

TOWARDS GUIDELINES FOR DROUGHT PREPAREDNESS AND MITIGATION PLANNING WITHIN EU WATER POLICY

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ABSTRACT

The drought management issues are only marginally addressed by the EU Water Framework Directive 2000/60. In order to overcome such a weakness, a group of experts on Water Scarcity and Drought from the Mediterranean countries of Europe, has proposed a specific “Drought Management Plan” (DMP) to be drafted as an annex to the “River Basin Management Plan” of each river basin, in order to develop suitable strategies to cope with drought.

The European countries present a great variability in the drought vulnerability due to climate, available water resources, water supply systems, institutional and economic characteristics, particularly between North Europe and Mediterranean regions. Thus, detailed criteria oriented to an effective drought management should be individuated in the different countries or regions.

In the paper, a review of the current drought management policy in Europe is presented and an analysis of the general guidelines suggested by the Water Scarcity and Drought Group for the DMP, including those devoted to allow the temporary relaxation of water quality requirements in water bodies during the prolonged droughts according to the WFD, are discussed.

Then specific criteria are proposed in order to achieve a suitable legislative and technical framework to face with drought and water shortage risk at national level in each European country. In particular, they are oriented: i) to develop drought monitoring systems, which represent key tools for adopting a pro-active approach towards drought risk management, ii) to identify and implement adequate drought preparedness and mitigation measures able to avoid the most severe water shortages in supply systems and harmful impacts on people, economic activities and environment, and iii) to define the emergency actions to be implemented in the case of a drought declared as a natural disaster. Such criteria are drawn from scientific researches and management experiences carried out in Mediterranean countries in the last decade.

1 INTRODUCTION

The European Water Framework Directive 2000/60 (WFD), though indicating among its objectives the mitigation of drought effects, yet faces only marginally the problems of drought management, both in terms of preparedness and mitigation. With the aim to develop an improved effort about drought and water scarcity problems within

the Common Implementation Strategy of the WFD, a group of experts on Water Scarcity and Drought (WS&D Group) was established in 2003 among the Mediterranean countries of Europe. Such a group proposed the preparation of a specific “Drought Management Plan” (DMP) as an annex to the “River Basin Management Plan” of each hydrographic districts (WS&DEN, 2007). Despite the group provided general orientations for developing the DMP, yet specific guidelines are needed in order to draft the DMP as a powerful tool to prevent and reduce the negative impacts of drought on economy, society and environment of each European country.

In terms of features of drought events and of water supply systems, as well as in the legislative and institutional framework, there is a great difference among European countries, especially between North Europe and Mediterranean regions. Therefore, even if common goals, principles and strategies of drought management can be identified for Europe as a whole, it is necessary that they are followed by specific criteria oriented to face the main critical conditions which, in the different regions, determine the limited reliability of systems to severe drought events and/or reduce the effectiveness of the planned measures.

After a brief review of the EU current drought management policy, in the paper the general suggestions of EU Water Scarcity and Drought Group for preparing a DMP are analyzed. Since the DMP should also develop a specific section related to prolonged droughts (PDs), a paragraph is specifically dedicated to some criteria to identify PDs. Also the main recent initiatives to review European policy on water scarcity and drought are discussed.

Besides, some specific indications already proposed to improve drought preparedness and mitigation in each European country or region (Rossi, 2009) are here updated and presented in some details. They have to be adopted according to the characteristics of each country, such as level of drought vulnerability and legislative and institutional features. They have been drawn mainly from the results obtained in two recent European projects: MEDROPLAN (Mediterranean Drought Preparedness and Mitigation Planning) (Iglesias et al., 2007) and PRODIM (Proactive Management of Water Systems to Face Drought and Water Scarcity on Islands and Coastal Areas of the Mediterranean) (Rossi et al., 2008).

2 DROUGHT MANAGEMENT IN EU WATER POLICY

2.1 EU current drought management policy

Since the 60', the European countries demonstrated a certain interest in water issues through the publication of the European Charter on Water by the European Council. In following years, such an interest continued by the establishment of several Directives on water quality topics by the European Commission. Nevertheless, the adoption of a comprehensive legislative tool for Community action in the field of water policy occurred only with the issuing of the Water Framework Directive 2000/60.

The stated goal of the WFD is the achievement of a good ecological status in all European water bodies, through the development at basin level of a complex planning process aimed to manage the water quality, both in terms of safeguard of the potential water uses and of protection of ecosystems. Because of this emphasis towards qualitative rather than quantitative issues, perhaps due to the prevailing role of North

European countries (which are affected more by pollution threats than by water quantity problems), the topics of mitigation of floods and droughts (though mentioned in the preamble) and water scarcity are only marginally addressed within the WFD.

In order to overcome this soon recognized limit, recently two important steps have been taken: the establishment of a specific Directive on the management of flood risks (2007/60/CE) and the starting of a process aimed to improve European policy on water scarcity and drought issues.

The WFD presents different weaknesses related both to the water quantity problems and drought and water scarcity and they are discussed in that following.

First of all, according to its main goal, the focus of the Directive is correctly placed on the qualitative dimension of water bodies. Indeed, the “control of quantity” is considered “an ancillary element in securing good water quality” and the assessment of quantitative status is not required for surface water bodies, but only for groundwater water bodies. Furthermore, the WFD does not appear adequate to face the drought risk, that is only marginally dealt. In fact, water demand management measures to be adopted in areas affected by drought are indicated as “supplementary measures” in the programme of measures of the River Basin Management Plan that the Member States must prepare for each river basin district. Besides, the drought impacts on natural water bodies are faced in an ambiguous way, whereas a definition of water shortages due to drought is lacking. Nevertheless, the 2000/60/CE (art. 4.6) tackles the problem of prolonged droughts (PDs) and permits a temporary derogation to requirements of good ecological status of water bodies under PDs, since they (as well as extreme floods) are considered as exceptional circumstances that could not be reasonably foreseen. This appears in disagreement with the general aim of the water resources management to modify natural hydrological conditions for benefit to the human use and ecological purposes.

In addition, further weaknesses related to drought and water scarcity issues are present in the current EU technical tools, financial instruments and legal acts, as recently pointed out by the European Water Partnership (see Table I).

Table I. Weaknesses in the EU current political strategy on drought and water scarcity

EU technical tools are missing with respect to: – advanced water stress monitoring indices – identification of areas vulnerable at risk of drought and water scarcity – assessment of the effects of quantitative measures (e.g. water saving, water reuse, desalination) – organization of initiatives to foster public awareness on water shortage issues
EU financial instruments are not adequate since: – financial aids encourage water demanding crops in areas suffering water stress – funds allocation is not at basin or district scale – civil protection funds give more emphasis to flood damages rather than drought
EU legislative acts are missing with reference to: – standards for non conventional water use (e.g. treated wastewater) – specific regulations for water resources management – water saving for all water uses (municipal, irrigation, industrial)

2.2 The proposal of EU Water Scarcity and Drought Group for a Drought Management Plan

In light of the above-mentioned weaknesses existing in the WFD and in European water policy, in 2003 a “Water Scarcity and Drought Group” was established in order to deal with drought and water scarcity issues within the implementation process of the WFD in the Member States. After two interim reports, the final text was issued by the European Commission in November 2007 as the “Drought Management Plan Report. Including agricultural drought indicators and climate change aspects” (WS&DEN, 2007).

A first important contribution of the Report may be considered the clear distinction between the concepts of drought and water scarcity:

- drought represents “a natural phenomenon due to a relevant temporary deviation from the average level of natural water availability”;
- water scarcity refers to “a long term water imbalance where the water demand exceeds the water resources exploitable under sustainable conditions”.

It should be noted that there is also a clear difference among the previous concepts and the concepts of “aridity” (natural but permanent climatic situation) and “water shortage” (temporary imbalance between demand and availability, influenced as the permanent water scarcity by characteristics of the water supply system).

The most significant proposal of the WS&DEN can be considered the drafting of a specific “Drought Management Plan” (DMP), as an Annex of the “River Basin Management Plan” (RBMP) and related general guidelines (WS&DEN, 2007).

The Plan is not mandatory for Member States, but can be a powerful tool to mitigate drought impacts. It has to be prepared when and where needed, in addition to adequate measures included in the programme of measures of the RBMP and its application must comply with WFD environmental objectives.

The main focus of the DMP is to minimize the negative impacts of droughts on the economy, social life and environment. Besides, it aims at extending WFD criteria and goals to implement drought management through a series of specific objectives:

- to guarantee sufficient water availability to cover essential human needs to ensure the population’s health and life;
- to avoid or minimize negative drought impacts on water bodies;
- to minimize negative effects on economic activities.

For the preparation of the Plan, that must be done in advance (before the starting of drought), careful studies concerning the characterization of the basin and its environmental elements, historical droughts in the basin and possible mitigation measures must be carried out. Since the DMP must be developed at river-basin or sub-basin scale, its promotion should be taken care by the institution in charge of the river basin planning.

According to a proactive approach, in addition to the mitigation measures to be implemented during an ongoing drought, the WS&DEN has also proposed specific actions oriented to reduce drought vulnerability that have to be adopted under a so-called “normal” status. In particular, such strategic measures are aimed to improve the “robustness” of the water facilities system in order to increase its response capability to droughts, meeting both users’ demands and environmental requirements.

The Plan can be developed taking into account a multi-level approach:

- national level: policy, legal and institutional aspects and funding to mitigate extreme drought effects have to be considered. Strategic actions should be implemented and, in connection with river-basin or local levels, they should be oriented to determine drought onset conditions through a network of global indices and indicators at national, regional or basin level;
- river-basin level: the DMP can be considered as a management plan supplementary to RBMP and in this case it must be mainly aimed at identifying and scheduling the activation of tactical interventions to delay and/or mitigate the drought impacts;
- local level: the DMP should include both tactical and response measures to guarantee essential public water supply as well as awareness measures.

The WS&DEN provides specific indications about the contents of DMP. In particular its main elements are:

- indicators and thresholds aimed to establish onset, ending and severity levels of the drought events;
- measures for each drought phase aimed to prevent deterioration of water status and to mitigate negative drought impacts;
- an organizational framework to deal with drought and the subsequent revision and updating of the existing drought management plan.

2.3 Criteria to identify prolonged droughts

Besides the items previously discussed, a specific section of a DMP should be dedicated to prolonged droughts, during which, as already indicated, a temporary derogation to requirements of good ecological status of water bodies is permitted by the WFD. To this regard, the 2000/60 recommends that river-basin authorities: adopt appropriate indicators to identify a PD, predict possible impacts, identify the measures to be taken under such exceptional circumstances and review their effects yearly.

At the aim to their determination, it is important to refer to a common definition of prolonged droughts, but it can be very difficult both because drought duration and impacts can vary considerably from country to country or within a country and because numerous variables are involved. In spite of the WFD considers the PDs as unpredictable natural phenomena, their impacts could be reduced through the adoption of preventive mitigation measures in drought prone areas. To this end, it appears necessary define specific indicators to identify PDs in different geographic and climatic contexts, since, due to the differences in EU Member States, no single indicator can be broadly applied at the European level.

The WS&DEN (2007) suggests to group into three different categories the indicators to be used to identify a PD:

- indicators aimed to identify and demonstrate the occurrence of a PD: physical indicators based on precipitation or soil moisture that demonstrate the exceptionality or the reasonable unpredictability of the drought event;
- indicators oriented to prove that a PD has produced a temporary deterioration of one or more water bodies;
- indicators aimed at identifying the socio-economic impacts of PDs.

In order to identify a PD, WS&DEN suggests to use several variables (e.g. precipitation or net rainfall, flow in rivers, storage level in reservoirs, soil moisture content, environmental parameters) aimed to compare their values during drought with

so-called “normal” conditions. Since during a PD a temporary derogation is allowed, in addition to variables, it can be useful to take into account some impact indicators, for both physical impacts on water bodies and neighbouring terrestrial areas and socio-economic impacts. A synthesis of such variables and indicators is reported in Table II.

Table II. Variables and indicators of a prolonged drought suggested by the WS&DEN (2007)

A. Variables to be analysed for identifying a prolonged drought
• Rainfall or precipitation • Flow in rivers • Storage level in reservoirs • Soil moisture content
B. Indicators for identifying a prolonged drought
• Duration indicator • Intensity indicator
C Indicators for identifying PD’s physical impacts on water bodies and neighbour terrestrial areas
• Hydraulic characteristics (e.g. minimum flow, minimum stage, no. of days with dry bed) • Ecological characteristics (e.g. no. of dead species of fish or individuals, no. of flora species not present, reduction in wetland extension) • Neighbourhood land (e.g. no. of forest fires)
D. Indicators for identifying PD’s socio-economic impacts
• Drinking supply (e.g. decrease of service’s reliability as restrictions in duration of supply or less quality) • Tourism (e.g. damage due to the decrease of quantity or quality of supply) • Industrial use (e.g. damage due to the decrease of quantity or quality of supply) • Agricultural use (e.g. damage due to the decrease of quantity or quality of supply) • Hydropower (e.g. damage due to the decrease of quantity or quality of energy production) • Water rights (e.g. transfer of water rights toward priority uses)

2.4 Recent suggestions to review European policy on drought

On the basis of the successive work of the Group on Water scarcity and Drought, recently the Report from the Commission to the European Parliament and the Council on these issues in the European Union (EC, 2011) has suggested to review the related European policy including some specific topics listed in Table III.

Table III. Main topics to review European policy on water scarcity and drought (from EC, 2011)

Improving water efficiency
– introducing water saving devices and practises in buildings and improving water-efficient construction – reducing water leakages in supply distribution systems – improving efficiency in agricultural use of water
Achieving better planning and preparedness to deal with droughts
– integrating actions against water scarcity and drought into other sectorial policies (agriculture, households, industry) – assessing the adequacy of the River Basin Management Plans on water scarcity and drought issues – further developing the prototype of an observatory and early warning system on drought – defining a more comprehensive list of indicators on water scarcity, drought and of vulnerability of water resources
Developing adequate implementation instruments of financing, water pricing, water allocation research and education
– encouraging EU funding of natural risks trough Cohesion Policy, Regional Policy, Solidarity Fund and Economic Recovery Plan and reforming Common Agricultural Policy – making more restrictive the national rules to authorize the water abstractions – developing new research projects on vulnerability and increased drought risk – introducing new educational programmes and awareness-raising campaigns

3 CRITERIA TO IMPROVE DROUGHT PREPAREDNESS AND MITIGATION IN EUROPEAN COUNTRIES

An efficient strategy to deal with drought in each country requires specific criteria aimed to adapt the general European principles on drought management to the characteristics of the country, in particular to drought vulnerability, water supply system features and legislative and institutional national framework. For instance specific objectives and contents of the proposed DMP should include appropriate legislative indications on drought preparedness and mitigation planning tools, on institutional competence sharing, as well as criteria for developing drought monitoring systems at national and/or regional levels and recommendations for defining measures against drought to increase drought resilience and actions to be developed in operation of water supply systems under drought conditions and during drought emergency.

To this regard, some specific indications from which the EU national governments could derive useful hints for improving its drought preparedness and mitigation are reported in that follows.

3.1 Legislative decisions about the drought planning levels and competences sharing

First of all, the national legislation framework, that each State should have to deal efficiently with droughts, should include specific recommendations on drought

management for reducing drought vulnerability and for mitigating its impacts. At this aim, the legislation should provide for the preparation of Plans and sub-Plans at different territory levels, including possible interventions against drought, taking into account water shortage problems in water supply systems. In particular, specific legislation must also indicate the various authorities and agencies involved and share the competences to implement specific actions. Among the planning contents, it is very important to provide for indications on management of drought emergency, which must be carried out through the structures of the Civil Protection Service at both the national and local level.

Within a comprehensive drought management process, three main tools can be identified at different level of planning:

- Strategic Water Shortage Preparedness Plan at strategic level,
- Water Supply System Management Plan at tactical level,
- Drought Contingency Plan at emergency level.

The links among the different Plans and the drought monitoring system are showed in Figure 1 where the authorities and agencies in charge for preparing the Plans are also indicated.

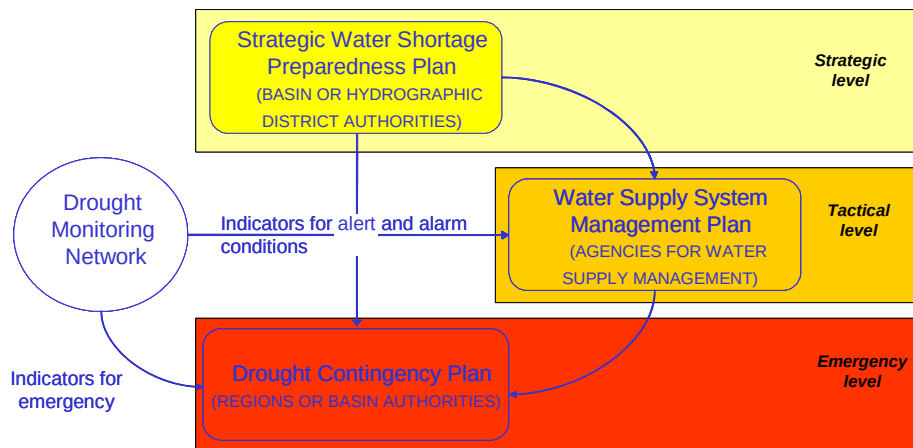


Figure 1. Drought management planning process

The Strategic Water Shortage Preparedness Plan (SWSP), whose institutions in charge are River Basin Authorities, can be considered coinciding with the Drought Management Plan previously discussed and is oriented to minimize the drought vulnerability of the Basin or District. Besides the drought risk on territory (referring mainly to the rainfed agriculture) and on the rivers (as prolonged droughts of the Water Framework Directive 2000/60) this Plan should be aimed to reduce the risk of water shortage due to drought in the water supply systems. In order to draft the SWSP, a large set of information concerning the water supply system under study is required. The data collection should include all the relevant information regarding the water supply system: meteorological and hydrological inputs, physical features of the elements of the system and different uses/sectors as well as their historical used volumes and water demands. Furthermore all the technical and institutional constraints,

the managing information such as the operating rules during normal hydrologic conditions and/or the mitigation measures implemented to face past historical droughts should be collected. Figure 2 indicates the main categories of basic information necessary to develop the different investigations to be used for drafting the SWSPP.

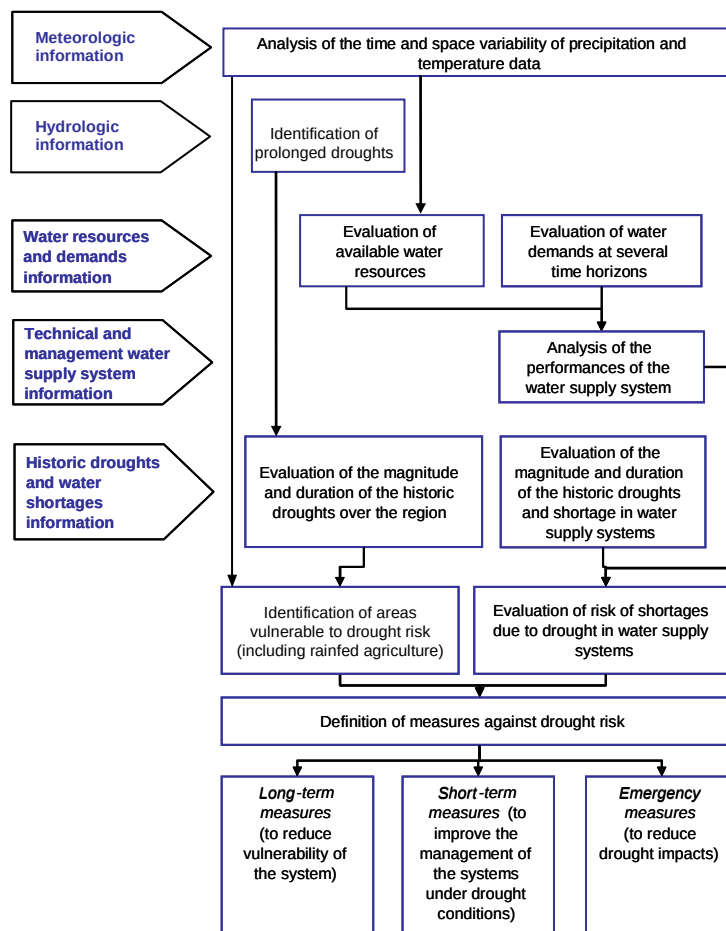


Figure 2. Information needed to draft SWSPP against drought

At tactical level, the Water Supply System Management Plan (WSSMP) contains the operational measures to be adopted in order to avoid water emergency situations in a specific water supply system. Because of this, the WSSMP preparation falls under the competence of the management body of each supply system for a specific sector or multipurpose supply.

The third suggested planning tool, the Drought Contingency Plan (DCP), should be prepared by Region or River Basin Authority and should include short term measures to be activated under water emergency conditions due to exceptional droughts, when drought is recognized as a natural calamity by the Government. In order to improve its

effectiveness, the DCP should be able to rely on public cooperation that can be decisive to obtain support for the Plan and to increase the likelihood of Plan implementation. Furthermore, since the Plan should be dynamic rather than static, it should take into account experiences acquired in previous droughts and should be frequently revised.

The main contents of the three Plans are reported in Table IV.

Table IV. Main contents of drought management plans

Strategic Water Shortage Preparedness Plan
• Identification of water supply systems within the territory • Identification of drought vulnerable areas • Estimation of water shortage risk in water supply systems including priority in water allocation and definition of guarantee levels • Definition of long term measures to reduce water shortage risk • Comparison and selection of alternative measures • Procedures for transparency of information and public participation • General indications for Water Supply System Management Plan • General indications for Drought Contingency Plan
Water Supply System Management Plan
• Definition of indicators for Normal, Alert and Alarm conditions • Definition of the best mix of long term and short term measures to avoid emergency • Estimation of costs and financing sources for mitigation measures • Tools for fostering the stakeholder participation and exchanges
Drought Contingency Plan
• Definition of indicators for declaration of a natural disaster • Tools for an institutional participation through a task force on drought • Definition of short term mitigation measures and their costs • Indications for the coordination of state, regional and local levels in emergency • Tools for transparency of information on drought situation • Recovery from drought damages

3.2 Criteria for developing a drought monitoring system

As indicated in the Figure 1, both the WSSMP and DCP are linked to the drought monitoring system that has to continuously monitor the hydrometeorologic variables and water resources state at the aim to identify possible situations of crisis. Indeed, an efficient drought management depends also on the capacity to monitor the phenomenon and its effects. Therefore, the specific legislation on drought should also indicate suitable “criteria for drought monitoring systems” since they represent an important support tool for the decision makers (Rossi, 2003), by enabling the identification of the drought warning conditions and providing timely and useful information both for the implementation of the Water Supply System Management Plan (under drought conditions) and for an objective declaration of drought as natural calamity. In order to be effective, the drought monitoring systems should give particular emphasis to graphical and understandable representation of the results of the monitoring phase in order to allow an immediate understanding of the severity and evolution of drought event. Furthermore, such systems should be able to reach and inform as many water

users as possible (besides the public institutions) through easy access to information (e.g. through public websites). In terms of responsibility sharing, meteorological or hydrographic services should be the authorities in charge for monitoring drought, whereas management agencies or national committees should deal with monitoring water shortage in supply systems.

3.3 Recommendations for defining drought preparedness and mitigation measures

In order to select specific measures to effectively face drought, the following criteria should be taken into account: the application of a proactive approach, the identification of the optimal combination of short term and long term measures, the individuation of adequate tools for the comparison and the ranking of the alternatives.

To put into practice an effective drought mitigation strategy, the application of a proactive approach proves to be better than a reactive approach which unfortunately is still dominant. The reactive approach is in fact inadequate because it identifies emergency measures to limit water shortage damages caused by drought once the phenomenon is started and perceived, often implying a waste of financial resources. On the contrary, since the proactive approach operates in advance with respect to the beginning of a water crisis, it allows to avoid and/or reduce water emergency consequences through the preparation of suitable plans and the consequent implementation of such plans taking into account the indications of a proper monitoring system (Iglesias et al., 2007).

A second fundamental criterion to pursue an efficient mitigation consists in the adoption of appropriate measures (structural, managing, administrative and economical actions) to face different drought phases. In literature, several classifications of drought mitigation measures are available and some have been adopted in important international meetings and/or discussed in some monographs specifically dedicated to drought and drought management.

According to a well consolidated classification, we can make the following distinction:

- long term measures oriented to reduce vulnerability of water supply system to drought, namely to improve the reliability of each system to satisfy water demand under drought conditions, as well with structural and institutional interventions. Moreover such actions are included into the general water resources planning and could refer to drought event characterized by a fixed exceeding probability (“design drought”);
- short term measures oriented to reduce the damages of a specific drought event after it has been forecasted or recognized as potential origin of severe impacts in the framework of the existing facilities and politics. Furthermore, they aim to mitigate effects of a drought that may overcome a “design drought” (considered in long term actions) and they are included both into the Water Supply System Management Plan under drought conditions and into the Drought Contingency Plan to face emergency situations.

In Table V and VI classifications of respectively long term and short term measures in different sectors (municipal, agricultural, etc.), grouped into three categories according to their purpose are reported.

Table V. Long term drought preparedness measures (Rossi, 2000 modified)

Category	Long term actions	Affected sectors			
Demand reduction	Economic incentives for water saving	U	A	I	R
	Agronomic techniques for reducing water consumption		A		
	Dry crops instead of irrigated crops		A		
	Dual distribution network for urban use	U			
	Water recycling in industries			I	
Water supply increase	Conveyance networks for bi-directional exchanges in water supply	U	A	I	
	Reuse of treated wastewaters		A	I	R
	Inter-basin and within-basin water transfers	U	A	I	R
	Construction of new reservoirs or increase of storage volume of existing reservoirs	U	A	I	
	Construction of farm ponds		A		
	Desalination of brackish or saline waters	U	A		
	Control of seepage and evaporation losses	U	A	I	
Impacts minimization	Education activities for improving drought preparedness and/or permanent water saving	U	A	I	
	Reallocation of water resources based on water quality requirements	U	A	I	R
	Development of early warning systems of drought	U	A	I	R
	Implementation of a Drought Contingency Plan	U	A	I	R
	Insurance programs		A	I	

U= urban; A= agricultural; I=industrial; R=recreational

Table VI. Short term drought preparedness measures (Rossi, 2000 modified)

Category	Short term actions	Affected sectors			
Demand reduction	Public information campaigns for water saving	U	A	I	R
	Restriction in some urban water uses (i.e. car washing, gardening, etc.)	U			R
	Restriction of irrigation of annual crops		A		
	Water pricing changes	U	A	I	R
	Mandatory rationing	U	A	I	R
Water supply increase	Improvement of existing water systems efficiency (leakages detection programs, new operating rules, etc.)	U	A	I	
	Use of additional sources of low quality or high exploitation cost	U	A	I	R
	Temporary over exploitation of aquifers or use of groundwater reserves	U	A	I	
	Increased diversion by relaxing ecological or recreational use constraints	U	A	I	R
Impacts minimization	Temporary reallocation of water resources	U	A	I	R
	Public aids to compensate income losses	U	A	I	
	Tax reduction or delay of payment deadline	U	A	I	
	Public aids for crops insurance		A		

U= urban; A= agricultural; I=industrial; R=recreational

3.4 Criteria for triggering actions in the operation of water supply system under drought conditions

An important issue in the implementation of specific measures to face water shortages due to drought concerns the individuation of specific triggering levels that should be suitably linked to specific thresholds on available water reserves in order to avoid crises. In particular, the Drought Management Guidelines developed within the MEDROPLAN project suggest three threshold levels to individuate different drought phases and to select related mitigation measures: pre-alert, alert and emergency (Iglesias et al., 2007).

The *pre-alert scenario* is declared when the monitoring system shows the initial stage of a drought, corresponding to moderate risk (i.e. 10%) of consuming all water stored in the system and not being able to meet water demands. Since the objective of this phase is to prepare to an oncoming drought, it needs to ensure public acceptance of actions to be implemented by increasing public awareness of the possibility of social impacts due to drought. The suggested measures for this situation, aiming to avoid alert or emergency situations, are generally indirect, non-structural, of low cost and are to be implemented voluntarily by stakeholders.

The *alert scenario* is declared when the monitoring shows that drought is occurring and will probably have impacts in the future if measures are not taken immediately: there is a significant probability (i.e. >30%) of forthcoming water deficits. In this phase, which aims to avoid drought emergency situations by applying water conservation policies and mobilizing additional water supplies, the suggested actions are generally not structural, coercive and of low/medium implementation cost. They are directed to specific water-use groups, generally include partial restrictions for water uses other than drinking water or water exchange between uses and can reallocate water for priority uses.

The *emergency scenario* is declared when indicators show that drought impacts have occurred and water supply is not guaranteed if the event persists. Under emergency conditions, the main purpose is mitigating the impacts and minimizing the related damages and the priority is satisfying the minimum requirements for drinking water. The suggested emergency measures are direct, restrictive and of very high economic and social costs. Furthermore, they can be structural (e.g. new wells for overexploiting groundwater abstraction, water transfer facilities, and so on) or not structural (e.g. water restrictions for all users, subsidies and low-interest loans).

In the case of a multipurpose water supply system, the choice of mitigation measures to be implemented depends also on priority of different water uses (e.g. municipal, agricultural and industrial), besides the triggering levels. To this end, a preliminary choosing of the priorities in water allocation under shortage conditions is necessary, also in order to distribute possible water deficits. Although such a choice must be taken on the basis of the legislative framework and of the economic, social and institutional conditions of an area, two levels of priority can be considered (Iglesias et al., 2007): the first is aimed to ensure adequate supplies of domestic water available for public health, safety and welfare, and the second is oriented to minimize negative drought effects on the economy, the environment and social well-being.

3.5 Criteria for drought emergency actions

Under emergency conditions, the activation of the mitigation measures included in

the Drought Contingency Plan should follow the declaration of drought as a natural calamity. In order to improve the implementation of drought emergency actions, it could be useful to foster the collaboration among structures of Civil Protection at different level to carry out actions of aid to population.

Another important issue during emergency situations concerns the appointment of suitable Task forces aimed to coordinate the actions against drought that should be formed by both representatives of regional government (Civil Protection, Provinces, Municipalities, Land Reclamation Consortia) and environmental and public interest groups and representatives from the private sectors.

With regard to involvement of public interest groups, should be noted that the effectiveness of the emergency measures depends strongly on public cooperation. In fact, public involvement could help to obtain support for the implementation of emergency interventions and to establish cooperative relationships.

Finally, following drought emergency phase, it could be taken into consideration the adoption of a responsive political strategy for choosing between damages recovery based on governmental support or on private insurance (eventually fostered by national funds).

4 CONCLUSIONS

Despite the European Water Framework Directive 2000/60 indicates among its objectives the mitigation of drought impacts, it does not deal explicitly with drought risk. In addition, other weaknesses related to drought and water scarcity issues are present in the current EU technical tools, financial instruments and legal acts.

In order to improve drought preparedness and mitigation, the European Group on Drought and Water Scarcity has proposed to prepare a specific “Drought Management Plan” (DMP) as an annex to the River Basin Management Plan (RBMP) provided by the WFD and has given a set of criteria about the contents of the Plan and a list of indicators to identify prolonged droughts which enable a temporary deterioration of the water body status.

On the basis of results of recent European research projects, some indications to improve drought preparedness and mitigation in European countries have been discussed. They are related to the legislative and institutional characteristics of an efficient drought management strategy, including drought and water shortage monitoring and definition and implementation of drought preparedness and mitigation actions, both in operation of water supply and in emergency conditions.

Despite the initiatives and the ideas presented in the paper, it should be pointed out that further efforts are still needed to foster an effective drought and water scarcity risk management at European level, from a legislative, institutional and technical point of view. To this end, scientific research can contribute by providing the necessary tools (e.g. for monitoring and forecasting droughts) for an improved risk management.

REFERENCES

- EC (European Commission) (2011). *Water scarcity and droughts in the European Union* Report from the Commission to the European Parliament and the Council. SEC(2011) 338 final. http://ec.europa.eu/environment/water/quantity/pdf/special_report.pdf

- Iglesias, A., Cancelliere, A., Gabi Gabiña D., López-Francos A., Moneo M. and Rossi G. (2007). *Drought Management Guidelines and Examples of Application*. www.iamz.ciheam.org/medroplan
- Rossi, G. (2003). Requisites for a drought watch system. *Tools for drought mitigation in Mediterranean regions*, G. Rossi, A. Cancelliere, L. Pereira, T. Oweis, M. Shatanawi, and A. Zairi, eds., Dordrecht, The Netherlands: Kluwer Academic Publishing, 147–157.
- Rossi, G., Cancelliere A. and Giuliano G. (2005) Case study: multicriteria assessment of drought mitigation measures. *Journal of Water Resources Planning and Management*, 131(6): 449-457.
- Rossi, G., Nicolosi, V., and Cancelliere, A. (2008). Strategic water shortage preparedness plan for complex water supply systems, *Proceedings of the International Symposium Water Shortage Management*. Athens, Greece: NTUA.
- Rossi, G. (2009). European Union policy for improving drought preparedness and mitigation. *Water International*, 34(4): 441-450.
- WS&DEN (Water Scarcity and Droughts Expert Network) (2007). *Drought management plan report. Including agricultural, drought indicators and climate change aspects*. Technical Report, 2008-023. Luxembourg, November 2007.