 of the MUHA project, the present report intends to provide a brief and comprehensive analysis on the improvement of the local governance structures in the external environment of water utilities, for the strengthening the water supply system resilience from a multi hazard perspective. For this purpose information derived from the previous phases of the project implementation, such as DT 1.1.3 REPORT ON STATUS OF CIVIL PROTECTION RESPONSE MECHANISMS – EATER RELATED PLANS AND PROCEDURES, 1.2.4 DT REPORT ON THE CROSS-INSTITUTIONAL PROCEDURES- GREECE, DT 3.2.1. D.T3.2.1.Report on key bottlenecks for the implementation of services and their requirements- "GREECE" and D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply- "GREECE", is used to facilitate the contingency of the present analysis.

Water governance in Greece follows the pattern adopted by the EU legislation, the multilevel governance in the water sector. In this framework, at the central administration level, the Hellenic Ministry of Environment & Energy, the General Secretariat for Environment & Water, is entrusted with the development of water resources protection and management policy that is approved by the National Water Commission. The latter is an Inter – Ministerial Commission, established according to the provision of the Water Frame Directive and apart from the Minister of Environment & Energy, it comprises of the co-competent Ministers, such as the Minister of Infrastructure and Transportation, Development & Public Investments, Agricultural Development, Health, Interior and Economics etc. In line with the Water Framework Directive, the General Secretariat for Environment & Water (GSEW) proposes the national programs for the protection and management of water resources, including the general framework for costing & pricing of water services. The GSEW is supported by an Advisory Committee for Water which comprises of representatives by co- competent Ministries, such as the Ministry of Agriculture, the Ministry of Development& Public Investments, Economics, Infrastructure, Interior etc.

At the decentralized level, the Water Directorates of the Decentralized Administrations support the GSEW with decisive competences within their jurisdiction and in accordance with the aforementioned water policy (such as drafting and implementing the River Basin Management Plans, Flood Risk Management Plans, licensing procedures for water abstractions, definition of drinking water protection zones, monitoring of quantity and quality of water resources etc). At the decentralized level, the participation of the stakeholders in decision making process is institutionally guaranteed through the Water Council of the Decentralized Administration. The latter consists of representatives by the local authorities, such as the water divisions, municipalities and municipal water and sewerage companies, as well as representatives of non-governmental organizations and the bodies competent for the protected areas management.

Regarding drinking water quality, the Ministry of Health is the competent central level authority for the implementation of the Drinking Water Directive and its requirements related to the ensurance of public health. In this framework, water utilities are monitored in terms of their alignment with legislative requirements on drinking water quality. Water Supply & Sewerage service providers are also under the monitoring of their performance by the GSEW of the Hellenic Ministry of Environment & Energy, providing operational, quantitative and qualitative data, as well as pricing information to the respective information systems managed by the Ministry.

As regards the National Crisis and Hazard Management Mechanism (Nat-CHAMM), it also goes through all governmental levels and it ends up at the water utility level covering the entire disaster management cycle. In the framework of the national policy for Civil Protection – National Civil Protection Planning- the General Secretariat for Civil Protection, subjected to the Ministry for Climate Crisis & Civil Protection, is at the core of the Nat-CHAMM playing a crucial role in both planning and operational arm. Furthermore, the Nat-CHAMM provides for the substantial contribution of regional coordinating bodies, central and regional operations centres, as well as independent bodies within Municipalities.

At national level, the General Plan for Civil Protection "Xenokrates" (adopted by the Ministerial Decision 1299/2003) constitutes the basic planning framework according to which the Ministries proceed to the development of the Special Plans for individual risks of their competence. In the light of the Special Plans, decentralized, regional and local structures/entities develop their own plans in order them to cope with hazardous events and their impacts.

At local level, Municipalities are obliged to draft the emergency response and immediate / short-term management plans in line with the planning requirements, instructions/guidelines released by the upper administrative level (decentralized, regional level).

The aforementioned structure could be considered as the external environment of a Municipal Water Utility that is responsible for the development of an internal regulation for civil protection in terms of water crisis management.

Focusing on the municipal water utilities' level (local level) the Civil Protection Service of the Decentralized Administration is obligated to proceed to the issuance of a Memorandum of Actions for emergency response and immediate / short-term management for earthquakes and floods, in order to facilitate the implementation of the Special Plans "Egelados" and "Dardanos", adopted by the General Secretariat for Civil Protection in order to address crisis management related to earthquakes and flood events, respectively. The Memorandum of Actions specifies the human and material resources and services that will be used for the implementation of civil protection actions in the framework of the implementation of the Special Plans. To this end, communication flow, forecasts related to the imminent hazardous event, contact details of the involved authorities/services, scientific and operational terminology, self protection measures for citizens, mechanical equipment, maps of the areas under emergency are included.

In that context, Municipalities have to develop the emergency response and immediate / short-term management plans for earthquakes ("Egkelados") and floods ("Dardanos").

Municipal water utilities are also responsible to develop an internal regulation for civil protection, in terms of the water supply service provision within the area of its responsibility in case of a disaster. In this framework, utilities have to designate a Head and his Deputy, as well as the teams charged with civil protection tasks. Utilities cooperate with the Municipalities and the regional divisions for civil protection and emergency planning policy in case of disaster phenomena.

Following the four – level (mitigation, preparedness, response and recovery) approach of the Disaster Management Cycle, water utility's contribution to the Emergency Response and Immediate / Short-Term Consequence Management Plan of the Municipality could be briefly described as follows.

At the Preparedness stage, municipal water utility takes care for the availability of the necessary human resources, equipment and means dealing with emergencies and the immediate / short-term management of the effects of disasters. Maintenance of equipment and means to be used to address emergencies and the immediate / short-term management of the consequences of the occurrence of disasters is also included in water provider's responsibilities. It also cooperates with the Independent Department of Civil Protection of the Municipality in order the operationally available means to be consolidated with municipality's ones. Water utility takes care for maintenance and cleaning works of the water collection wells, as well as for the rehabilitation of damaged water supply infrastructure and networks under its jurisdiction. Municipal water utility's delegation participates in the coordinating body meeting in order to inform about the protection measures for the water supply infrastructure in case of earthquakes.

At the Response stage and immediately after the occurrence of a natural disaster (earthquake or flood), the Mayor, in the framework of his institutional role in dealing with emergencies that may arise from the natural disaster, communicates with local services of the Hellenic Police and the Fire Corp, the competent Deputy Mayors, the Presidents of the Local Communities and the president of the competent water utility, in order to assess the effects of the event.

The Mayor, assessing the consequences of the natural disaster, mobilizes through the Independent Department of Civil Protection of the Municipality, the operational staff and the means of civil protection of the Municipality, in order to launch actions related to the control of the drinking water supply network (water source, distribution network, etc.) by the competent water utility of the Municipality and taking measures to ensure the quality of drinking water, according to the relevant circular of the Ministry of Health(Δ1δ / ΓΠοικ.20275 / 23-03-2020). The competent services of the Municipality in cooperation with the Division of the Public Health of the Region carry out a sanitary inspection of water supply systems in the affected areas to ensure the quality of drinking water in case of damages in the water supply network of their responsibility.

At the stage of Response water utility immediately disposes the human resources, equipment and means to deal with emergencies and immediate / short-term management of the consequences of floods / earthquakes. It controls the supply of drinking water (water source, distribution network, etc.) and it takes measures to ensure the quality of drinking water. Utility is responsible to repair the water infrastructure and water supply networks that have been damaged by floods / earthquakes events. Cleaning of water abstraction points in the affected area is also listed in utility's response stage tasks.

Finally, at the Recovery stage after the response in case of water supply crisis utility provides qualified personnel for immediate inspection and restoration of the operation of any damages in water supply and sewerage network.

All the aforementioned reflects the governance structure, the inter agency relationships among the key actors (agencies) in the water sector, in the emergency response and management cycle, at local level where the water utility interacts with Municipality and Regional authorities. It is actually the entire scheme of institutional relations at the levels of governance reaching the water utility.

Furthermore, under a combining analysis of the information released in the previous sections of the present report, the existing governance structures encounters gaps and weaknesses that result in operational capacity and coordination deficits undermining systems resilience. These could be outlined as follows

Planning inefficiencies: As it is derived from the consultation procedures conducted under the MUHA project, the progress in the adoption of Water Safety Plans, as well as Master Plans, by water utilities could be considered insufficient with significant delays even in their development. Response measures in case of hazards are not addressed within an organized management plan, while risk assessment tools are not in place -ad hoc decisions on measures taken on the basis of operator's experience/implementation of empirical practices (*see DT 1.1.1 Report on the National Consultation – Greece and Section 2 of the present report*).

Planning inefficiencies entails gaps in vulnerability evaluation of water systems (or of their critical components). In this context, vulnerability estimations are based on expert's judgment' leading to limited capabilities for identification of mitigation options and consequently of a robust long term planning for the resilience improvement.

Monitoring weaknesses: Monitoring gaps are usually observed due to the lack of innovative monitoring technologies (automated sensing technologies) for real time water quality monitoring inside water systems. Especially in case of small water utilities, service providers face difficulties in the adoption of available technologies dealing with deficiencies in their infrastructure (age and condition of the networks, inefficiencies of monitoring tools etc.)

Information gaps: Utilities usually maintain records for failures in the water supply systems however they do not apply a standardised registry for failures related to disaster events. In addition, post events reporting procedures have not been endorsed. Thus, the capabilities of internal information flow concerning water safety mechanism are limited. Furthermore, external information flow to the agencies outside the utility is obstructed.

At state level, a registry for drought events is not in place stressing the need for the improvement of the external information. With regard to earthquakes, there is no external information related to failures to the water supply system. The earthquake's consequences related to water contamination/ water interruption are not regularly recorded. The only available sources related to earthquakes are scientific publications from institutes and research teams.

Generally, inefficiencies in the collection and management of incident Information (in a standardised way) entails signification difficulties in planning, management and operational functions affecting the interagency operation (governance structure).

Staffing requirements: understaffing in municipal water utilities is crucial. Usually human resources, high skilled personnel to confront with challenges/requirements of integrated safety planning approach, is limited. Innovative tools for collection, management and analysis of information, data bases, simulation models as well as management and planning functions demand expertise, communication skills as well as conduction of regular training activities. Thus, limited water utilities staff strives to perform "day to day business" and it is not able to be engaged in the pre mentioned services indicated by complexity, uncertainty and near and long term change conditions.

Limited human resources is related, inter alia, to the delays and inefficiencies in the adoption of internal rules for emergency response, standardization practices regarding collection of information, communication and reporting and generally to the deficiencies in the implementation of strategic plans endorsed by higher levels of governance. It is noted that such constraints are also observed in the public services involved in the water sector affecting the governance efficiency in reverse.

Considering the above mentioned key aspects, it could be highlighted the risk of potential cases that development of planning documents (strategies, action plans etc) would be completed for regulatory compliance purposes with significant implementation deficits.

Strengthening the weaknesses of the governance structure that reaches the water utility's area towards the improvement of water system resilience, a set of recommendations could be drawn as follows.

The establishment of regional cooperation networks with the participation of institutes and interdisciplinary groups of experts could benefit water operators to cope with their inefficiencies, enhancing the operational capacity on multi hazard water management. Informal networks maintain connections and distribute knowledge across different institutions and disciplines. Coordinated capacity building is recommended to create synergies and avoid inefficient use of limited resources. In addition, ddecentralized and informal structures enables new relationships and test innovations.

The aforementioned networks and synergies could be also benefit by the contribution of the Water Directorates of the Decentralized Administrations, as they are the primarily competent authorities for water management planning at regional level (providing expertise and useful information).

On the same concept, development of databases at regional level for recording of incidents (and relevant information), response/mitigation measures is recommended.

Therefore, water operators within the same basins, supplied by the same water bodies/systems and serve areas of the wider administrative unit (regional unit) could substantially support Water Safety Planning.

Improvement of governance structure could also include the adoption of mutual agreements between water service providers in the wider area of a utility's jurisdiction (e.g. at regional level, or at water district level) on the basis of emergency planning and response support/assistance. This kind of networks might be encouraged through an incentive mechanism for entities to provide their contribution within the network partnership (e.g. privileges regarding access to funding instruments).

Towards governance improvement, adoption of the involvement of interdisciplinary groups of experts as external members in the utilities' WSP teams is recommended. Scientific research groups and interdisciplinary networks consist of Research Institutes and Universities, work in certain hazardous incidents in combination with disaster/crisis management, and will provide their expertise to water operators towards the improvement of resilience of water services. In this context, water management authorities in the service area of water utilities' should also be involved covering planning aspects related to water resources in the emergency planning process of water utilities (preparedness phase) concern.

Joint exercises are recommended to be performed by the agencies involved at the area of water of utility in a regular base (adoption of an exercise schedule). This will contribute not only to the improvement of staff skills inside the utility but also to the release of useful information concerning bottlenecks and review/update needs towards the improvement of the inter agency operation. Inter agency exercises should be incorporated in the staff training policy of the water utility. In addition, exploring the possibilities and the way of high skilled staff recruitment to meet human resources' requirements and enhance the operational capacity of the utilities is also proposed.

Water utilities and agencies involved in water management should highly prioritize the standardization of collection and management of incident Information facilitating both operations and planning functions. Indicatively, incident status reports sampling and analysis results contribute to a robust risk assessment.

Furthermore, development of applicable and practical communication patterns should be adopted in order to improve internal and external information flow bridging information gaps.

Conclusions

Nowadays challenges stress the necessity of strengthening water systems resilience by the adoption of more proactive approaches, than reactive ones in the past, oriented to preparedness, emergency responses and efficient operations. In this framework, water safety planning mechanism goes through modifications to infrastructure design, investment analysis processes as well as policy decisions on financing and disaster risk management that should undoubtedly be assisted by a well structured organizational system for limited resources management, not only at internal level but also in integration with external environment.

In this context, a combining analysis targeting to water services' requirements mapping with regard to water safety planning mechanism towards the improvement of water systems is performed. In the light of information derived from consultation procedures, S.W.O.T. analysis and Table Top Exercise's conduction at utility's level, the main aspects related to water safety mechanism are set under consideration leading to a set of key guidelines and recommendations for the improvement of systems incorporating the interdependencies with the agencies involved in the water sector.

The key elements arisen by the aforementioned analysis lie on internal management inefficiencies that are strongly related to the constraints in the availability of human and financial resources, planning shortcomings and information flow gaps inside the utilities. These elements affect the interagency cooperation effectiveness against the improvement of operational capacity of the entities in emergency conditions. In this framework, the guidelines and recommendations towards the mitigation of deterrents to operational capacity improvements are focused on the adoption of organizational patterns, available innovative technologies as well as interdisciplinary safety planning groups participating in the decision making schemes at the water utilities' jurisdiction area (local level).

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e. Serbia & Montenegro

Introduction

General statement regarding the specific deliverables.

This report presents the outputs created from the testing phase of the MUHA toolbox WASSP-DSS for the PA Nikšić focused on the four project hazards (drought, flooding, accidental pollution). Parts of this report related to PA (2.1 and 2.2) have been prepared by both project partners, PP8 and PP3, while the part 2.3 related to country level have been prepared separately (PP3 for Serbia, and PP8 for Montenegro).

In order to link the WPT2 to the WPT3 activities, feedback is structured according to the guidelines provided by UTH (WPT3 leader).

D.T3.2.1. Report on key bottlenecks for the implementation of services and their requirements - Montenegro and Serbia

Identification of gaps and weaknesses identified in WPs T1 and T2 and implemented specific tools developed in T3.1 with recommendations drafting the necessary solutions.

Based on the results from the national consultations carried out under DT1.1.1. describe Water Safety Plans development & implementation status (providing feedback for the progress – if applicable).

Point out the issues of your concern stem from the consultation main outputs that will be under consideration within the activity 3.2.

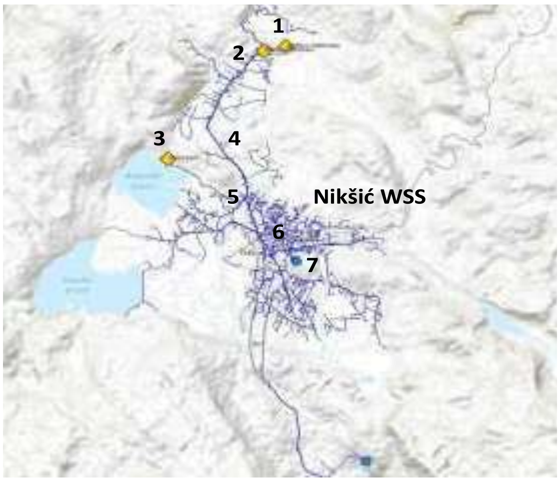
NOTE: WSPs' implementation status is the basis for the PPs experience and their ability to identify key bottlenecks in terms of water services requirements under the MUHA project perspective.

Based on the information reported in D.T2.2.4.- Evaluation reports for each pilot action - MUHA Toolbox- identify the capabilities provided by the toolbox in your case (advantages and disadvantages with respect to water service requirements, identified gaps), focus on the aspects in the following paragraphs 2.1 & 2.2

Description of the pilot area and planned actions

Today, WSS Nikšić supplies about 65,000 consumers, and has about 24,000 connections (water meters). The main elements of the system are the springs "G. Vidrovan" and "D. Vidrovan", the source "Poklonci", the gravity pipeline ϕ 1000, booster pump station (BPS) "Duklo", and the tank "Trebjesa" (R Trebjesa). Annual average produced water (Entry in the system) varies between 340 and 380 L/s, while NRW vary between 62% and 70%. Disposition of the main elements of the system and their characteristics, are shown in Figure 1.

Vidrovan springs (joint «G. Vidrovan» and «D. Vidrovan») capacities meets the needs of the system for 9-10 months a year. Wells at Poklonci are included only in the dry summer - autumn period. Water from Vidrovan arrives by gravity through pipeline θ1000, and from Poklonci by pumping through pipeline θ500 to the central BPS Duklo. There is no tank at both springs. The two pipelines are connected at 200m in front of BPS Duklo, from where the water is further distributed to the city and the counter tank Trebjesa (while it was working) through pipeline θ700. Produced pressure in the network was up to 9 bars, at the time of tank Trebjesa operation.



1. Karst spring «G. Vidrovan», elevation 664 m.a.s.l., together with karst spring «D. Vidrovan», deliver to WSS Nikšić 250-450 L/s, depending on the time of year; maximum capacity is over 1 m^3/s
2. Karst spring «D. Vidrovan»
3. Water source «Poklonci», 5 wells, total capacity 200 L/s, in work mode when karst springs are low.
4. Gravitational steel pipeline ϕ1000, L = 15 km
5. BPS "Duklo" (Q = (1 + 1) x 400 L/s, H = 55m)
6. City center with 70% of consumers (80% of them between 600-630 m.a.s.l., and 15% of them between 630-650 m.a.s.l.)
7. Tank «Trebjesa» (BA/OA = 691/697 m.a.s.l.; V = 7.500 m^3)

Figure 1. Disposition of the WSS Nikšić main elements

This concept has could work in the first few decades of the system's existence, while the pipes were new. With the increase in losses and consumer complaints, it was decided to change the concept of the system. To reduce the pressure, some 10-15years ago R Trebjesa was excluded from the system work and pump units at BPS Duklo were replaced with new ones, with a smaller value of outlet pressure. The system started to operate with a pressure up to 6 bars, downstream of BPS Duklo (Figure 2).

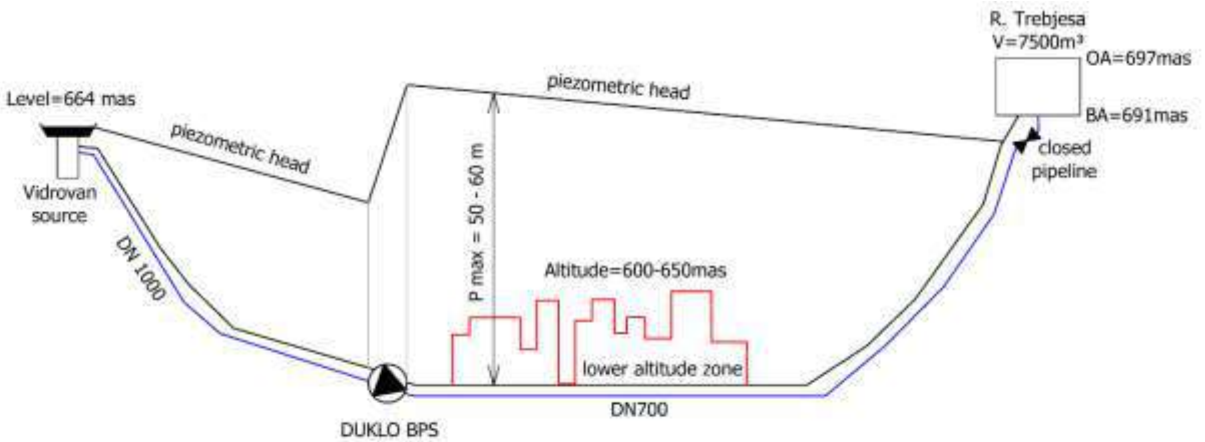


Figure 2. Longitudinal profile from Vidrovan source to tank Trebjesa (R Trebjesa out of order)

Since then, all the uneven consumption is regulated by BPS Duklo, so the pressure regime has become extremely variable, which has intensified the occurrence of losses in the system. This problem will likely be started to be solved in the next few years.

Main Pilot action in MUHA project is related to investigate possibilities for increasing capacity at Vidrovan source.

Main goals are split in two directions.

First direction is related to strictly Pilot action: Research at Vidrovan source, in the aim of considering possibilities to increase capacity of this source.

Second direction is related to preparation of Water safety plans for analyzed hazards.

2.1 Evaluation of the toolbox in making of PA Water Utility WSP

Evaluation of the toolbox in making of PA Water Utility WSP (missing parts/additional information, reporting requirements, difficulties in the use of the tool-implementation bottlenecks and reliability issues. Consider difficulties in the use of the tool-implementation, bottlenecks and reliability issues, reevaluation requirements will also be assessed and included.

In this context, structure your analysis on the following:

General comments (link to WPT2 reports)

Based on the testing done on Toolbox, our opinion is that in general the toolbox can be used as a useful tool in generating of the WSP, particularly in defining the module 3 of the WSP where Key actions include identifying the hazards and hazardous events and assessment of risk with when no control is in place.

We believe that the toolbox is an excellent help to water companies, especially in defining potential hazardous events that may negatively affect water supply systems. It is useful for clearly assessing and ranking different risks

The most useful thing in our opinion is the database of various hazardous events. We didn’t start collecting any additional data after the toolbox use.

The data that we already had were enough in the process of Toolbox usage.

Our proposal for re-evaluation of MUHA Toolbox is after 1 year.

Our opinion the appropriate timeframe for the revision or update of the WSP is one year.

There are no "components" of our water supply system that the MUHA tool does not consider.

“Earthquake” hazard

Possible risks can be estimated using the MUHA tool, but the exact defined value should be tested over a period of time.

There are no drought, accidental pollutions, floods and earthquakes hazard events nor are they considered within the tool, but they are not met due to lack of internal (WU level) or external information.

Some data were entered based on experience, for example for data related to the probability of hazardous events or based on monitoring water quality, ie measuring flow and pressure. Our estimation is that the reliability of these data are limited inside an error of ± 15%.

Civil protection or in Montenegro Protection and rescue in the future should play a significant role in the development of the WSP.

The Institute of Public Health of Montenegro is an institution that could play a significant role in the development of a water safety plan related to all 4 hazards. Also in Montenegro, an important institution that can play a significant role in the development of WSP is the Department of Hydrometeorology and Seismology.

2.2 Evaluation of PA goals fulfillment

Considering the information reported in paragraph 2.1, point out the contribution of the MUHA toolbox to the fulfillment of your goals. Except for the usefulness of the toolbox provide information on the other parties/actors (at the external environment of the Water Utility-) that are directly involved in the Water Safety Plan development and implementation (e.g. Institutions/organizations, regulatory or civil protection authorities).

NOTE: Based on the information reported in WP1 to focus on the stakeholders that directly related to the water services management (Water Utility level) under multi hazard risk analysis and management.

MUHA toolbox has confirmed WU company Nikšić commitment related to directions of solving the problems and goals how to decrease possible hazards.

As noted, main goals are split in two directions - First related to investigate possibility to increase capacity of Vidrovan source, and second related to preparation of Water safety plans for analyzed hazards.

First direction: After the tender procedure, a contract was signed with the Public Institution " Zavod za geološka istraživanja " for the implementation of exploration works and preparation of final studies on the tests performed at the sources of Gornji and Donji Vidrovan. In October 2021, investigative works were performed, after which individual hydrogeological and engineering geological studies, a report on the condition of buildings and a geophysical report were made. A joint final study on all research in the pilot area is underway.

In addition to the above activities at the springs, the yield and quantity of water abstracted are regularly monitored. Drinking water quality surveys are also regularly conducted and all irregularities in the operation of the Water Supply System are registered.

After the hydrogeological research was conducted, it was concluded that additional quantities of water can be provided at the Donji Vidrovan spring up to Q = 10 l / s. The report on the condition of the construction facilities showed that it is necessary to perform additional construction works on the existing catchment at the source Donji Vidrovan. in order to prevent leakage and enable the capture of a larger amount of water. It is estimated that an additional Q = 30 l / s would be obtained in this way.

Second direction: Model simulations indicate a relatively good adaptability of WSS Nikšić to drought conditions, while the situation is less favourable when it comes to accidental pollution of two sources. The model analyses of the conditions in WSS when floods or earthquake occur has not been performed due to unpredictability of these hazards.

Depending on the degree of drought, the pressure in the central zone would be reduced if nothing was done. Several hydrophore stations for peripheral DMA zones would also be difficult to operate. They would be under lower pressure, and with a prolonged drought they would be left without supplies. Then the measure of adaptation would be the exclusion of certain DMA zones, and their supply with cisterns. That has not happened so far, the worst thing that has happened is the reduction of network pressure. It is also unlikely that such a scenario will occur to a significant extent, primarily due to the constant activities of PUC Nikšić in increasing its source capacity.

The accident at the Poklonci spring can vary from negligible to moderate, depending on the time of year when it would occur. If it happens at the time of year when there is enough water on Vidrovan for the whole system, it would not be felt (approximately 9 months during the year). If it happened in a transitional mode when the system consumes a little more water than the capacity of Vidrovan source, simple adaptation measures would solve the problem, while pollution at the peak of annual consumption, which coincides with the minimum yield of Vidrovan would result in the exclusion of almost all peripheral settlements. and downturn in downtown.

Pollution of the Vidrovan spring, with the current capacities of other springs, would lead to interruptions in the supply of all, except for priority consumers in the city center, which would be isolated from the rest of the network by the existing shutter (valve) system.

2.3 Addressing weaknesses/bottlenecks in the implementation of the multihazard management – Water Utility Level

After identified bottlenecks in the pilots (WP T2) and in general (WP T1) the main key services that are still missing will be identified and descripted (planning, logistics, public communication, interagency cooperation service, communication/messaging section, situation service) and their linkage.

Based on DT3.1.1, DT3.1.2, DT3.1.3, DT3.1.4, from SWOT analysis at Water Utility Level, determine the weaknesses and gaps in terms of services requirements. The outcomes of the SWOT analysis will be the baseline to extend your analysis in order to include possible inter-services and interdependencies (if applicable) in overcoming the weaknesses of Water Utilities. Use the results of consultations with stakeholders (water operators, agencies etc.) on the deliverables of Activity 3.1. and provide recommendations to address the issues of your high concern (identify good practices – if applicable).

NOTE: Please mind that the above requested information should go a step further from basic reports of previous deliverables, facilitating the scope of action planning and strategy development. In this context try to stay in line with the simplicity, clearness and applicability of the guidelines will be produced within WP3.

Montenegro

Droughts

- Significant level of water losses in water supply systems. Limited storage capacity in some WUs

Accidental pollutions

- Insufficient number of qualified and experienced staff.
- nadequate technical capacities in small WUs.
- Significant level of water loss in individual WUs.

Floods

- Some municipalities do not have adopted plans for protection from floods
- Lack of plans for protection from floods for WU
- Aged i infrastructure
- Lack of qualified staff

Accidental pollutions

- Aged infrastructure.
- Limitedness of resources especially in smaller water supply companies.
- Insufficient number of qualified and professional staff.

Serbia

General

Different problems occur in different WSS in Serbia. If we would explain it in general through the parts of the country (regions), it could be said:

- On the north of the country (Vojvodina region) the most significant problems are related to the quality of water: organic matters, colour, ammonium ion, iron, arsenic are some of the quite often present substances above the rulebook limits in this region. The treatment processes of these waters are often difficult.
- WSS of the capital city Belgrade, the biggest in the country, has occasionally all type of problems, and related to hazards, WSPs most consider accidental pollution.
- The central part of central Serbia (Šumadija region) has very limited groundwater resources. Similar situation is on the south of the country, which lead to more frequent drought occurrence in hydrologically unfavorable years. Such conditions have clearly increased last 20 years.
- Problem of nitrogen in raw water (NO_3 and NO_2) are often present in the municipalities, which are in the valley of rivers Great Morava and South Morava.
- Significant level of NRW (water losses) exist in some number of WSS, all over the country, and especially in Eastern part of central Serbia.
- About 20 reservoirs in central Serbia intended for water supply systems of about 30 municipalities, are faced with possibility of algae blooming problems, and other hazards related to possible AP of lake water.
- Aged and somewhere not best applied infrastructure material (particularly pipelines) are often present.

Some of the main weaknesses related to four hazards are follow listed:

Droughts

- On many sources water availability has a decreasing trend due to several reasons.
- Limitedness of resources (technical, financial) particularly in small WUs.
- Not always qualifying stuffs capable to do the best when Drought situation occurs, particularly in small WUs.
- Global warming increase water demand and decrease water resources availability.
- Likely worse precipitation pattern occurs related to extreme events.

Accidental pollution

- Accidental pollution with smaller impact (like turbidity) are often neglected, especially in smaller community.

- Not always qualifying stuffs capable to do the best when AP situation occurs, particularly in smaller WUs.
- Limitedness of financial resources.

Floods

- Lack of funds in WUs.
- Flood risks zones are not properly addressed in the RB and spatial plans at the local level.
- Floodplains uncontrolled urbanization.

Earthquakes

- Limitedness of resources (technical, financial) make repairs difficult when earthquakes happen.

The most vulnerable are cities and regions with a lot of old infrastructure, more present on the south than in the other regions.

D.T3.2.2. Key guidelines for improved inter-agency operation services in the field of resilient water supply - "name the country"

Guidelines to overcome gaps and weaknesses identified with the improved water safety plans. The guidelines will be based upon the ICS (Incident Command System) theory. In addition, guidelines should be structured on the Inter-agency operation services that strongly affect the capacity of the key water services (water utilities, water authorities-local/regional level, institutions) to meet incident requirements (within the framework of the mutlihazard risk analysis and management). It is noted that coordination between the different Bodies in ordinary conditions should also be considered.

Based on current legislation, all water companies in Montenegro are required to implement the HACCP quality system (Food Safety Law, Law on Providing Safe Water for Human Consumption) which provides an acceptable level of safety that is monitored at critical points characteristic of the water supply of the population (sources, distribution system, etc. Article 17 of Law on Providing Safe Water for Human Consumption prescribes that the legal entity is obliged to establish a system of self-control, based on the analysis of pollution risk; the system of self-control enables the identification of control points and critical control points in the entire system of water capture, additional treatment and distribution. According to HACCP, it is necessary to identify what dangers ("hazards") might threaten the safety of water supply. So, critical points are defined, after which preventive measures and measures for their control are determined. That is the way to reduce the risk of hazards causing harm to water supply system.

So far, WSP has not been implemented in Montenegro, but we hope that in the coming period, every water company will implement the WSP.

The Republic of Serbia Drinking water safety Act is updated, its adaptation is pending, and it includes recommendation for DWSs to develop Water Safety Plans. Although the discrepancy between WSP and HACCAP exist, significant number of DWSs has developed HACCAP since it is mandatory (Food for human consumption safety). Majority of DWSs are trying to follow the standard EN 15975-1with respect to protocols and documentation framework for the crisis management.

1.1 Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs)

To this end, input from DT 2.3.1 Validation of implemented Improved Water Safety Plans (IWSPs) and implemented measures in PAs will be used. Information regarding the overall evaluation on the efficiency and effectiveness of implemented IWSPs and measures performed in PAs within the MUHA project will be the basis for drafting the guidelines, while some hints could be found also in DT 1.2.4 “Report on cross-institutional procedures”

Key issues-outcomes from the Implemented Improved Water Safety Plans (IWSPs) could be:

Development of the Water supply information system (Scada),

Continuously WUC’s staff education,

Continuously improvement of WSPs in WSS,

Using defined Toolbox in MUHA project, and it further development,

Development of Cooperation between relevant actors (WUC, National and Local Civil Protection agency, and other relevant Institutions),

Development of the Water source availability, including treatment and distribution network,

Development of the procedures for all type of hazards,

1.2 Table Top Exercise Results to define and bridge inter –agency operation services

Given that Table Top Exercises support bridging the gap between Civil Protection Authorities and other water cycle managers (Water Authorities) and service providers (Water Utilities), information reported in DT2.3.4 Reports on the performed table-top exercises can also be used by the 5 PPs of Pilot Actions that will perform TTEs.

The TTX in the Nikšić PA was successfully organized on May, the 10th 2022, and practically all the main and specific goals of the exercise were achieved. All participants in the exercise, especially employees of WUC Nikšić were introduced to the functioning of the Civil Protection and Rescue System in Montenegro, current national legislation and the applicable emergency response procedures. Certain shortcomings in the functioning of the System and the need to improve legislation in this area have been identified. It was concluded that special emphasis should be placed on improving communication between all levels of the Civil Protection and Rescue System (especially between staffs of WUC Nikšić and staffs of the Civil Protection and Rescue Service). At the local level, it was concluded that it is necessary to improve cooperation between TTX actors. Having this in mind, future cooperation has been agreed and the implementation of a couple of joint projects is planned. Particular emphasis was placed on vaguely defined competencies and poor communication between various actors at the state and local level.

1.3 Key guidelines

Based on the paragraphs 1.1 and 1.2 proceed to the guidelines for the improvement of inter-agency operation services toward the resilient of water supply.

Guidelines should be structured (at least) on the following points:

Clear definition of the scope of the provided guidelines/requirements, Identification of institutional actors and stakeholders

Recognition of existent procedures

Emergency Planning Process,

Water System Information,

ICS Integration and Organization, Operations,

Communication Procedures (Command Chain),

Restoration and Recovery Activities.

Guidelines should be focused on ICS Integration and organization, where inter agency services plays a crucial role.

NOTE: Internal consultations/structured personal interviews within water services of PPs are proposed in order to identify substantial dimensions 0like goals and sub goals of the entities oriented to the enhancement of water supply resilience (planning and finance are among the most fundamental factors that should be included). Consultation/interviews procedures could be implemented for drafting recommendations regarding the core elements of the ICS: management ("Command" at the Field Level), Operations, Planning/Intelligence, Logistics and Finance/Administration.

Based on the paragraphs 1.1 and 1.2, and other written in previous deliverables, main guidelines toward the improvement water supply security, including WSPs, could be:

A. General (related to all type of hazards)

Improvement availability of information about the Water supply system,

Improvement of WUC staff’s knowledge regarding the national legislation, and existent procedures,

In addition to Civil protection Agency, and relevant Ministry, identification of other institutional actors and stakeholders (like Universities, Institutes, private companies),

Improvement of WUC staff’s knowledge regarding the functioning of National or/and Local Civil Protection and Rescue Service,

Cooperation WUC and Local Civil Protection and Rescue Service, including implementing TTX occasionally,

Improvement of WUC staff’s knowledge related to possible hazard events, relevant for their WSS,

Defining of Emergency Planning Process, including Communication Procedures (Command Chain),

Defining of funds and the way of Restoration and Recovery Activities,

In addition to general guidelines, certain specific guidelines for each of the hazards could be pointed out.

B. Related to Drought hazard

- Doing continuously analysis of all relevant patterns related to drought occurrence possibilities,
- Plans preparation and construction of alternative water sources, with adequate treatment and distribution to the relevant point of existing WSS,

C. Related to Accidental pollution hazard

- Improvement of knowledge related to predictive (and possible) different Accidental pollution situation,
- Improvement of cooperation with the relevant Institutes and Universities,

D. Related to Flood hazard

- Upgrading and maintenance of monitoring system for flood prevention,

E. Related to Earthquake hazard

- Building Facilities in accordance with the seismic requirements for that region,

D.T3.2.3. Local application: recommendations for optimal governance structures for resilient water supply - “name the country”

This deliverable will analyse status of the governance structures necessary for resilient water supply and suggest feasible implementation options.

- **Input from DT1.1.1 Report on National consultations on water supply safety mechanisms, DT1.2.4 - Report on the cross-institutional procedure & D.T1.1.3 - Report on status of Civil Protection Response Mechanisms – water related plans and procedures**

  - Provide the entire scheme (STRUCTURE/FLOW CHART) of institutional relations at these levels of governance that directly reach the water utility level, interactions and relations between the parties involved necessary to build the resilient of water supply.

Montenegro

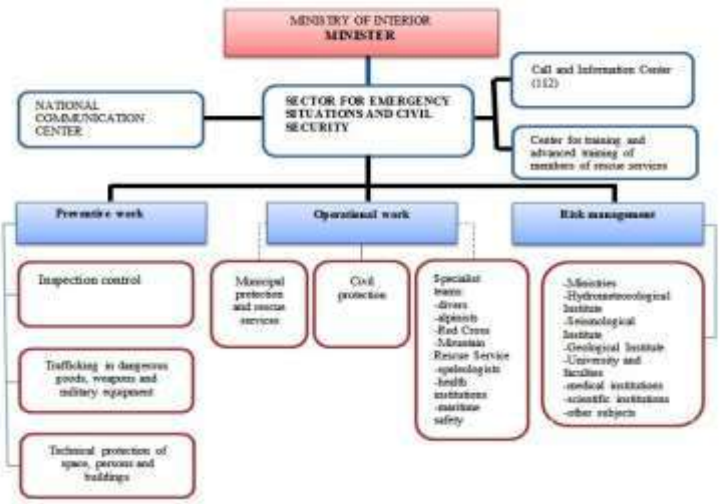


Figure M1: The structure of the national civil protection system of Montenegro

Serbia

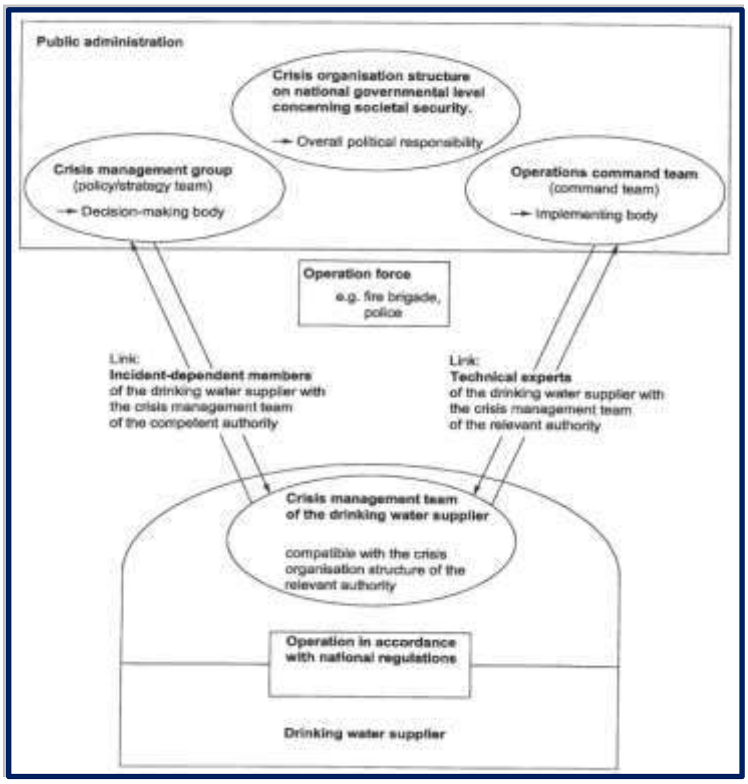


Figure S1: (Figure from the EN 15 975): Example of a cooperation structure of the crisis organizations of a drinking water supplier and the competent authorities in Serbia

- Have all institutions involved developed and issued management plans (addressing measures for accidental pollution, flooding, drought and failure of critical infrastructure due to earthquakes). Do they include in their plans measures for resilient water supply.

Legislation framework about civil protection in Montenegro:

- Protection and Rescue Law (No. 13/07, 5/2008, 86/2009, 32/11, 54/16);
- National Strategy for Emergency Situations (main strategic document for emergancy management adopted by the Government on the proposal of the Ministry of Interior);
- Law on local self-government (No. 2/2018, 34/2019 and 38/2020);
- Law on Protection of Persons and Property (43/18);
- National and municipal plans for protection and rescue (from fires, floods, earthquake…) all aproved by Minister of the Interior;
- The Strategy for Disaster Risk Reduction with Dynamic Plan of Activities for implementation of the Strategy for the period 2018-2023 (Ministry of the Interior, 21 December 2017).

Protection and rescue in Montenegro is carried out on the basis of protection and rescue plans. Protection and rescue plans are: national protection and rescue plans, municipal protection and rescue plans and protection and rescue plans of companies, other legal entities and entrepreneurs. National plans are prepared by the Ministry of the Interior, ie the Directorate for Emergency Situations, in cooperation with other state administration bodies, scientific and professional institutions and experts for certain types of risks, and are adopted by the Government of Montenegro. In order to ensure mutual harmonization, municipal plans are adopted by municipal assemblies, and prepared in accordance with the national planning documentation, with the consent of the Ministry of Interior. Entrepreneurial plans are adopted by companies (Water supply company too), other legal entities and entrepreneurs, in accordance with national and municipal protection and rescue plans with the obligatory consent of the Ministry.

Water companies are obliged to, in the event of a threat of a certain hazard (eg floods) to:

- inform the Municipal Team and the Operational Headquarters on the safety of the key infrastructure, in order to help prepare the activities for response;
- maintain or improve the safety of key infrastructure;
- check and repair, where possible, the functioning of key infrastructure during floods;
- informs the authorities in case of flooding of the key infrastructure.

It is the obligation of the municipality to solve water quality problems (if it is a case) together with the Institute for Public Health and other services.

Legislation framework about civil protection in Serbia:

The Republic of Serbia has been a Participating State of the Union Civil Protection Mechanism (UCPM) since 2015.

The leading national authority of the Republic of Serbia in charge of civil protection and emergency management in the event of natural or man-made disasters is the Sector for Emergency Management (SEM), a successor to the Sector for Protection and Rescue, which was created within the Republic of Serbia Ministry of Interior in 2007. They cooperate with other Ministries, Hydrometeorological service and Seismological survey of Serbia, Water Utility Companies, and other relevant institutions.

In case of large-scale disasters, however, when the emergency response capacities of the SEM cannot cope adequately, other resources of the national protection and rescue system should be activated, including personnel, vehicles, construction machinery and specialised police equipment, specialised companies or armed forces, and NGOs (Red Cross, Alpinists, Divers, Mountain Rescue Association, voluntary firefighting associations, etc.)

The legislative framework is comprehensive and clearly allocates responsibilities throughout the DRM process. The accompanying national programme for disaster risk management (DRM) is fully aligned with the Sendai Framework for Disaster Risk Reduction (Sendai Framework). The Disaster Risk Reduction and Emergency Management Act was adopted in November 2018 and is pivotal for the system. The Act is supported by 43 bylaws, and some of them are still in development. Additional laws relevant for DRM and Civil Protection in Republic of Serbia, are:

- Act on Critical Infrastructure
- Act on Voluntary Fire-Fighting Service
- Act on Amendments to the Law on Fire Protection
- Act on Reconstruction following Natural and Other Disasters
- Act on National Spatial Data Infrastructure
- Act on Meteorological and Hydrological Activities;
- Other sectors (water management, forestry, environmental protection, infrastructure, health, education, etc) legal framework and strategies.

The national programme is implemented via a DRM action plan. In recent years, Serbia's government has also increased funding for DRR, albeit starting from a low base. Local governments, based on the Law on disaster risk reduction and emergency management, must draw up their own plans for DRM. Initiatives contained in these local plans can be financed from the national budget through specific projects (allocated by the Public Investment Management Office) or through their own, sometimes limited resources.

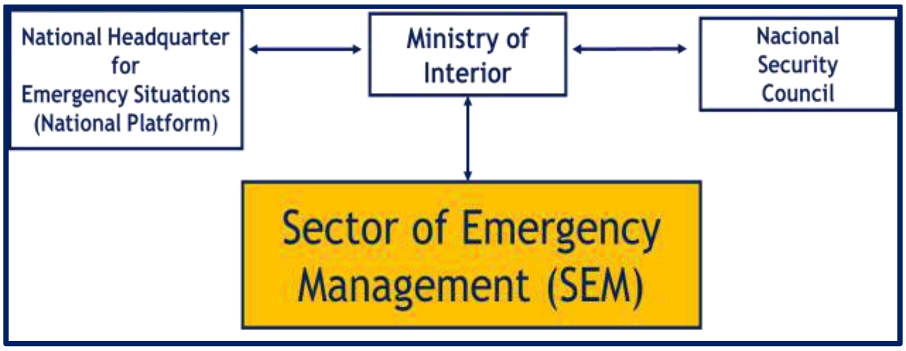


Figure S7: General structure of the national emergency management is Serbia

In its administrative seat and 27 county departments throughout Serbia, the SEM comprises the Department for Preventive Protection, the Department for Risk Management, the Department for Fire and Rescue Units and Civil Protection, the Division for Legal Affairs and International Cooperation and the Division for Economic, Material and Technical Support. The SEM's operational capacities comprise approximately 4000 professionals, of which 3300 are specialised fire and rescue units and emergency first responders. In addition to professional firefighters, there are also many volunteer fire-fighting units throughout the Republic of Serbia.

- Define the gaps (in terms of structure, communication, collection of data, reporting, post event analysis, and consensus on important decisions).

In Montenegro, water companies are part of the protection and rescue system and are obliged to respond to the call. The entire civil protection system in Montenegro is still not developed as it should be. Communication with various instances of the system is almost non-existent, and data collection, post-event reporting are not defined in the best possible way.

In Serbia, with some exceptions related to Belgrade and few other larger WUCs, WSP do not exist, or are not enough developed. Therefore, it is difficult to talk about the gaps. In majority of WUCs, many current issues must be first solved (water quality issue, water quantity issue, distribution problems, NRW), and then attention will be focused on WSP. It can be said that all numerated type of gaps exists, but also that not so rare WSS is functioning very well in emergency conditions. In general, WUCs usually do the best when some emergency situations occur, often/usually in cooperation with civil protection agency or relevant Institution or/and State help, as well.

Propose corrective and preventive actions:

NOTE: To deal with the aforementioned aspects, paragraph 3.2 and 3.3 should also be the basis for drafting of recommendations. Special focus on mapping of the key players, inter agency services and operational capabilities/gaps is proposed in order recommendations to be structured on a practical/feasible basis.

PPs could define the "local scale" according to their case. Thus the final action plan at local level could cover all PPs cases (e.g. municipal, regional structures that interact with the water utilities or even a national authority). Local scale could be referred to the area of utility and involved services' jurisdiction.

To increase the robustness of the DT3.2.3, information stemming from focus group discussions/personal (structured) interviews related to governance structures could be used.

Corrective and preventive actions for Montenegro:

- Improving legislation in the field of civil protection and further improving the procedure of the protection and rescue system in Montenegro;
- Improving the communication between the government and local levels in the protection and rescue system;
- Improving the communication between the municipal structures of the system of protection and rescue and water supply companies;
- Government investments in the field, especially in strengthening technical and human capacities

Corrective and preventive actions for Serbia:

- Further developing communication and coordination between WUCs and CPA,
- Providing significant funds at the municipal and national level for emergency situations, and their rapid activation when needed,
- Continuously WUCs staffs education (especially high qualified youngers),
- Upgrading monitoring system wherever is possible.

Conclusions

Please provide conclusions incorporating key messages for the country (priorities). Focus on guidelines and recommendations on a water utility level.

In Montenegro, water companies are part of the protection and rescue system as an operational force. They have the task to put all their available funds for the use of the protection and rescue system on the orders of the headquarters. Companies implement preventive measures related to their activities and are not competent or required to perform or organize civil protection exercises. The civil protection system in Montenegro is not at a satisfactory level and needs to be improved. Communication between civil protection and water companies is at an unsatisfactory level, especially the collection and exchange of information.

In Serbia, Water Utility companies are involved in solving of all type of problems (regular and incidental) which could occur in their Water supply system. Regular (common) issues they generally solve alone, or with a help of certain specialized Institutions (Institute, University, or private company). In general, scheme (approach) of solving incidental (hazard) situations is presented in part 2 of this deliverable (DT 3.2.3). But some differences regarding the approach depend on the type of hazard. As known, MUHA project consider 4 types of hazards which could disrupt certain WSS:

- Floods (F)
- Accidental pollution (AP)
- Drought (D)
- Earthquake (E)

Ways of reacting to each of these dangers are different, some require a quick response (F, E), some know how to solve a problem (AP), and some need to have well-prepared and implemented plans (D). Labels in parentheses are not exclusive. For some extreme situations, it is not possible to predict (all) the circumstances that may occur, as well as the best possible reactions / adaptations.

For most water supply systems and potential hazardous situations, the knowledge how to solve a problem is almost always required. Also, the existence of monitoring is of great importance in order to prevent or better adapt to critical situations. In addition to develop coordination between WUCs and Civil Protection agency, these to aspects (knowledge and monitoring), and their further upgrading, seem to be the most important WSP development factor for the most WSS.