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Towards the harmonization of water-related policies for managing drought risks across the EU

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ABSTRACT

Drought is recognized as a major issue in the EU, particularly in the Mediterranean region, posing risks to the environment as well as to local and regional economies. The EU policy on water management is continuously evolving, particularly in relation to water scarcity and drought. Starting with the Water Framework Directive (2000/60/EC), which sets the general policy framework for water management across the EU, the EC Communication on Water Scarcity and Drought COM(2007) 414 final set the priorities for managing water scarcity and drought risks. Three follow-up reports (COM(2008) 875 final, COM(2010) 228 final and COM(2011) 133) highlighted achievements and yearly progress within the context of the implementation of the Water Framework Directive, whereas guidance has further been provided through the issue of Technical Reports (e.g. the EC Water Scarcity Drafting Group Technical Report 2008–023 on Drought Management, Including agricultural, drought indicators and climate change aspects). The 2012 EU Water Review (“Blue Print for Safeguarding European Waters” will assess achievements and identify further requirements towards long-term sustainable water use across the EU. However, a harmonized approach on drought risk management at the EU level is still lacking, whereas drought risk in several countries and regions has not been yet fully integrated in water management and relevant sectoral policies.

This paper focuses on a proposed paradigm shift from crisis to risk management, which is currently gaining ground as a means of reducing societal vulnerability to droughts. The paper underlines the importance of engaging into risk assessment and management practices and identifies policy gaps and requirements for further improvement of the drought management policy framework at all levels of governance: at the EU, at the national and at the river basin and regional levels.

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1. Introduction

Drought is a recurring natural phenomenon that can evolve into a disaster, depending on the severity and duration of the

episode, and most importantly on the vulnerability and the capacity of the affected society to manage its impacts. Drought episodes in the EU are frequent, spanning all geographical scales and hydro-climatic conditions. Current estimates indicate that an average of 15% of the total EU area and 17%

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of the EU population were affected by drought during the period 2000–2006 (CEC, 2007b). The severity of recent events is manifested by the importance of economic losses. During the period 2001–2006, economic damages were estimated at 37.2 billion €, accounting for nearly 40% of the total economic damages from droughts over the last 30 years (CEC, 2007b). Past episodes revealed that drought can have severe impacts even in comparatively water rich countries and river basins, which were not considered drought-prone in the past. As a result, the challenge of drought management, and particularly its interrelations with other environmental policies and development strategies, has begun to receive increasing attention by researchers and policy makers in all European contexts. Concerns have further been driven by the projected increasing frequency and severity of future events, as foreseen by the outputs of climate change models (Bates et al., 2008).

Experience in the EU and in other developed countries has often shown that policy responses to past drought events have been untimely and focused on addressing immediate needs, mainly through remedies targeted to specific areas and interest groups (Sivakumar and Wilhite, 2002). It is argued that these remedies, which aim at returning the system to pre-drought conditions, result in a greater dependence on state aid and contribute very little to the mitigation of the underlying causes of drought vulnerability, and thus to long-term risk reduction (Wilhite, 2005). This crisis management approach, which perceives drought as an ephemeral situation, rather than as a risk, has resulted in significant failures in the mitigation of drought impacts, encouraging also the continuation of unsustainable practices which increase the vulnerability of water resource systems.

The need for a shift to risk management approaches was one of the main driving principles of the FP7 EC-funded Xerochore Project (An Exercise to Assess Research Needs and Policy Choices in Areas of Drought, Grant Agreement No.: 211837). Xerochore was aimed at reviewing existing information (policy documents and research projects) on drought management, in order to pinpoint critical requirements for integrated drought management in the EU. The project adopted a three-fold perspective, by: (a) analysing drought as a physical phenomenon (drivers and descriptors), (b) providing guidance on the assessment of drought impacts, and (c) analysing current drought-related policies and identifying requirements towards the integration of drought risks in different EU policies.

This paper focuses on policy-relevant dimensions and summarises the main Xerochore findings with regard to current policy gaps at different levels of governance: (i) the EU level, where policies support the overall strategy of the Union towards sustainable development and environmental protection, (ii) the national level, where these policies are adapted to local specificities and national development goals, and (iii) the river basin/regional (district) level, where actual Drought Management Plans, decisions and actions are implemented.

2. Premises and policy dimensions of drought management

The new paradigm for drought management focuses on risk management rather than on the previously followed crisis

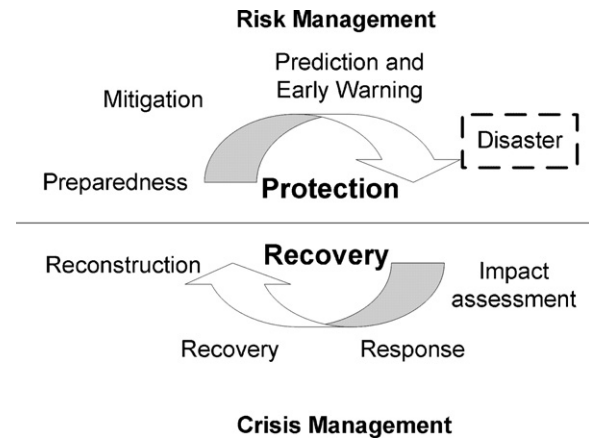


Fig. 1 – Risk and crisis management cycle (Wilhite, 1999).

management approach, which contributed to increased societal vulnerability to droughts (Sivakumar and Wilhite, 2002). Risk is a combination of natural factors (hazard) and social factors (vulnerability), which should be addressed within drought management. A risk management approach primarily concerns the issues of hazard prediction and vulnerability, placing the focus on pre-disaster activities and is based on drought preparedness and long-term risk reduction in order to reduce vulnerability and increase resilience to drought in society.

According to Alexander (2002), specific elements of a risk management approach concern protection and recovery (Fig. 1). Particularly with regard to drought, protection concerns actions undertaken before drought events, and refers to preparedness and risk mitigation activities. Drought preparedness refers to pre-drought activities designed to improve institutional and operational capabilities for responding to a drought event. Drought mitigation corresponds to response actions planned in advance of a drought event, so as to minimize the impacts on people, the economy and the environment. Key elements of protection involve (i) drought characterization through the selection of indicators and relevant thresholds to characterize the type and severity of future events, (ii) risk mapping, through the assessment of the degree and extent of exposure and vulnerability to droughts, including also the a priori rating of impacts in different sectors and regions, and (iv) the establishment of monitoring and early warning systems. A key element concerns the development of Drought Management Plans (DMPs), specifying courses of action and concrete plans for responding to droughts. Recovery corresponds to actions undertaken in response to a crisis situation, during or after the drought event, and concerns emergency responses and restoration to the pre-drought conditions, where feasible. Ideally, such actions should already form an integral part of the DMPs; to that end an important element concerns the post-drought evaluation of the process followed and of the actions undertaken (lessons learned), in order to continuously update and improve drought management efforts.

The implementation of drought mitigation options generally distinguishes between three threshold levels, each corresponding to different drought phases: pre-alert, alert

and emergency states (Iglesias et al., 2007; Assimacopoulos and Davy, 2010). Drought monitoring indicators and thresholds that describe the transition among the different drought states vary significantly among the EU MS, according to climatic and geographic specificities (CEC, 2007a,b,c; CEC, 2011a). They range from systems based primarily on meteorological parameters (e.g. Finland) to combinations of meteorological and hydrological indicators in comparison with expected demands (e.g. Portugal, the Netherlands) or can encompass systems or formal weighted indices that take into account multiple meteorological and hydrological variables across river basins (e.g. Cyprus and Spain, respectively).

The *state of pre-alert* is declared when the monitoring system shows the initial stage of a drought, corresponding to a moderate risk of depletion of water storage if all demands are satisfied. Relevant actions concern preparation for a possible drought, through indirect and non-structural measures of low cost, implemented on voluntary basis. A *state of alert* is declared when monitoring shows that future impacts of drought are unavoidable unless immediate measures are taken. Relevant actions are generally direct and coercive and of low/medium implementation cost. They may, however, have significant economic impacts, as they can include partial restrictions for specific water uses and transfer of water use rights, where allowed. A *state of emergency* is declared when drought impacts have occurred and aim at the minimization of drought damage. Corresponding measures are direct and restrictive and can entail high economic, environmental and social costs.

A key element of effective drought management concerns actions under *normal conditions*, when strategic and long-term measures are required to reduce risks and vulnerabilities. These should be aimed at enhancing resilience, protecting vital, strategic reserves, and at developing new infrastructure, where justified by anticipated risks. Measures should be oriented towards delaying or averting drought impacts, and minimize negative consequences at different drought stages.

Planning for drought concerns the a priori definition of measures to address all the aforementioned stages, the establishment of indicators and thresholds describing each drought stage and the development of strategic options to reduce risks to levels acceptable by the society. In turn, this requires addressing the four main pillars of a drought risk reduction strategy, which include (O'Meagher et al., 2000; Wilhite, 2005): (i) the availability of information to base decisions, (ii) policies and institutional arrangements, (iii) details on measures, and (iv) actions by decision makers. A further element concerns the integration (mainstreaming) of drought risk in all relevant sectoral and environmental policies concerning water management, land uses, energy production, tourism development and protection of natural resources, and the coordinated implementation of policy instruments across these to achieve reduction in vulnerability.

Therefore, even though drought events differ in terms of intensity, duration and spatial extent, general guidelines are needed on the processes and the measures to be used in the case of drought, in order to guide future efforts. Primary goals include (i) the harmonization of policies for managing drought, and (ii) the emergence of the new paradigm for drought management that focuses on risk management. As

explained in the following sections, the EU policy framework should address these primary objectives/gaps, acting as a guiding instrument for Member States that are solely responsible for addressing drought. The aim is to develop drought resilient societies by engaging the necessary human, technology and financial resources in drought management.

3. Drought policy requirements at different scales across the EU

The development and successful implementation of drought risk management actions requires the integration of policies across different sectors and geographical scales. As proposed by Young (2002) and by Urwin and Jordan (2008), this integration should be both horizontal, referring to policies at the same level of governance, and vertical, spanning policies at different scales of governance (from local to regional, national and international).

The way that drought risks are shared in society, avoided, accepted or transferred to a particular sector or social group is related to a broad range of policies, which range from how water allocation is prioritized, to the development objectives of a local society or a State. These in turn affect land use, set the principles for water management and supply enhancement and define water demand patterns, thus shaping the vulnerability of water systems and of society. In this regard, drought risks need to not only be embedded in water management policies, but also incorporated in Integrated Natural Resource Management strategies, development plans, and sectoral policies, including agriculture, energy and tourism.

The development of a drought-resilient society, able to cope with the impacts of extreme events, requires developing long-term strategies to reduce relevant risks (UN/ISDR, 2007). It further calls for the integration of the elements of preparedness and mitigation, building on advanced forecasting and monitoring tools, and on a broad understanding of the risks entailed and how these are to be mitigated or shared.

As elaborated below, the development of the adaptive capacity for coping with drought episodes requires harmonizing and mainstreaming policies, decisions and actions at different levels of governance: at the level of the European Union, at the national (Member State) level, at the river basin level and/or the regional/district level, and at the community level.

3.1. Policy requirements at the EU level

At the European level, the EU Water Framework Directive (WFD) is the main legislative instrument for water protection, which builds upon the principles of Integrated Water Resource Management and Planning to achieve “good status” of European water bodies by 2015. Within the context of the WFD, the development of river basin management plans (RBMPs) also foresees the elaboration of Drought Management Plans (DMPs) on a voluntary basis. Their objective is to avoid or prevent a crisis situation, by defining in a comprehensive and concrete way the measures and actions to be taken at different triggering levels or thresholds for water reserves.

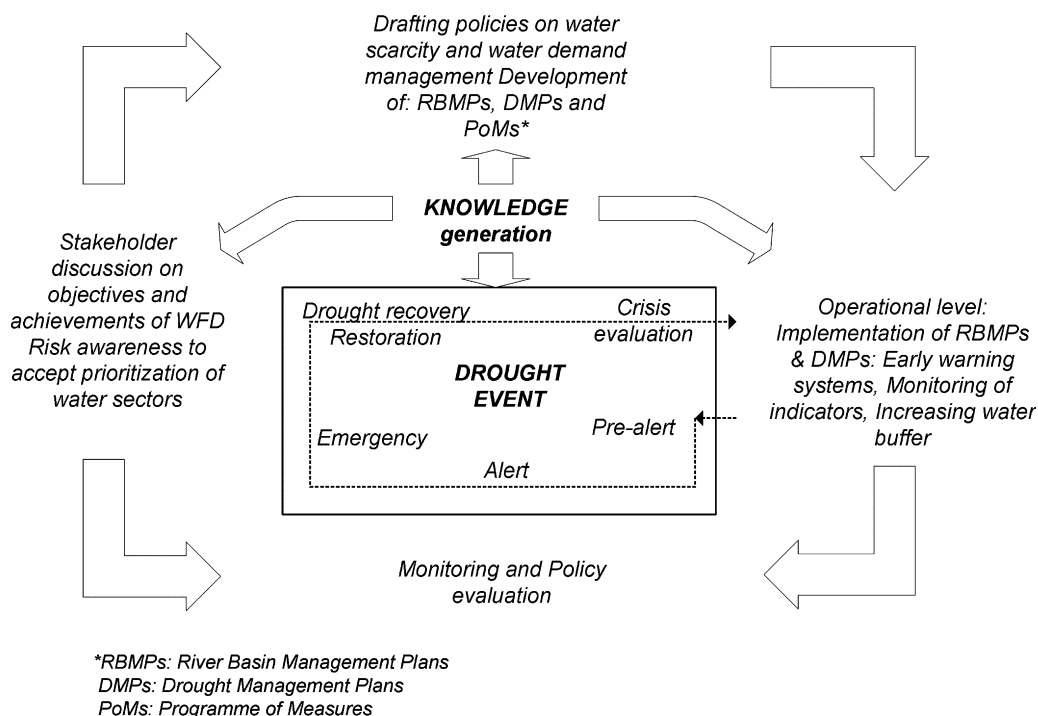


Fig. 2 – The WFD process in relation to drought management (Xerochore, 2010).

Inarguably, the 6-year policy cycle of the WFD offers opportunities for embedding drought risk assessment and reduction measures in water management plans and policies (Fig. 2), at least in terms of enhancing preparedness and re-assessing drought risks within the context of a changing climate. Furthermore, several provisions of the WFD touch upon drought-relevant issues, thus setting the milestones for an EU Drought Policy (EurAqua, 2004). Although explicit references and links are lacking, drought planning, management and risk reduction can concern several articles and provisions (Table 1).

Nevertheless, weaknesses and gaps still exist. These primarily concern the formalisation of the development of DMPs consistently with RBMPs, within the environmental objectives described in the WFD. The relevance of the environmental objectives set and their derogation in cases of extreme events still remains an open question. In addition, technical guidance is required to support the elaboration of National Drought Management Plans (DMPs) and strategies,

and for developing reporting mechanisms at all stages of planning, in order to achieve consistency in approaches used for drought characterization and risk assessment (Rossi, 2009).

In the above framework, the EU is pursuing an evolving strategy to address water scarcity and drought challenges, under the context of future climate changes. The goal is to provide technical tools and guidance to Member States on how to incorporate and address drought risks in future management plans. Key aspects and milestones of this effort are summarised in Table 2, which further presents indicative weaknesses and priorities for further action.

The milestones of the EU policy to address Water Scarcity and Drought were set through the first, 2007, Communication Document to European Parliament and the Council, “Addressing the challenge of water scarcity and droughts in the European Union (COM/2007/0414 final)”. The 2007 Communication identified an initial set of policy options to address the challenge, focusing particularly on aspects relating to water

Table 1 – Relevance of WFD articles to different aspects of drought planning and management.

WFD article and focus	Relevance to drought management and planning
Art.5 – Characterization of water bodies:	Assessment of vulnerability to drought, including drought propagation and addressing climate variability aspects
Art.8 – Monitoring of water bodies:	Incorporation of drought indicators and triggers and monitoring methods.
Art.9 – Cost recovery:	Assessment of costs, benefits and trade-offs of drought mitigation measures (as well as non-financial costs and benefits)
Art.11 – Programme of Measures for river basins:	Incorporation of measures to cope with drought, as well as of long-term water saving and conservation methods on a compulsory basis.
Art 13 – River basin management plans:	Voluntary development of DMPs, supplementary to the RBMPs.
Art.14 – Public information and consultation:	Stakeholder participation in the selection of mitigation options and the definition of water use rights and allocation priorities during drought.

Table 2 – Drought-relevant policy initiatives and guidance at the EU level.

Policy-related document	Link to drought management	Gap
Water Framework Directive 2000/60/EC (CEC, 2000)	Protection of water bodies that among others will “contribute to mitigating the effects of floods and droughts”.	Lack of explicit reference to drought conditions, vulnerability assessments and the need for quantitative measures (focus on water quality objectives). Voluntary, instead of obligatory, preparation of Drought Management Plans. No explicit link to Directive on groundwater (2006/118/EC).
EC Communication on “Addressing the challenge of water scarcity and droughts in the European Union” COM(2007)414 final (CEC, 2007a)	Initial set and prioritization of policy options to enhance water efficiency and proposals for enhancing drought preparedness.	Lack of explicit evaluation considerations on the efficiency of alternative measures, under the context of uncertainty, feasibility, acceptance and risk of future drought episodes. No clear distinction between measures to cope with long-term water imbalances (water scarcity) and droughts.
EC Follow-up reports to the COM(2007) 414 [COM(2008) 875 final, COM(2010) 228 final, COM(2011) 133 final] (CEC, 2008; CEC, 2010; CEC, 2011a)	Reporting on progress made by Member States with regard to the policy priorities, also with regard to drought management and planning.	Same as above. The COM(2011) 133 final further identifies the need for differentiating between indicators for water scarcity and for drought monitoring.
Drought Management Plan Report, Including agricultural, drought indicators and climate change aspects, Technical report 2008–023 (EC, 2007)	General, non-binding guidelines for the development of Drought Management Plans.	Limited elaboration on drought-relevant monitoring indicators at river basin level, including indicators on evapotranspiration, “green water”, soil moisture content, reliability of water supply.
River basin management in a changing climate, Guidance Document No 24, Technical report 2009–040 (EC, 2009)	Guidance on how Member States should address climate variability and change within the framework of the EU water policy, addressing also issues of monitoring and adaptation.	Need to make a distinction between drought, drought spells and prolonged drought (reference to prolonged drought under the WFD Article 4.6 provisions).
Green and White Papers on Adaptation to Climate Change: COM(2007) 354 final & 2009)147 final (CEC, 2007c; CEC, 2009)	General framework for reducing vulnerability to the climate change impacts across the EU. Consideration and elaboration of options meant to reduce vulnerability and enhance adaptive capacity.	Insufficient linkage between quantitative issues and climate change effects, and between policies that can affect future vulnerability.

pricing, land use planning and water saving (CEC, 2007a,b,c). Particularly with regard to drought management and planning, the Communication indicated that priorities across the EU should entail the elaboration of drought risk management plans, the development of the European Drought Observatory and the optimisation of the use EU Solidarity Fund and of the European Mechanism for Civil Protection. The first two follow-up reports to the 2007 Communication were released in 2008 and in 2010, reporting on the progress made with regard to the set priorities in 2008 and 2009, respectively (CEC, 2008; CEC, 2010). These two reports indicate achievements towards improved water management efficiency, but highlight the limited response of Member States towards drought risk assessment, management and the development of DMPs. A key drawback lies in the fact that water scarcity and drought are dealt within a common framework, which does not adequately differentiate policy options and responses to cope with permanent discrepancies between water supply and

demand (water scarcity) and temporary decreases in water availability due to natural phenomena (drought). The most recent (2011) follow-up report and the corresponding accompanying document recognizes developments towards drought risk management, as the elaboration of Drought Management Plans is progressing (either separately or as part of RBMPs) and the need for developing separate indicator frameworks for assessing water scarcity and drought, respectively (CEC, 2011a; CEC, 2011b). Droughts, within the framework of vulnerability to climate change are further discussed in the EC Green and White Papers on Adaptation to Climate Change (CEC, 2007c; CEC, 2009), which touch upon the integration of drought risks in water management and RBMPs, in the light of improving the resilience of water systems.

In addition to the above, technical documents have been developed to assist Member States on drought management and on integrating climate variability and change in water resources management. Relevant initiatives concern the

Technical Report 2008–023 on “Drought Management Plan Report – Including Agricultural, Drought Indicators and Climate Change Aspects” (EC, 2007) and the Guidance Document on “River basin management and Changing Climate” (EC, 2009). However, these reports tend to focus on reviewing current approaches, in an effort to identify best practice examples, and do not indicate research advances, which could benefit drought risk management and planning.

The overall effort is expected to evolve further through the 2012 EU Water Review “Blue Print for Safeguarding European Waters”, to be developed in collaboration with stakeholders. Among others, the Blueprint will assess the implementation of the EU policy on water scarcity and drought and the vulnerability of Europe’s resources to climate change, and identify further needs, supporting measures and legislation to achieve long-term sustainable use of water in the EU (CEC, 2011a,b).

Despite the overall concerted effort and progress, an important gap remains both at the level of the EU and at the level of individual Member States, in the horizontal integration with other sectoral and environmental policies (e.g. the Common Agricultural Policy, Climate Change Mitigation, soil strategies, etc.). Although it is recognized that the integration of drought risks in all relevant policies would effectively assist in reducing the vulnerability of sensitive sectors and areas, relevant synergies remain largely unexplored both by the scientific community and by policy makers, thus missing out on an opportunity for integrated responses to increasing drought risk.

3.2. Policy requirements at the national level

At the level of individual Member States, national policies are required to develop the environment that can enable effective drought management. This can entail the enhancement of awareness on drought-related hazards, the analysis of the causes of vulnerability and the development of guidelines, addressed to regional and river basin authorities (Wilhite, 2002). In accordance with the need to promote an overall shift from crisis to risk management, a key element of national policies refers to the clear and a priori definition of actions and measures, and the allocation of responsibilities among agencies and authorities at different drought states (normal, pre-alert, alert and emergency). Operational mechanisms to deal with normal, recurring and exceptional phenomena need to be formalised and universally accepted to enable effective and timely action for drought impact mitigation.

In addition to EU-wide early warning, official drought monitoring and state of alert processes should be enforced to guarantee the homogenous development of drought indicators and triggers, and to ensure consistent and harmonized activation of drought contingency plans across different river basins. This is particularly true in the case of large-scale inter-basin transfers between river basins or transboundary waters, where more coordination is needed among authorities, on the basis of unified approaches. Additional (formal) processes are needed to foster the compilation, review and update of DMPs, building on post-drought evaluations of contingency plans. These are considered of critical importance for recognizing past successes and failures, and for justifying future investments for

drought risk reduction, particularly if these entail the employment of costly solutions to enhance water supply reliability and security, such as desalination or interannual storage schemes (Wilhite et al., 2007). National priorities towards long-term risk reduction need to be mainstreamed with broader sustainability perspectives, prioritizing initiatives for water conservation, water saving practices and sustainable use of available supply, and resorting to supply enhancement only when other alternatives have been thoroughly explored and assessed. Post-evaluation processes can further be used as a basis for enhancing knowledge on drought impacts and mitigation efforts, thus informing future decisions and actions.

The definition and acceptance of damage due to drought that water users can expect and should accept, as normal entrepreneurship risks, is an essential part of national processes. Risks can be internalized through innovative methods, including weather insurance schemes, so that government support during drought periods is oriented towards those that are exceptionally affected e.g. through the suspension of water use rights. To that end, risk identification mechanisms, and the a priori formulation of assistance programmes needs to become part of national drought management processes, building on stakeholder consultation and engagement.

Adaptive governance approaches can be adopted as means to support the development of drought policies, in order to integrate both the scientific and local knowledge in policy design and implementation (Nelson et al., 2008). Adaptive governance is based on the shared management of common assets, among communities and governments, through systems of governance at multiple levels with a certain degree of autonomy and limited overlap in authority and capabilities (Folke et al., 2005; Low et al., 2003). Further to this, the formalisation of participatory programmes across all levels, combined with nationally funded research to address emerging decision-making needs, can help to achieve an improved understanding of the causes and impacts of drought, as well as technological advances, and enhance the ability of individual countries to effectively manage and cope with drought events (Wilhite, 1997).

3.3. Policy requirements at the river basin and at the regional level

As implied also by the relevant provisions of the WFD, drought planning and management should be performed at the level of river basins (GSA, 2007). The river basin is the physical entity where drought impacts develop, and where rainfall deficiencies propagate through the system to reduced water stores and discharges. At this level, drought characterization and vulnerability assessments are required to provide the basis for the development of DMPs.

Vulnerability to drought depends on drought exposure, on the sensitivity of the system and on the adaptive capacity. Drought management at this level should be carried in accordance with EU and national policy directions and objectives, vertically informing relevant policies on significant issues that can affect the systems’ response to drought events, and thus defining an informed decision base. Mitigation options can be sectoral or global and will depend on the

drought severity level. Their definition will involve the setting up of clear allocation priorities and restrictions in water use, and the assessment of damages, trade-offs and long-term impacts of allocation schemes and mitigation options.

Measures included in DMPs are to be defined and implemented according to indicator thresholds. In turn, this requires consistent and regular monitoring, to early detect droughts already at their onset. Indicators must be monitored and be able to define the alert status of a drought incidence, in order to allow the timely initiation of actions. Where relevant, river basin authorities should further incorporate the development of strategic reserves in long-term planning, and define water use rights according to the availability of water resources (Bazza, 2002).

Drought management and planning further involves the regional (local administrative) level, where drought alert actions need to be coordinated and implemented by local authorities, in close interaction with water users and their representatives. Particularly in the case of emergency situations, relevant plans are to be activated by local authorities; in the post-drought recovery phase damages are to be recorded and cross-checked, and compensations are approved in collaboration with national authorities. Future reviews, evaluation processes and re-formulation of plans during this phase are needed to ensure integration of lessons learned and more robust management and responses. Besides political commitment and stewardship, drought mitigation plans and strategies need to build on the involvement and contribution from regional actors, to ensure their acceptance and effectiveness. To that end, regional processes need to involve water users, their representatives, authorities, and administrative organizations to ensure that all specificities, constraints and interests are met to the fullest possible extent and that a common understanding of the acceptable levels of risk and damage is reached among the local society.

Political commitment and stakeholder involvement are particularly challenging requirements for drought management in transboundary river basins, as often the case across Europe. Drought management in transboundary basins requires coordination over different political, legal and institutional settings, as well as over different information management approaches and financial arrangements (Timmerman and Bernardini, 2009). Integrated drought information systems, common indicator frameworks, and vulnerability assessments considering cascading impacts in the different sub-basins is an important step. However, the main challenge lies in reaching consensus on the way through which costs and risks can be shared among riparian countries.

3.4. Prioritizing policy requirements – experts' perspectives

The above requirements, as defined at different levels of governance, were prioritized through a survey, undertaken within the framework of the Xerochore Project, which was aimed at (a) collecting and evaluating information on existing drought policies at national level; (b) identifying drought mitigation options already applied in various countries or regions; and (c) defining key issues in the development of drought adaptation strategies.

The survey was addressed to the Xerochore Network Partners, involving more than 80 institutions from European Countries (including Italy, Hungary, Slovenia, Norway, the UK, France, Greece, Germany, Bulgaria, Spain, Slovakia, France, The Netherlands, Belgium and Turkey), and from Morocco and China, with 52% of participants employed in universities and research institutes, 33% in public authorities, and 15% representing the private sector or acting as consultants.

The main factor perceived to increase the vulnerability to drought was climate change. Other critical factors included inefficient water management practices, the limited investments in water infrastructure, the dependency on transboundary waters, potential changes in weather patterns, non-flexible agricultural practices and limited coordination of actions among the different institutions. According to vulnerability assessments undertaken in several countries, agricultural and lowland areas were identified as the most vulnerable to drought. In addition, the most commonly implemented options, as indicated by the respondents, concerned water pricing, restrictions on water use and awareness campaigns. Drought planning and risk reduction mostly encompassed options towards supply enhancement, but also water saving and diversification of water supply sources to improve reliability in water supply.

Within the survey, the weaknesses of the drought management policies and policy components identified throughout Europe were attributed to the current focus on a crisis rather than a risk management approach and to the fragmentation of responsibilities among the different agencies, as well as the lack of implementation mechanisms. Other replies concerned the increased reliance on surface water supply, the limited consideration of groundwater-relevant issues, the insufficient targeting of drought recovery and the lack of structured processes for determining the onset of a drought event and for evaluating potential impacts.

Overall, the survey clearly indicated the requirement for a shift from reactive to proactive approaches, in other words to promote the integration of drought risk in water resource planning, in order to minimize the severe water shortage and its adverse impacts. Timeframes for action (short or long-term) and the importance (medium, high) of key challenges in drought management, as indicated by the majority of Xerochore Network Partners, are presented in Table 3. Further information on the survey can be found on the project deliverable D5.2. "Extended Guidance document after Conference on Drought management and policy options" that is publicly available on the official project website (<http://www.feem-project.net/xerochore/>).

4. Discussion: the emerging challenges and the way forward

A key policy concern in the EU is the potential to address the three phases of drought management (preparedness, mitigation, recovery) within the current policy framework and particularly through the procedures set by the WFD. Important milestones concern: (i) the definition of procedures and processes that can improve governance in the development and implementation of DMPs, (ii) the analysis of the limita-

Table 3 – Importance and time-frame for action of some key challenges in drought management, as indicated by the Xerochore Network Partners.

Critical issue	Importance	Timeframe for action
<i>EU level</i>		
Shift towards risk management approaches	High	Short-term
Reporting and publication of post-drought analyses and dissemination of good practice examples	High	Long-term
Strengthening of links between policy/decision makers and scientists	Medium	Long-term
<i>National level</i>		
Capacity building in agencies entrusted with drought management	High	Short-term
Selection and definition of mitigation measures in consistency with the environmental objectives set by the WFD	Medium	Short-term
Need to apply measures during the recovery phase as a means to improve society's capacity to cope with drought	High	Long-term
Establishment of monitoring and early warning systems – Improvement of drought characterization processes and forecasting tools, taking uncertainty into account	High	Short-term
<i>River basin level/Regional & District level</i>		
Development of harmonized methodologies for defining regional-based drought indicators and triggers	High	Short-term
Development of methodologies for vulnerability assessment at river basin level	Medium	Short-term
Improvement of participatory processes	High	Short-term

tions and opportunities for linking DMPs to the WFD RBMPs, and (iii) the establishment of procedures for reaching a decision on an acceptable level damage from a potential drought occurrence. The latter should be based on the thorough assessment of the (often) high financial and economic costs of measures for risk reduction vs. potential economic and environmental damage and restoration costs, eventually decided upon by consensus of all potentially affected groups and stakeholders.

Based on the identified policy gaps and requirements, several challenges should be explored at the EU level:

- (i) Promoting the shift from crisis to risk management: this approach indicates the importance of monitoring and early warning as a means of preventive action, and identifies risk-based assessment as the appropriate method for the selection and implementation of the most

effective reactive measures for addressing extreme events.

- (ii) Launching initiatives and developing policy instruments and guidelines to promote the efficient use of water (water saving, water efficient devices and water-friendly products, use of alternative resources), introducing new rules on managing water quality and certification schemes and expanding existing EU labelling schemes, whenever appropriate. As pointed out in the relevant EC communications (CEC, 2007a,b,c; CEC, 2008; CEC, 2010), priority should be given to the demand management side; however, the development of additional water supply infrastructure can possibly be considered for mitigating the impacts of severe drought in regions where: (a) all prevention measures have already been sequentially implemented (from water saving to water pricing policy and alternative solutions), (b) a cost-benefit analysis has been taken into account, and (c) demand still exceeds water availability.
- (iii) Integrating environmental considerations in the selection of drought mitigation actions, since some measures may be subject to the Strategic Environmental Assessment Directive (SEA) provisions and should be assessed according to Article 4.7 of the Water Framework Directive. Furthermore, “Green Infrastructure” should be promoted, which is expected to contribute to adaptation to climate change and extreme climatic conditions. Climate change impacts on water resources as well as the interrelationship between environmental protection and water management should be further analysed.
- (iv) Building a knowledge base (data, tools and experiences) for developing drought mitigation strategies and assessing alternative management schemes. The EEA (2009) stresses that information sharing on best practices will foster the development of DMPs in the EU. Therefore, the elaboration of educational programmes and advisory services, the exchange of know-how on new technologies and best practices, and large targeted campaigns of communication related to water quantity issues should be encouraged at national level.
- (v) Establishing holistic response and recovery frameworks, especially targeting highly impacted areas by drought, including vulnerable aquatic ecosystems.
- (vi) Harmonizing and mainstreaming different policies and instruments to incorporate drought risks, considering that drought impacts are often indicators of non-sustainable land use, water management and sectoral policies that have been designed without integrating risks and uncertainties in future water availability and climate conditions.

The main challenge for implementing the above lies in the wide(r) recognition of the need for drought preparedness and for long-term reduction of drought risks. So far, it has often been the case that policy initiatives faded after the end of a drought event, and drought risk management and planning has mostly been endorsed by countries and regions that faced severe impacts fairly recently. Nevertheless, the investment in drought monitoring and early warning systems, and most importantly in policy integration to

Table 4 – The course of action for developing and implementing a drought policy.

Action	Main components
Setting of objectives	Focusing on risk management instead of crisis management Acknowledgement of environmental needs and considerations (WFD) Effective communication of drought risk at all levels
Policy & plan formulation	Formalisation of drought declaration processes Definition of responsibilities & cooperation framework among different management levels (national, sectoral, regional) Application of economic instruments to internalize costs & risks (e.g. insurance schemes) Development of Drought Management Plans at the river basin scale through harmonized procedures
Consultation–adoption–implementation	Establishment of procedures to ensure that all issues & interests are taken into account Addressing interlinkages with other policies (EU, national, regional) Improvement of implementation by enhancing collaboration among involved authorities & developing information and data exchange networks (national & international level)
Evaluation–revision	Use of Virtual Drought Exercises to evaluate a system's readiness to deal with drought Post-drought evaluation of plans and actions Integration of ongoing research outcomes and scientific knowledge Sharing of lessons learned (successes, failures, critical factors) to inform policies & Drought Management Plans

address the underlying causes that increase drought vulnerability becomes a requirement, particularly as many regions across Europe are becoming more drought-prone due to climate change.

It is thus argued that the development of national drought policies and plans for the implementation of the EU policy framework should be prioritized within the national initiatives for drought management in all Member States. The course of actions for developing and implementing drought policies is a cyclic and incremental process, whose main elements are presented in Table 4. Whereas actual plans and actions are to be implemented at the level of river basins or districts, the coordination and support to different sectors and authorities and the overall compliance to broader policies are largely tasks of national policy development. To that end, key challenges are the promotion of appropriate institutional arrangements, the building of bottom-up stakeholder engagement processes and participation, and the development of the capacity of authorities to effectively mitigate drought risks. The above issues, which clearly reflect the need for the development of an enabling environment, are particularly relevant in the case of transboundary basins, where the development of joint plans and common information systems requires significant cross-border cooperation and coordination among riparian countries.

In the above context, future drought-related research would concern the development of advanced assessment, monitoring, forecasting mechanisms and early warning systems, as well as societal vulnerability assessments, under the frame of climate predictions. The above priorities are relevant to all the policy and decision-making contexts analysed in this paper, but need to be addressed considering the specific constraints and characteristics of local societies and their priorities. A key challenge remains in developing efficient linkages between the scientific and policy spheres, building on enhanced coordination in order to prioritize efforts according to policy-making challenges, and ensuring that relevant results are effectively communicated to the different decision-making levels that they concern.

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