



Intecsa-Inarsa

Analysis of the implementation of Drought Management Plans in the wider context of the River Basin Management Plans

(Report drafted in the framework of the *Comparative Study of Pressures and Measures in the Major River Basin Management Plans. Task 3d: Water Abstraction and Water Use*)

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1. Abstract and Key Messages

Drought is a natural phenomenon. It is a temporary, negative and severe deviation along a significant time period and over a large region from average precipitation values (a rainfall deficit), which might lead to meteorological, agricultural, hydrological and socioeconomic drought, depending on its severity and duration.

In November 2003, EU decided to develop an initiative on Water Scarcity & Drought which has led to the establishment of an initial set of policy options for tackling these issues. Developing and putting into force Drought Management Plan [DMP] is one of these possible policy responses to drought. The main items needed to develop a DMP are:

- **Indicators and thresholds** establishing onset, ending, and severity levels of the exceptional circumstances (prolonged drought).
- **Measures** to be taken in each drought phase in order to prevent deterioration of water status and to mitigate negative drought effects. These measures may be of different type: strategic, operative, organizational, follow-up and recovery).
- **Organizational framework** to deal with drought and subsequent revision and updating of the existing DMP.

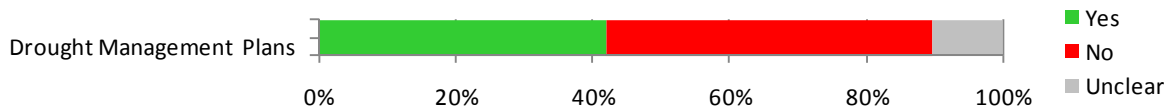
Some MS or RBDs may count on part of these elements but not consistently structured in an operational DMP. In some cases this is not an easy question to elucidate.

A growing number of Member States have developed Drought Management Plans or similar tools. ES and UK (England and Wales) have separate DMPS already in place while FR and NL have equivalent operative tools. CY has included its DMP as an Annex of the RBMP and GR is currently working on them within the same framework. UK -Scotland, MT and CZ are also in the drafting stage. In IT, only the northern and central RBDs have proper DMPs. In the rest of IT, AT, BE, HU, RO & SK drought management is considered as part of RBMPs or regional plans. Other countries have tools focused on emergency management (LU, UK - North Ireland) or specific early warning systems (PT, PO).

With the available information, further screening at RBD level has been carried out, starting from River Basin Management Plan Assessments [RBMPAs]¹, and extended by own assessment in the framework of this contract –covering Spain and Portugal, with most of their plans in Public Consultation stage– and complemented by consulting a variety of other sources as national questionnaires and personal contributions, mainly from *Water Scarcity & Drought* Expert Group members.

¹ Systematic assessment of RBMP carried out in the framework of the Compliance checking of the River Basin Management Plans.

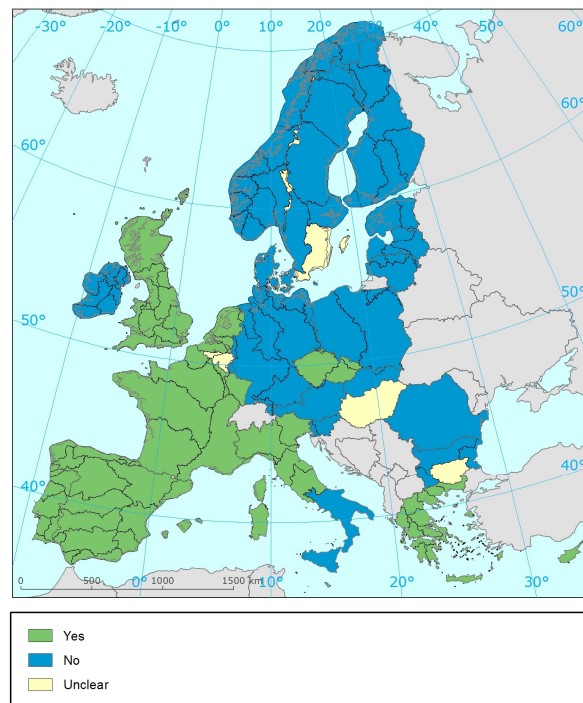
Fig. 1. Statistics of application of DMPs in European RBDs



Source: previous and own assessments

According to these analysis, up to 78 River Basin Districts [RBDs] (42%) have implemented DMPs (or similar tools)² or have planned it in the framework of the Programme of Measures [PoM], while other 89 (48%) show no explicit intention in this regard, though may count with some simpler drought management tools. Finally, in 19 RBDs (10%), available information is not sufficient to assess.

Fig. 2. Maps of application of DMPs in European RBDs



Source: previous and own assessments

The potential (expected effectiveness) of DMPs has also been evaluated at RBD level, with the intention to identify in which RBDs the implementation may be expected to contribute in a higher degree to environmental and management objectives. The assessment (high / moderate / low) has been made on the basis of the information compiled in this study (see section 4.6), basically: RBMPAs, WISE data on abstraction and hydro-morphological pressures, national questionnaires, and expert judgment (including further assessment of RBMPs). The Water Exploitation Index - WEI (at national or RBD level) has also been used as a basic indicative of the existence of water scarcity problems generally associated with

² The positive value may have quite different meanings with regard to the level of implementation (from a proposal in the PoM to full implementation).

severe drought episodes. This work is done for all RBDs, even not assessed ones. The level of confidence has also been qualified.

2. Introduction

2.1. Main objectives of the assessment

Water abstraction and water use are a key pressure on many water bodies, in particular during temporary drought phenomena or in water scarcity prone areas. The current RBMPs have only partially dealt with water quantity aspects, and often only focused on the water supply for households and economic activities.

At present, we do not know the size of the projected gap in Europe between water demand and water availability. In this respect, the water and ecosystem accounts, developed together with the EEA, will quantify how much water flows in and out of the river basins. They are also expected to provide a comprehensive overview of water use and water availability, but it is still necessary to carry out a screening of measures taken to address pressures arising from water use.

This sub-task will provide detailed information on how **water scarcity and drought** (WS&D) and **environmental water allocation** (EWA) are dealt in the RBMPs and, more generally, in the management of European river basins. It requires, where applicable, a closer look at Drought Management Plans (DMPs) and/or E-flows assessment and provisions for implementation where applicable. The task is linked to the screening of RBMPs and is bound to feed to the Blueprint (policy options and impact assessment). The sub-task will also provide a comprehensive overview of pressures from water abstraction and measures addressed to mitigate its impacts. This analysis will inform the horizontal task.

This Report focuses on DMPs while a similar one is dedicated to eflows.

2.2. Definition of Drought Management Plan

Schmidt et al 2012 propose a standard definition for both Drought & Water Scarcity (D & WS) to be used onwards in the policy context.

***Drought** is a natural phenomenon. It is a temporary, negative and severe deviation along a significant time period and over a large region from average precipitation values (a rainfall deficit), which might lead to meteorological, agricultural, hydrological and socioeconomic drought, depending on its severity and duration.*

***Water scarcity** is a man-made phenomenon. It is a recurrent imbalance that arises from an overuse of water resources, caused by consumption being significantly higher than the natural renewable availability. Water scarcity can be aggravated by water pollution (reducing the suitability for different water uses), and during drought episodes.*

Both, the drought and the water scarcity definitions can be complemented by information on their impacts (based on Xerochore, 2007 and CONHAZ, 2012), whenever the context is appropriate (e.g. policy documents).

If droughts or water scarcity pass certain thresholds, they can significantly affect the environment (terrestrial and freshwater ecosystems, air, soils), the economy (agriculture and water uses) and society (e.g. public water supplies, welfare, recreational activities, cultural and aesthetic concerns).

In relation to measures and policy responses, relevant similarities and differences derived from these definitions may be pointed out:

Table 1. Drought & Water Scarcity. Possible measures and policy responses

	Drought	Water Scarcity
Possible measures to prevent or mitigate effects	Drought forecasting, risk prevention (e.g. insurances, climate change adaptation, increased flexibility of water usage, increase water efficiency, protection of vulnerable species and habitats, governance rules for different drought thresholds) and emergency actions (e.g. water supply)	River Basin Management Plans (RBMPs) , water management, metering and allocation, water demand management, increase water efficiency and reusing, protection of vulnerable species and habitats, pricing policies, etc.
Possible policy responses	Development of Drought Management Plans (DMPs) , water allocation systems and water governance rules and regulations. Support for insurance systems. Financial support for emergency actions (e.g. Solidarity Funds)	Reduction of pressures via sectoral policies (e.g. agriculture, energy, urban development) related to water usage (e.g. on water-usage planning, water allocation and pricing systems, control)

Source Schmidt et al 2012

In recent years drought planning is moving from a crisis management approach (by declaring a national or regional drought emergency programme to alleviate drought impacts) to risk management based on the development of comprehensive, long-term drought preparedness policies and plans of actions intended to significantly reduce the risks and vulnerabilities to extreme weather events³.

DMPs may be one of the *more detailed programmes and management plans for sub-basin, sector, issue, or water type, to deal with particular aspects of water management* stated that may supplement the RBMP, as stated in the article 13.5 of the WFD, in addition to adequate measures included in the Programme of Measures [PoM].

Some confusion may arise without a conceptual clarification on what a DMP is. The *Drought Management Plan Report (including Agricultural, Drought Indicators and Climate Change Aspects)* (WSDEN, 2007) summarize the main items needed to develop a DMP:

- **Indicators and thresholds** establishing onset, ending, and severity levels of the exceptional circumstances (prolonged drought). A drought early warning system should provide values of these drought indicators correlated with thresholds for different stages of drought as it intensifies and recedes.
- **Measures** to be taken in each drought phase in order to prevent deterioration of water status and to mitigate negative drought effects. Measures should be designed to achieve specific objectives in each phase.

³ WSDEN 2007.

- **Organizational framework** to deal with drought and subsequent revision and updating of the existing drought management plan
- A **section dedicated to 'prolonged drought'** as defined in article 4.6 of WFD, which includes the following requirements: prevention and restoration steps and measures for water bodies; measures to be taken in case of prolonged drought; indicators for prolonged drought; annual review of the effects of prolonged droughts.

Some MS or RBDs may count on part of these elements but not consistently structured in an operational DMP. In some cases this is not an easy question to elucidate.

2.3. Policy Background

In November 2003, the informal meeting of the EU Water Directors reached the agreement to develop an initiative on WS&D issues. This decision came after one of the most widespread droughts, in 2003, when over 100 million people and a third of the EU territory were affected. Some concerns and gaps of the WFD relating to **quantitative issues, which influence the achievement of the environmental objectives**, were identified, particularly in regard to floods, water scarcity and droughts. The need for further developments was envisaged by the MS, both at a political level.

In 2006 and early 2007 the Commission carried out an in-depth assessment of WS&D in the EU. Following this assessment an initial set of policy options to increase water efficiency and water savings was presented in a Communication from the Commission to the European Parliament and the Council - **Addressing the challenge of water scarcity and droughts in the European Union** (COM/2007/0414 final) published in July 2007. Seven policy options were identified for tackling these issues:

1. Putting the right price tag on water
2. Allocating water and water-related funding more efficiently
 - a) Improving land-use planning
 - b) Financing water efficiency
3. Improving drought risk management
 - a) **Developing drought risk management plans**
 - b) Developing an observatory and an early warning system on droughts
 - c) Further optimising the use of the EU Solidarity Fund and European Mechanism for Civil Protection
4. Considering additional water supply infrastructures
5. Fostering water efficient technologies and practices
6. Fostering the emergence of a water-saving culture in Europe
7. Improve knowledge and data collection
 - a) A water scarcity and drought information system throughout Europe
 - b) Research and technological development opportunities

Based on information from the MS and its own research, the Commission prepares annual Follow-up Reports that assess the implementation of the policy options throughout the EU. The 2007 Communication also sets deadlines for certain actions. In relation to the development of **Drought Risk Management Plans**:

1. **At European level.** *Foster exchanges of information and best practices on drought risk management. Identify methodologies for drought thresholds and drought mapping. By the end of 2008, develop recommendations.*

The publication of the previously mentioned *Drought Management Plan Report* (2007) followed this mandate, and prepared by the Water Scarcity and Droughts Expert Network, it was published the *(including Agricultural, Drought Indicators and Climate Change Aspects)*. This report presents general guidelines to develop a Drought Management Plan, complying with WFD environmental objectives.

2. **At national level.** *By 2009, set up specific drought management plans to supplement WFD river basin management plans, where needed, in accordance with WFD provisions (Article 13(5)).*

The fulfilment of this mandate will be reviewed in a later chapter.

In addition, the *Guidance Document on “River basin management in a changing climate”* provides recommendations referring to drought management.

2.4. Linking EWA & DMP

The WFD places the integrity of freshwater ecosystems at the core of water management. For the purpose of protecting the environment is necessary to consider the water needs of aquatic ecosystems, thus contributing to preserve, protect and improve environmental quality and the rational use of water resources. Measures to prevent and alleviate drought consequences and water scarcity are thereby entirely appropriate within its context (WSDG 2006)

Although the WFD is not directly designed to tackle quantitative issues, its purposes include contributing to the mitigation of drought effects (art. 1. e) and the promotion of sustainable water use (art 1.b) and its environmental objectives include ensuring a balance between abstraction and recharge of groundwater (art 4.1(b)ii). Furthermore, water quantity can have a strong impact on water quality and therefore on good ecological and chemical status. In this respect, the Directive can be an instrument for addressing drought and water scarcity management (WSDEN 2008):

Water uses may alter natural conditions, affecting the associated ecosystems. It is therefore necessary to establish some criteria and general rules –in line with WFD requirements– to make sure that water use is consistent with EWA, which ensure protection for the associated flora and fauna. By determining the characteristics of the vulnerable areas and their dependence on water, it will be possible to establish minimum and required water inputs for the maintenance and conservation of habitats and species. These minimum inputs could be defined within each DMP through indicators related to EWA, such as eflows regime, minimum water volumes in lake type WB or maximum abstractions from GWB with dependant riverine ecosystems and wetlands.

In addition to WFD Protected Areas, other natural ecosystems linked to water systems can present vulnerability to drought episodes. They can include:

- Plain areas that have a high evapotranspiration in the absence of water inputs.
- Lowlands near coastal areas easily invaded by marine waters with alterations in the ecosystems equilibrium.
- Geological areas dependent on groundwater springs.
- Areas linked to ephemeral or intermittent flows (surface inputs).
- Natural systems very close to the saturated level, and highly sensitive to variations in water levels.

During drought, a decrease in water inputs might endanger EWA, with an added risk of lowering water quality also affecting associated biological elements. Actions and measures that guarantee minimum EWA need to be established and monitored (measuring river flows, water levels in lakes and aquifers, physico-chemical parameters, and biological indicators), to ensure the survival of flora and fauna in these areas, in accordance with the WFD requirements, which include an obligation of no deterioration of the status of all water bodies.

3. Methodological approach and data sources

Phase 1

The first step is the re-evaluation of other support studies and assessments for the Blueprint, some of them still in progress, to better adapt the output of the sub-task to the real needs of the Blueprint and its timing requirements.

The main documents and datasets that have been collected and analyzed are:

- Compliance checking River basin management plans [2012]
- Drought Management Plan Report (including Agricultural, Drought Indicators and Climate Change Aspects) [2007]
- Water Scarcity and Drought: towards a European Water Scarcity and Drought Network (WSDN) [2010]
- Third follow-up of the Communication on Water Scarcity and Droughts [2010]
- Water Scarcity & Droughts Policy in the EU - Gap Analysis. Inception Report [2012]

Phase 2

In this stage the **Data collected and information obtained in different sources will be crossed** to progress in the general understanding of the situation of DMPs across Europe: implementation, pressures addressed, and other relevant features of both measures.

Depending on the results of these analyses, two complementary tasks would be carried out:

- Apart from RBMPs assessments, most of the available information deals with measures at the national or regional level. Occasionally it will be necessary to go back to RBMPs or to separate

DMPs identified in the overview stage to clarify some aspects at the basin scale. For instance, a new screening could address those RBMPs where the development of DMPs has been classified as issue of high or moderate importance or where evaluators have not been able to assess significance.

- Information interchange with some selected experts from the Water Scarcity & Droughts TWG or other institutions to confirm diagnosis at different levels and validate the identified links between pressures & measures.

This phase will also feed the horizontal task: measures database and factsheets, general assessment of effectiveness in different types of water bodies and at RBD scale and storylines. Study cases and specific examples will be provided under the envisaged overall coordination of Task 3.

Phase 3

This phase is the Drafting of the **Final Report**. This report will include a summary of the work done and it is specifically designed to feed subsequent documents in the frame of the 2012 Blueprint for Water, giving policy recommendations and assessing impacts.

4. Drought Management Plans in Europe

4.1. Initial screening of the RBMPs

The European Commission is currently assessing the compliance of RBMPs against the provisions of the WFD and carrying out a “bottom up” assessment of the plans. The compliance assessments is organised by topic templates, each of them answering a battery of specific questions, so that their results are expected to provide, in many cases, the basis or source of the data and information required for many of the Tasks under this Study Contract.

In relation to Sub-Task 3d, there is a specific template dealing with information on **Strategy to deal with water scarcity and droughts**. In the following pages the available assessment are reflected in summary tables and figures.

4.1.1. TOPIC: Strategy to deal with water scarcity and droughts

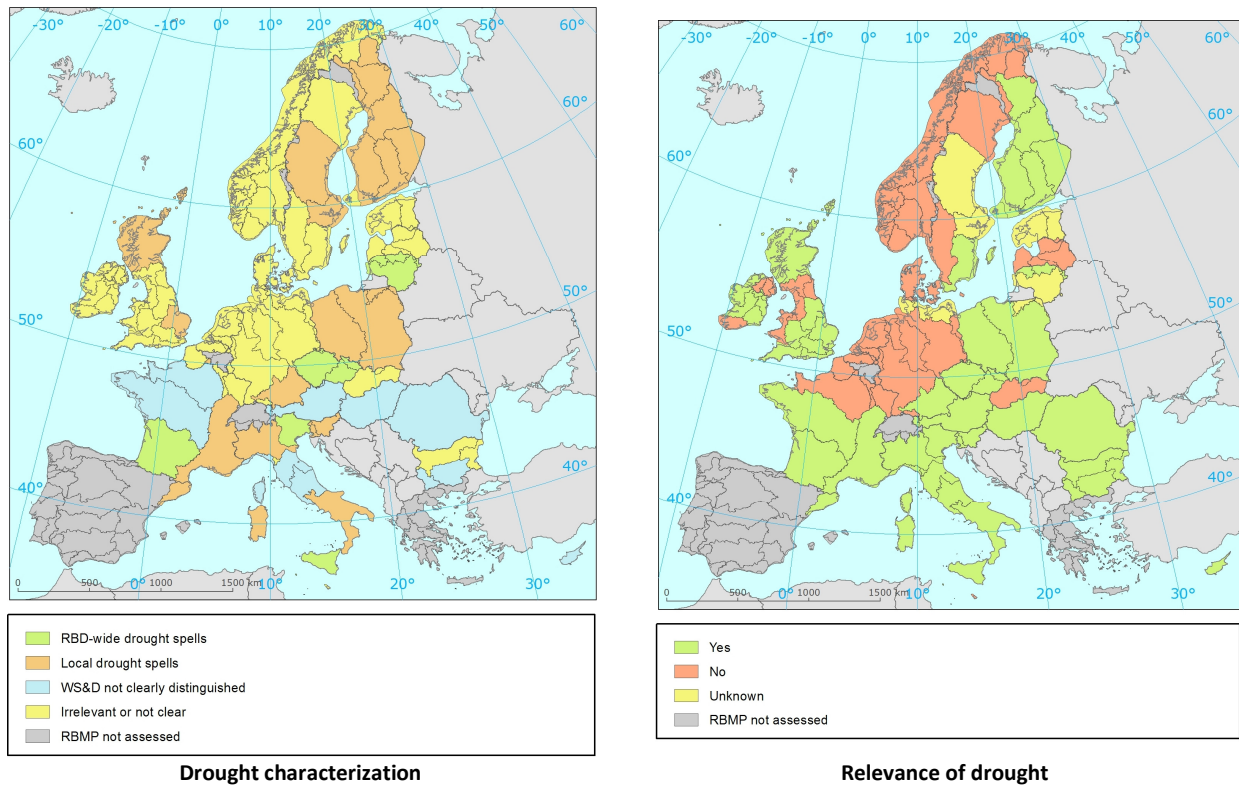
WSD-Q1) Which of the following phenomena characterise the RBD?

This question helps to determine if drought (also water scarcity) are perceived as relevant issues:

	Phenomena that characterise RBD						Relevance of drought (evaluator`s opinion)
	RBD-wide water scarcity	Local, sub-basins water scarcity	RBD-wide drought spells	Local, sub-basins water drought spell	Both WS&D, not clearly distinguished	Other (irrelevant, not clear, no info)	
True	9	35	10	27	14	6	56
False	114	88	113	96	109	117	55
Unknown							12

Droughts in RBMPs, it is considered a RBD-wide event in only 10 out of 123 RBMPs assessed (8%)⁴ and a sub-basin problem in 27 RBMPs (22%)⁵. For 14 RBMPs (11%)⁶ drought and water scarcity are referred to as not clearly distinguished phenomena. By contrast, almost half of the evaluators— 56 (51%)⁷— consider drought to be a relevant issue in the RBD assessed.

Fig. 3. Which of the following phenomena characterise the RBD?



Source: RBMPs Assessment

⁴ CZ_1000, CZ_5000, CZ_6000, FRF, ITA, ITH, LT1100, LT2300, LT3400, LT4500.

⁵ CZ_1000, CZ_5000, DE1000, ES100, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRB2, FRD, FRL, ITB, ITF, ITG, PL2000, PL6000, PL7000, PL8000, SE2, SE3, SI_RBD_1, SI_RBD_2, UK01, UK05.

⁶ AT1000, AT2000, AT5000, BG3000, BG4000, CY001, FRE, FRG, FRH, HU1000, ITC, ITE, ITG, RO1000.

⁷ AT1000, AT2000, AT5000, BG1000, BG2000, BG3000, BG4000, CY001, CZ_1000, CZ_5000, CZ_6000, DE1000, ES100, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIWDA, FRD, FRE, FRF, FRG, FRK, FRL, GBNIENB, GBNIENW, HU1000, IEEA, IEGBNISH, IESE, IEWE, ITA, ITB, ITC, ITD, ITE, ITF, ITG, ITH, LT2300, LT3400, LT4500, PL2000, PL6000, RO1000, SE4, SI_RBD_1, SI_RBD_2, UK01, UK04, UK05, UK06, UK07, UK08, UK09.

WSD-Q3) What are the effects of past and expected water scarcity and droughts?

As effects of Droughts (and WS) in environmental issues are described at RB level, the impacts an eventual DMP should address are indirectly identified:

Effects of past and expected droughts						
	Degradation of surface water quality	Degradation of groundwater quality	Groundwater over-abstraction	Wetlands degradation / disappearance	Disruption of environ. instream flow regimes	Exemption for environ. objectives
True	23	14	13	12	16	4
False	100	109	110	111	107	119

The effects in environmental elements coincide with the impacts DMP should address: Degradation of surface water quality has been identified in 23 RBMPs (19%)⁸; Degradation of groundwater quality in 14 RBMPs⁹ (11%); Groundwater over-abstraction in 13 RBMPs¹⁰(11%); Wetlands degradation or disappearance in 12 RBMPs¹¹ (10%); Disruption of environmental flow regimes in 16 RBMPs¹² (13%); and eventually the Exemption for environmental objectives in 4 RBMPs¹³ (3%).

⁸ AT1000, AT2000, AT5000, BG3000, CY001, DE1000, DE2000, DE3000, DE4000, DE5000, DE7000, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRF, FRH, FRK, MTMalta, UK01.

⁹ CY001, DE9650, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FIWDA, FRF, MTMalta, SI_RBD_1, SI_RBD_2.

¹⁰ AT1000, AT2000, AT5000, CY001, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIWDA, FRF, FRG, FRH, MTMalta.

¹¹ BG3000, ES100, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRF, FRG, ITF.

¹² AT1000, AT2000, AT5000, CY001, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRF, FRG, HU1000, PL6000, UK01.

¹³ ES100, FRC, FRF, FRH.

Fig. 4. What are the effects of past and expected (water scarcity and) droughts?

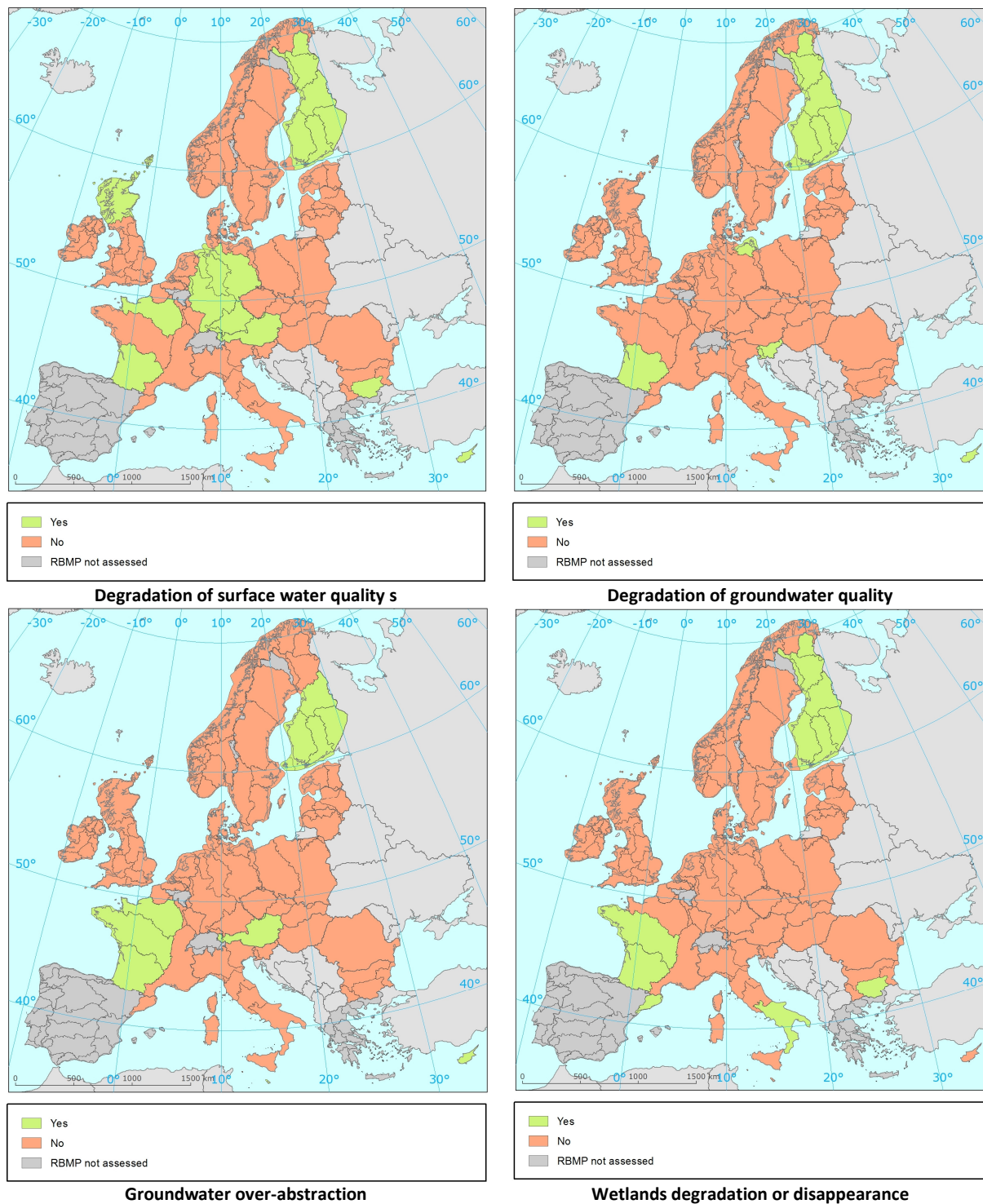
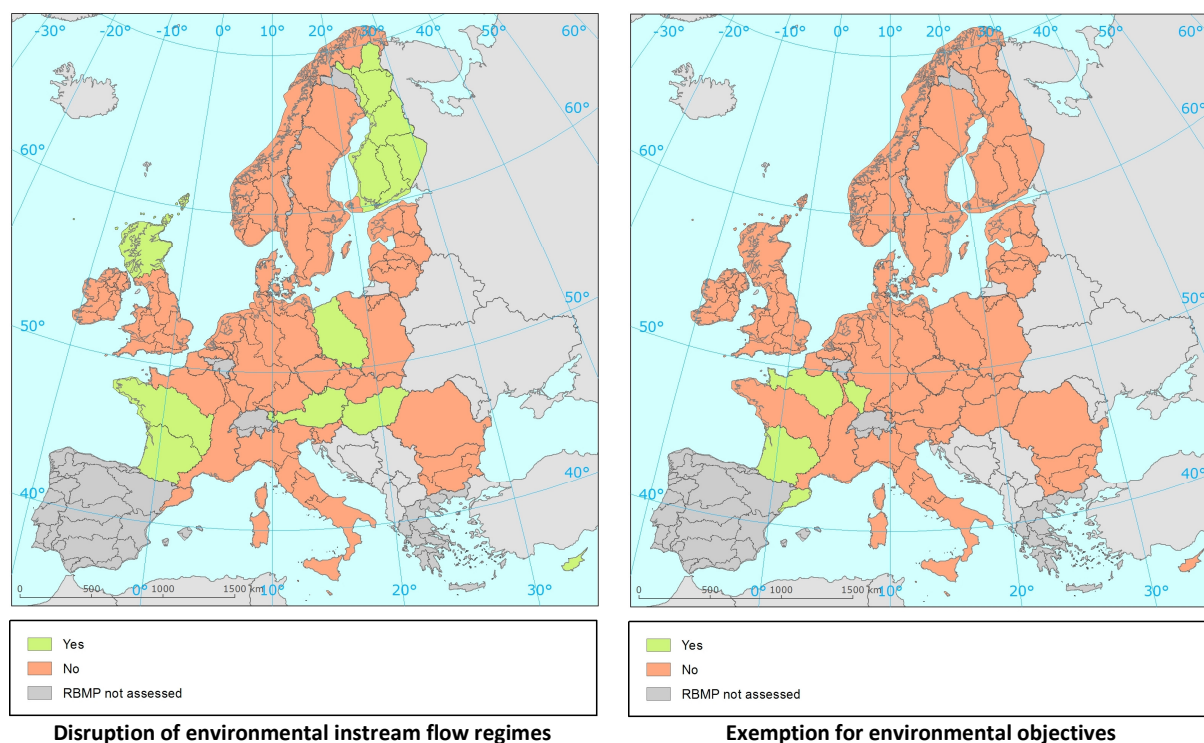


Fig. 4. What are the effects of past and expected (water scarcity and) droughts?



Source: RBMPs Assessment

WSD-Q5) Which measures have been included in the Programme of Measures?

	Which measures have been included in the Programme of Measures?
	Develop Drought Risk Management Plan
High	1
Medium	2
Low	5
Unable to asses	28
No information	71
Not relevant	11
Unclear	5

Only 1 out of 123 RBMP (1%)¹⁴ has been identified like of high Importance for basin management, 2 RBMP (2%)¹⁵ as of moderate importance and 5 RBMP (4%)¹⁶ as of low importance, while in 28 RBMPs (23%)¹⁷ it has been impossible to assess importance. Other 71 RBMP (58%)¹⁸ contains no reference to

¹⁴ BG3000.

¹⁵ ES100, FRL.

¹⁶ UK01, UK02, UKGBNIIENB, UKGBNIIENW, UKGBNINE.

¹⁷ BEMaas_VL, BESchelde_VL, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FIWDA, FRA, FRB2, FRD, FRE, HU1000, ITC, ITE, SE4, UK03, UK04, UK05, UK06, UK07, UK08, UK09, UK10, UK11, UK12.

DMP, while in 11 (9%)¹⁹ drought management is considered not relevant and in 9 RBMP (4%)²⁰ the information is unclear.

The information of the existence of DMPs has been re-evaluated in depth and complemented in the framework of this study. Results are presented in section 4.5.1.

Fig. 5. Which measures have been included in the Programme of Measures? (Develop Drought Risk Management Plan)



Source: RBMPs Assessment

4.2. Pending issues not included in previous assessment

The existence of DMPs has been established in a variety of countries. In the preliminary scope of the RBMP assessment and other sources, it has been identified a certain level of confusion about the proper concept of DMP. So the first issue is to check what kind of Drought Management document or

¹⁸ AT1000, AT2000, AT5000, BENoordzee_FED, BG1000, BG4000, CY001, CZ_1000, CZ_5000, CZ_6000, DE3000, DE6000, DE7000, DK1, DK2, DK4, EE3, FRB1, FRC, FRF, FRG, FRH, FRI, FRJ, FRK, GBNIENB, GBNIENW, IEEA, IEGBNISH, IESE, IESW, IEWE, ITA, ITB, ITD, ITF, ITG, LT1100, LT2300, LT3400, LT4500, LVDUBA, LVGUBA, LVLUBA, LVVUBA, MTMalta, NLEM, NLMS, NLRN, NLSC, NO1101, NO1102, NO1103, NO1104, NO1105, NO5101, NO5102, NO5103, NO5104, NO5105, NO5106, PL2000, PL6000, PL7000, PL8000, RO1000, SE2, SE3, SE5, SI_RBD_1, SI_RBD_2.

¹⁹ DE2000, DE4000, DE5000, DE9500, DE9610, DE9650, DK3, LU2000, SE1, SK30000, SK40000.

²⁰ BG2000, DE1000, EE1, EE2, ITH.

administrative tool are been referred to as DMP. The items to be included in a DMP according to WSDEN (2007) must be:

- Indicators and thresholds
- Prevention / Mitigation measures
- Organizational framework
- Section on 'prolonged drought'

Other significant issues for screening are:

- The **zoning**, relevant to assess expected effects that may be quite different, for instance, in a rain-fed agriculture region with low population than in an area hosting a big public supply system.
- The inclusion or not of specific **measures for recovery of freshwater ecosystems**.
- The description (if any) of the basin's management **experience on historical droughts** (learned lessons), relevant to evaluate cost and effectiveness of past episodes and the strategies adopted.
- The existence of a properly designed **monitoring scheme** of the DMP. If positive, some kind of assessment of their effectiveness may be feasible (Identification of Case Studies).

4.3. Contributions from other documents

Other documents generated in a variety of projects & works supply relevant data and analysis, complementing RBMP assessments and partially answering the pending questions. Jointly they provide a wider understanding of the actual and potential role of DMPs as a Water Policy tool. The most significant ones, particularly those that contribute with specific description of the situation at country or basin level, are summarized below:

Water Scarcity and Droughts Expert Network 2008. Drought Management Plan Report Including Agricultural, Drought Indicators and Climate Change Aspects. European Commission

This report, previously mentioned when defining DMP and their Policy Background, presents general guidelines to develop a Drought Management Plan, complying with WFD environmental objectives. The report summarizes the main items needed to develop a Drought Management Plan:

- Indicators and thresholds establishing onset, ending, and severity levels of the exceptional circumstances (prolonged drought).
- Measures to be taken in each drought phase in order to prevent deterioration of water status and to mitigate negative drought effects.
- Organizational framework to deal with drought and subsequent revision and updating of the existing drought management plan.

A DMP should also include a section dedicated to 'prolonged drought' as defined in article 4.6 of WFD, which includes the following requirements:

- Prevention and restoration steps and measures for water bodies
- Measures to be taken in case of prolonged drought
- Indicators for prolonged drought

- Annual Review of the effects of prolonged droughts

Annex 1 includes a proposal of a General Measures Programme, with a relation of possible measures and the proper status for application (from approval of the DMP, to normal, pre-alert, alert and/or emergency).

A review of existing DMPs in some MS is presented in Annex 2 for the following countries: **ES, UK** [England & Wales] & **PT**. Other experiences are cited for NL and BG (Flemish) regions.

Finally, in Annex 3 compiles examples on drought indicators systems from **UK, ES, PT, FR, FI** and **IT**.

This report clarifies the main items to be considered in a genuine DMP, helping to better assess completeness, importance and the significance of eventual DMPs included in RBMPs. It also provide study cases to characterize effectiveness of DMPs.

DG Environment 2007. Water Scarcity and Droughts 2nd Interim Report. European Commission

This second interim report follows a previously released first interim report on basis of Member State replies to an in-depth questionnaire and information provided by other DGs of the Commission.

After outlining the general situation and context in relation to water resources and water uses (distribution and trends of water abstraction for different sectors), the report analyses water scarcity issues and droughts events and the Implementation of existing measures to address both problems.

The exposure to droughts is characterized as follows:

- At least AT, BE, CY, FR, HU, IT, LT, MT, NL, NO, PT, ES and UK have been affected by droughts, in the last thirty years. IT, PT, CY, ES and FR have registered the highest frequency of droughts from 1976 to nowadays, with 8 to 21 events by country. Several Northern and Eastern countries have experienced droughts in the last years such as BE, UK, FI, DE, HU, LT, NL, NO and SI. The other Member States did not provide information
- Some countries (CY, FI, FR, IT, MT, PT, ES) have a large part of their territory being touched whenever droughts occur, while some other countries may be frequently affected within a specific part of their territory (BE : area under influence of Meuse canal system, AT: Eastern, Southern and South Eastern regions).
- In CY, IT, PT, ES, droughts may last one or more successive years. In other countries, droughts have been predominant during one month (HU, DE, LT) or from two to six months (AT, BE, FR). FI was affected by a 270 day drought from August 2002 to April 2003.

Information from Member States provides a first estimation of economic costs incurred due to specific drought events. According with these data the overall economic impacts of drought events in the past thirty years to a total of 100 billion € at EU level. Results show that the annual average impact has doubled between the 1976-1990 period and the next 1991-2006 period. It reached an average of 6.2 billion €/year in the most recent years, with an exceptional cost of 8.7 billion € in 2003.

Social and environmental costs have not been estimated due to an absence of data, though some specific impacts have been identified:

Social impacts

- Quality problems in waterworks and private wells (FI)
- Restrictions to consumers and households (most countries)
- Decrease in employment (ES, UK)

Environmental impacts

- Surface waters: sharp decrease in river flows and associated eutrophication (PT, ES, FI)
- Groundwater: significant decreases in aquifer levels that may be accompanied by further risk of sea intrusion (PT, BE, FI, UK)
- Coastal waters: upstream migration of saline concentration (PT, BE) frequently linked to exacerbation of groundwater abstractions.
- Wetlands: desiccation (BE, UK)
- Soils: water erosion, loss of soil fertility (organic matter decline) and lower water-retention capacity (soil degradation is an issue all over the EU). Driven or exacerbated by human activity such as inadequate agricultural and forestry practices, industrial activities, tourism, urban and industrial sprawl and construction works; also climate change, fires.
- Biodiversity: desiccation of wetlands (NL, BE), disappearance of species (BE), occurrence of fires (PT, ES, FR, FI), fish mortality (PT, FR, UK), alga development and increased eutrophication (FR)
- Other environmental impacts: air pollution associated to the lack of hydroelectricity production (ES)

Kossida et al. 2009. Water Scarcity and Drought: Towards a European WS&D Network. European Topic Centre on Water (European Environment Agency)

The scope of this report is to:

- a) Perform a Gap Analysis at National and European level towards the development of a coherent water scarcity, drought and desertification information system for Europe desertification.
- b) Propose a structure for a European Water Scarcity and Drought Network (WSDN)
- c) Propose a DPSIR framework for drought and water scarcity to be populated with indicators (Water Scarcity and Drought indicators' System WSDiS).

A complete overview of WS&D management at National Level is carried out, and abstracts are presented on the following terms of references:

1. Problem identification of WS&D
2. National objectives and priorities in relation to WS&D awareness and management [Secure public water supply, Secure Other Water Uses (agriculture, industry, hydroelectric power, fisheries), Secure Vital flow – Ecological Status, Social Activities Status]
3. Presentation of the country's main bodies and structures responsible for WS&D management [Ministries, organizations, authorities, etc]
4. Current status for WS&D management

This paper proposes the assessment of the GAP analysis of European Countries by 4 geographical zones²¹, mostly based in the 2nd interim report:

Mediterranean – Southern Europe Countries: CY, GR, FR, IT, MT, PT & ES

According to the Water Exploitation Index (WEI)²² all these countries are impacted by water scarcity. In terms of drought, IT, PT, CY, ES and FR have registered the highest frequency of droughts. These episodes may last one or several years (CY, IT, PT, ES). Furthermore, in most of these countries, a large part of their territory is affected. Most of the countries are also focused in observing and monitoring WS&D and mitigating their impacts, with a proactive planning in the form of DMPs and setting objectives of ensuring public water supply and other uses.

Central European countries – West: AT, BE, DE, LU, NL & UK

BE, DE and UK have specified river basins affected from water scarcity. In addition, in terms of drought events, AT, BE, DE, NL and UK have reported to experience severe droughts, particularly in recent years. Only a specific part of AT and BE are affected from relatively prolonged drought events (two to six months) while in DE the length of drought events is typically one month. Only DE, UK and NL have elaborated DMPs, but most of the countries do have a monitoring programme that includes water quantity issues and have set objectives of ensuring public water supply and other uses.

Central European countries – East: BG, CZ, EE, HU, LV, LT, PL, RO, SK & SI

HU, even though not classified as water stressed country, has identified river basins affected from WS&D. In terms of drought, HU and LT have been affected by severe drought events in the last thirty years that lasted one month. BG and RO are severely affected from water scarcity based on WEI but only BG has set clear objectives and implements measures for proactive management of WS&D. PL implements DMPs, monitoring programmes and mitigation measures.

North European countries: DK, FI, IE & SE

DK has reported specified river basins that were affected from WS. In terms of drought events NO has been affected by severe droughts in the last thirty years, and a large part of Finland is affected whenever droughts occur. Furthermore, Finland was affected by a 270 day drought from August 2002 to April 2003.

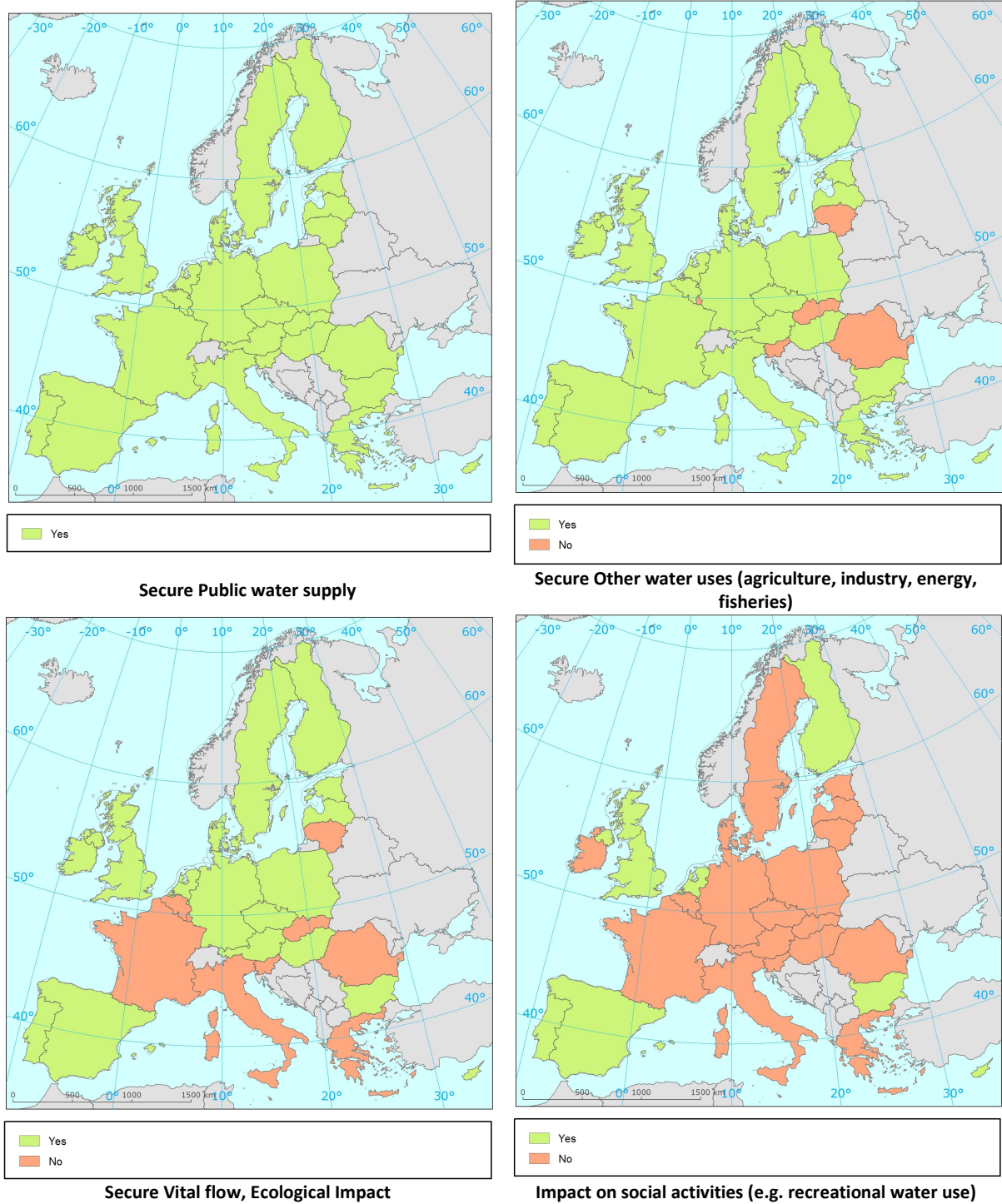
This Report also includes useful national overviews and current status for WS&D management, including the existence (or not) of DMPs. Summarizing, according to this paper 16 countries counted with some kind of DMP: **BG, CY, DE, DK, ES, FI, FR, HU, IE, IT, MT, NL, PL, PT, SE & UK.**

²¹ This zoning may be of interest for DPSIR storyline.

²² The Water Exploitation Index (WEI) in a country is the mean annual total demand for freshwater divided by the long-term average freshwater resources. Its calculation is based on national data provided by Member States to EUROSTAT. For the purpose of the assessment, river basins will be considered water scarce whenever their WEI is above 10% or expert judgements identify them as such. The Index is a national value and does not reflect at all possible high regional pressures on water resources.

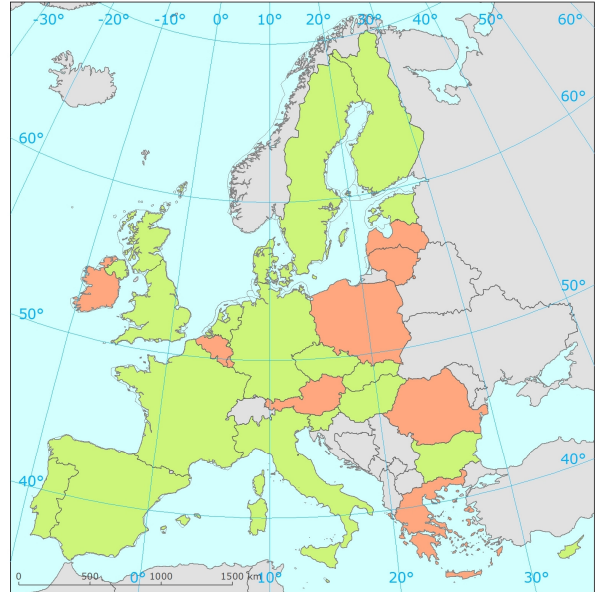
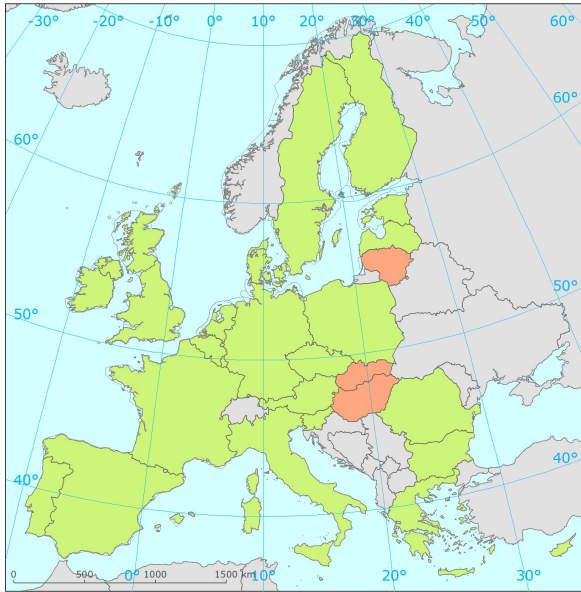
The following graphics summarize the assessment in relation to Objectives and Current Status.

Fig. 6. Assessment of countries on water scarcity and droughts. Country objectives [Kossida et al 2010]

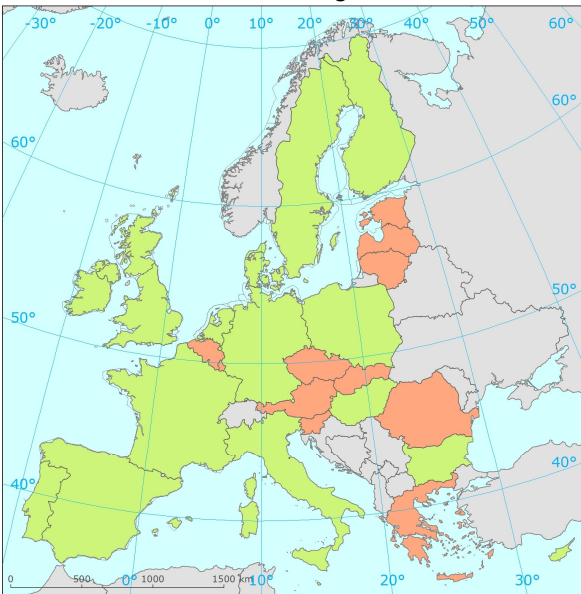


Source: Kossida et al 2010

Fig. 7. Assessment of countries on water scarcity and droughts. Current Status [Kossida et al 2010]

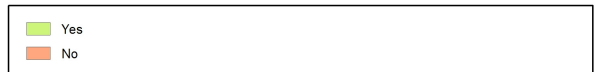
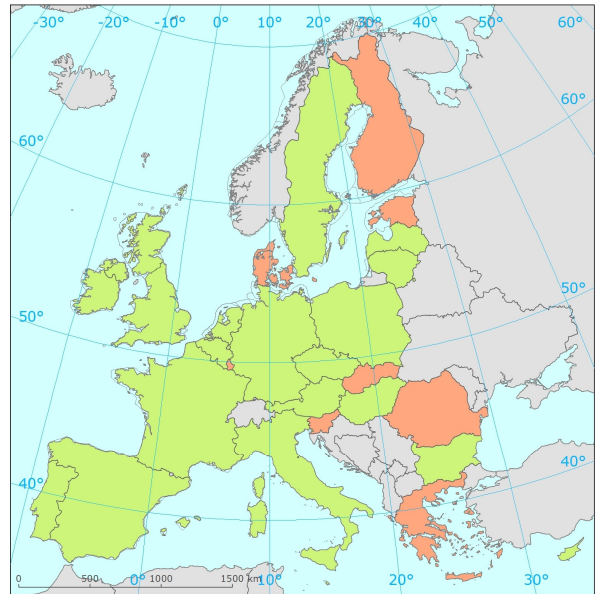


Monitoring



Drought Management Plans

Indices



Mitigation measures, Policy

Source: Kossida et al 2010

European Commission 2011. Third Follow up Report to the Communication on water scarcity and droughts in the European Union COM (2007) 414 final. Report from the Commission to the European Parliament and the Council

The Commission Staff Working Paper (Accompanying document to Report) explains the situation with respect to specific drought management plans:

(...) several Member States reported not to have separate plans. These are in most cases considered as part of RBMPs or regional plans (AT, BE, HU, NL, RO, SK), emergency management (LU) or specific early warning systems (PT). Three Member States reported that their drafting process for these plans is ongoing (MT, CZ, CY), and in others the need for such a plan is under discussion (EE), or they have regional plans (IT) or do not have such a plan at all (IE, SE, BG). FR, ES and UK are the only Member States who reported that separate drought management plans are already in place.

Regarding protection of aquatic ecosystems:

(...) restrictions on water use were reported as having been applied to preserve aquatic life and the ecological status of water bodies (AT, CY, CZ, ES, FR, HU, IT, NL, PT, RO, SK, SE, UK). In CY an index of pressures on river ecosystems is calculated in order to monitor the effects of droughts on the environment. Only few Member States reported that the minimum water flow and groundwater level conservation have not been taken into account yet (EE, IE, LU, MT) or are planned but not implemented yet (BE, BG).

A detailed questionnaire on the implementation of the 2007 Communication on Water Scarcity and Droughts was circulated to Water Directors including two batteries of questions about: 1. General information for water scarcity and droughts; 2. Indicative list of measures (included in the communication on water scarcity and droughts) to be implemented on Nation Level.

Xerochore Project 2011. Extended Guidance Document after Conference on Drought Management and Policy Options (D. 5.2.). Work Package 5. 7th Framework programme. Theme 6: Environment (Including Climate Change)

XEROCHORE is a Support Action founded by European Commission under the FP7 - Theme 6, Environment (Including Climate Change). It is aimed at assisting in the development of a European Drought Policy in accordance with the EU-Water Framework Directive (EU-WFD). One of the objectives of the Work Package 5 is to review the state of art and knowledge gaps in drought management and links to IWRM.

In Chapter 2, current policies and strategies for drought management at national level are described for **GR, IT, ES, UK** (England & Wales), **FR, CY & NL** as well as for some non-European countries.

Another policy framework, particularly relevant to semi-arid countries, is set through the National Action Programmes for Combating Desertification²³. EC Member States that have submitted their corresponding National Action Programme, also addressing aspects of drought planning, include **GR** (2001), **RO** (2000), **IT** (2000), **PT** (1999), and **ES** (2008).

²³ Under the relevant United Nations Convention (UNCCD). Among expected results, the corresponding Regional Action Plan lists the identification of “areas that need the development of pro-active drought contingency planning”.

In Chapter 3, some case examples of drought management at regional level are given: city of Athens (GR), Garonne Basin(FR), River Po Basin (IT) and the Meuse River (BE&NL) and Rhine., periods of low discharge in the Meuse River).

A questionnaire survey was undertaken within the Xerochore Project framework among the Xerochore network and project partners. In total, 22 questionnaires were collected and processed, mainly representing institutions from EU countries, namely IT, HU, SI, NO, UK, FR, GR, DE, BG, SP, SK, NL & BE and three external countries: Turkey, Morocco and China. The answers in relation to national drought policies are summarized in the following table.

Active policy components	Is there a national drought policy?			Countries with drought policy
	Yes	No	Not aware	
Establishment of committees for the analysis and evaluation of drought related data	5	2	1	IT, UK, ES, FR, NL
Definition of a drought declaration process	5	1	1	IT, ES, FR, NL
Definition of relief programs (process for implementing compensation measures)	6			BG, IT, ES, FR,NL, UK
Setting the drought planning framework (responsibilities for developing and implementing drought management plans)	5			UK, ES, FR, NL
Integration with other (national) policies	4			ES, FR, NL, UK
Research & Development on relevant issues	6	2	1	IT, UK, ES, FR

Acteon 2012. Inception Report of Water Scarcity & Droughts Policy in the EU - Gap Analysis. Tender ENV.D.1/SER/2010/0049

The overall objective of this study is to identify new policy measures that would be required to address WS&D in the EU, feeding into the Blueprint to Safeguard Europe's Water To address this overall objective, the study will:

1. Provide a sound overview of the magnitude of the WS&D problem in Europe, today and by 2030, taking into account for global changes such as socio-economic developments and climate change;
2. Assess of the adequacy of existing measures (at national, river basin district or local levels) to prevent, manage or mitigate WS&D situations in individual Member States;
3. Identify remaining gaps (WS&D problems that remain unsolved after implementing all existing measures) and suggest possible new measures or mix of measures to fully address WS&D in the EU;
4. Assess the environmental, economic and social impacts of these new measures, along with their feasibility.

The Report include a DPSIR framework is used for reviewing the causes of WS&D and for assessing the “adequacy” of existing measures to prevent, manage or mitigate these situations in MS.

Regarding the Development of DMPs (considered as a Support Action) it is stated that a good progress has been achieved with respect to the number of countries in which they have been put in place or is under development. Though it is difficult to assess the economic and environmental impacts of DMPs, as promoted by the 2007 Communication, it is assumed they contribute to reducing the economic losses and environmental hardship caused by droughts.

In the framework of this work, a matrix of WS&D Measures and Support Actions has been developed in a country basis. A variety of features of these actions / measures have been classified or described: type, objective, character, DP(S)IR, river basins, date range of implementation, sector(s) affected, costs, time to implement, impacts, assessment tools...).

DMPs have been identified in **BE, CY, ES, FR, GR, LU, PL & UK** (England & Wales).

The initial analysis of the adequacy of proposed measures in relation to existing DPS is complemented by a subsequent quantitative assessment using the WaterGap model. For assessing whether responses put in place are sufficient to tackle WS&D, a separate modelling exercise has been performed for a sample of six countries, namely CY, FR, DE, IT, MT, ES & UK. Though a variety of measures have been taken into account in each country, DMPs are not explicitly considered.

4.4. Summary of previous assessments

Regarding the global **relevance of droughts** in RBMPs, it is considered a RBD-wide event in only 10 out of 123 RBMPs assessed (8%)²⁴ and a sub-basin problem in 27 RBMPs (22%)²⁵. For 14 RBMPs (11%)²⁶ drought and water scarcity are referred to as not clearly distinguished phenomena. By contrast, half of the evaluators— 56 (51%)²⁷— consider drought to be a relevant issue in the RBD assessed.

The **effects of past and expected water scarcity and droughts** in environmental elements (so the impacts DMP should address) are indirectly identified at RBD level. Degradation of surface water quality has been identified in 23 RBMPs (19%)²⁸; Degradation of groundwater quality in 14 RBMPs²⁹ (11%); Groundwater over-abstraction in 13 RBMPs³⁰(11%); Wetlands degradation or disappearance in 12

²⁴ CZ_1000, CZ_5000, CZ_6000, FRF, ITA, ITH, LT1100, LT2300, LT3400, LT4500.

²⁵ CZ_1000, CZ_5000, DE1000, ES100, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRB2, FRD, FRL, ITB, ITF, ITG, PL2000, PL6000, PL7000, PL8000, SE2, SE3, SI_RBD_1, SI_RBD_2, UK01, UK05.

²⁶ AT1000, AT2000, AT5000, BG3000, BG4000, CY001, FRE, FRG, FRH, HU1000, ITC, ITE, ITG, RO1000.

²⁷ AT1000, AT2000, AT5000, BG1000, BG2000, BG3000, BG4000, CY001, CZ_1000, CZ_5000, CZ_6000, DE1000, ES100, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIWDA, FRD, FRE, FRF, FRG, FRK, FRL, GBNIENB, GBNIENW, HU1000, IEEA, IEGBNISH, IESE, IEWE, ITA, ITB, ITC, ITD, ITE, ITF, ITG, ITH, LT2300, LT3400, LT4500, PL2000, PL6000, RO1000, SE4, SI_RBD_1, SI_RBD_2, UK01, UK04, UK05, UK06, UK07, UK08, UK09.

²⁸ AT1000, AT2000, AT5000, BG3000, CY001, DE1000, DE2000, DE3000, DE4000, DE5000, DE7000, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRF, FRH, FRK, MTMalta, UK01.

²⁹ CY001, DE9650, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FIWDA, FRF, MTMalta, SI_RBD_1, SI_RBD_2.

³⁰ AT1000, AT2000, AT5000, CY001, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIWDA, FRF, FRG, FRH, MTMalta.

RBMPs³¹ (10%); Disruption of environmental flow regimes in 16 RBMPs³² (13%); and eventually the Exemption for environmental objectives in 4 RBMPs³³ (3%).

At RBD level; the **existence of DMP** have been assessed: 1 RBMP (1%)³⁴ have been identified like of high Importance for basin management, 2 RBMP (2%)³⁵ as of moderate importance and 5 RBMP (4%)³⁶ as of low importance, while in 28 RBMPs (23%)³⁷ it has been impossible to asses importance. Other 71 RBMP (58%)³⁸ contains no reference to DMP, while in 11 (9%)³⁹ drought management is considered not relevant and in 9 RBMP (4%)⁴⁰ the information is unclear. As previously commented in section 4.5.1, this data yield some inconsistencies with the information available at national level, differences that are clearly reflected in Table. 2. Only CY, ES, FR, NL & UK (England & Wales) have genuine DMPs or equivalent tools in force, while other countries are in the drafting stage (CZ, GR, MT & Scotland) or are equipped with less ambitious monitoring tools. Finally, some countries have not developed specific protocols to deal with drought situations, mainly because this problem is not relevant in their territories.

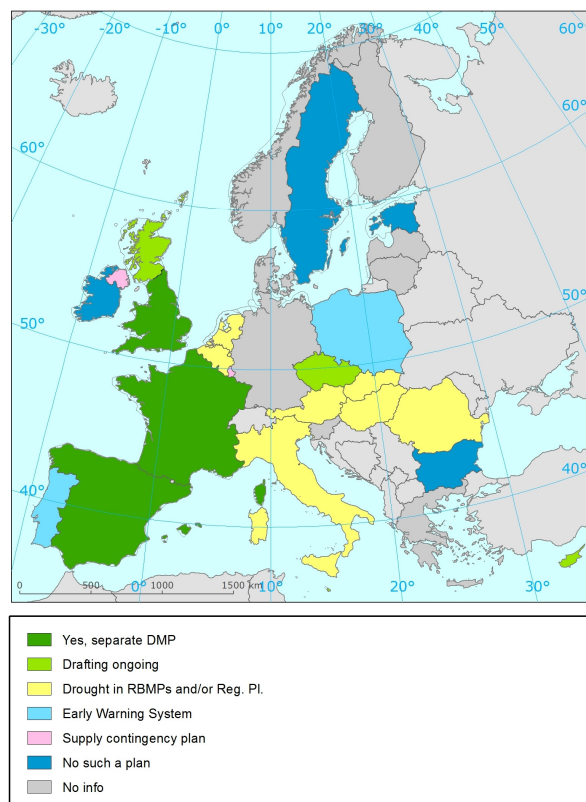
4.5. Completion of information gaps

4.5.1. The existence of proper DMPs

By crossing the information collected, it is evident than a clarification is needed since documents differs in establishing the existence or not of DMP for the same country. This may be appreciated in the following figure and table.

-
- ³¹ BG3000, ES100, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRF, FRG, ITF.
- ³² AT1000, AT2000, AT5000, CY001, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FRF, FRG, HU1000, PL6000, UK01.
- ³³ ES100, FRC, FRF, FRH.
- ³⁴ BG3000.
- ³⁵ GBNIENB, UK01.
- ³⁶ UK01, UK02, UKGBNIENB, UKGBNIENW, UKGBNINE.
- ³⁷ BEMaas_VL, BESchelde_VL, FIVHA1, FIVHA2, FIVHA3, FIVHA4, FIVHA5, FIVHA6, FIVHA7, FIWDA, FRA, FRB2, FRD, FRE, HU1000, ITC, ITE, SE4, UK03, UK04, UK05, UK06, UK07, UK08, UK09, UK10, UK11, UK12.
- ³⁸ AT1000, AT2000, AT5000, BENOordzee_FED, BG1000, BG4000, CY001, CZ_1000, CZ_5000, CZ_6000, DE3000, DE6000, DE7000, DK1, DK2, DK4, EE3, FRB1, FRC, FRF, FRG, FRH, FRI, FRJ, FRK, GBNIENB, GBNIENW, IEEA, IEGBNISH, IESE, IESW, IEWE, ITA, ITB, ITD, ITF, ITG, LT1100, LT2300, LT3400, LT4500, LVDUBA, LVGUBA, LVLUBA, LVVUBA, MTMalta, NLEM, NLMS, NLRN, NLSC, NO1101, NO1102, NO1103, NO1104, NO1105, NO5101, NO5102, NO5103, NO5104, NO5105, NO5106, PL2000, PL6000, PL7000, PL8000, RO1000, SE2, SE3, SE5, SI_RBD_1, SI_RBD_2.
- ³⁹ DE2000, DE4000, DE5000, DE9500, DE9610, DE9650, DK3, LU2000, SE1, SK30000, SK40000.
- ⁴⁰ BG2000, DE1000, EE1, EE2, ITH.

Fig. 8. Situation at country level according to the 3rd Follow-up Report



Source: European Commission 2011

Table 2. Existence of Drought Management Plans according to different sources

Countries	RBMP Assessment	Kossida et al 2009	Gap Analysis, 2012	3d follow-up Report, 2010	
				Color	Description
AT Austria	NI			Yellow	Drought dealt with in RBMPs or regional plans
BE Belgium	Yes (NA)		Yes	Yellow	Drought dealt with in RBMPs or regional plans
BG Bulgaria	Yes (H)/NI	Yes		Dark Blue	No such a plan
CY Cyprus	--	Yes	Yes	Light Green	Drafting ongoing
CZ Czech Republic	NI			Light Green	Drafting ongoing
DE Germany	NI/NR/U	Yes		Grey	No answer of the questionnaire
DK Denmark	--	Yes		Grey	No answer of the questionnaire
EE Estonia	NI/U			Dark Blue	Need under discussion
ES Spain	Yes (M)	Yes	Yes	Dark Green	Separate DMP
FI Finland	Yes (NA)	Yes		Grey	No answer of the questionnaire
FR France	Yes (M,NA)/NI	Yes	Yes	Dark Green	Separate DMP
GR Greece	--		Yes	Grey	No answer of the questionnaire
HU Hungary	Yes (NA)	Yes		Yellow	Drought dealt with in RBMPs or regional plans
IE Ireland	NI	Yes		Dark Blue	No such a plan
IT Italy	NI	Yes		Yellow	Regional plans
LT Lithuania	NI			Grey	No answer of the questionnaire

Table 2. Existence of Drought Management Plans according to different sources

Countries	RBMP Assessment	Kossida et al 2009	Gap Analysis, 2012	3d follow-up Report, 2010
LU Luxembourg	--		Yes	Emergency management
LV Latvia	NI			No answer of the questionnaire
MT Malta	--	Yes		Drafting ongoing
NL The Netherlands	NI	Yes		Drought dealt with in RBMPs or regional plans
PL Poland	NI	Yes	Yes	Early Warning System (previous Reports)
PT Portugal	--	Yes		Specific early warning systems
RO Romania	NI			Drought dealt with in RBMPs or regional plans
SE Sweden	Yes (NA)/NI	Yes		No such a plan
SI Slovenia	NI			No answer of the questionnaire
SK Slovakia	NR			Drought dealt with in RBMPs or regional plans
UK Scotland	Yes (L)			Drafting ongoing
UK England & Wales	Yes (L,NA)	Yes	Yes	Separate DMP
UK North Ireland	Yes (L)			Water supply drought contingency plan

Source: own from the referred documental sources

So the first issue is to check what kind of Drought Management document or administrative tool have been referred to as DMP. The items to be included in a DMP according to WS DEN 2007 must be:

- Indicators and thresholds
- Prevention / Mitigation measures
- Organizational framework
- Section on 'prolonged drought' as defined in article 4.6 of WFD

The distinction between a genuine DMP and other kind of tools is not always easy since:

- Monitoring and indicators are operative in most cases. Determinate values of these indicators (thresholds) should be associated with problem identification / alert.
- All kind of prevention and mitigation measures may (should) take part in DMPs.
- There is always some kind of organizational framework, identified with country's main bodies and structures responsible for WS&D management.

The distinctive feature of a DMP has very much to do with the appropriate linking between all the available technical and institutional tools to build a consistent approach to prevent / manage drought episodes. Adequately monitored indicators and thresholds should establish onset, ending, and severity levels of the exceptional circumstances. These thresholds should trigger concrete measures in each drought phase in order to prevent deterioration of water status and to mitigate negative effects. Finally, the organizational structure should clearly state action protocols and responsibilities for each of the measures involved as well as dealing with monitoring and subsequent revision and updating of the DMP.

After a comparative analysis and further review of documents, the most reliable source has is the 3rd Follow-up Report and related questionnaires, containing the last formal and systematic evaluation of the

existence of DMPs at country level. Nevertheless, information from previous reports and further communications and assessment has been carried out both at national and RBD level to update this information. In some cases, though no formal DMP has been put into force, a similar set of tools is operative so that expected benefits in terms of drought impact mitigation are equivalent. For these cases, the category has been widened to include equivalent tool.

The current situation has been reflected in the in Fig. 2 and summarized in the following table, where some corrections have been made, according to updated information and above mentioned criteria.

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information
AT1000	No	Based on RBMPAs and 3rd Follow-up Report. Droughts are occurring only occasionally, limited in time and extent (not a key water management issue)
AT2000	No	
AT5000	No	
BEEscaut_RW	Unclear	Based on RBMPAs and 3rd Follow-up Report. Severe rainfall deficits may affect surface rivers. Where depending on groundwater, local supply could be affected. A specific DMP as such has not been set up, but actions and measures are included in RBMPs (Flanders)
BEEscaut_Schelde_BR	Unclear	
BEMaas_VL	Yes	
BEMeuse_RW	Unclear	
BENoordzee_FED	No	
BERhin_RW	Unclear	
BESchelde_VL	Yes	
BESeine_RW	Unclear	
BG1000	No	Based on RBMPAs and 3rd Follow-up Report. According to the latter there are no DMPs in BG, which is contradictory with RBMPA for BG3000 (East Aegean RBD) ⁴¹ .
BG2000	No	
BG3000	Unclear	
BG4000	No	
CY001	Yes	Included as Annex VIII of the RBMP (see section 6.1).
CZ_1000	Yes	Based on 3rd Follow-up Report. RBMPA indicates that there is no such plans, but national questionnaire clarifies that DMPs are in progress at river basin level.
CZ_5000	Yes	
CZ_6000	Yes	
DE1000	No	Based on RBMPA. Moreover, in 2nd Follow-up Report (2009), DE was considering droughts as a matter to be addressed in the context of the ongoing RBMPs.
DE2000	No	
DE3000	No	
DE4000	No	
DE5000	No	
DE6000	No	
DE7000	No	
DE9500	No	
DE9610	No	
DE9650	No	

⁴¹ Other sources suggest the existence of DMP(s) (e.g. Ecorys 2012) but scope and geographical definition level has not been clarified.

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information
DK1	No	Based on RBMPA. No information about Danish tools in F-U reports.
DK2	No	
DK3	No	
DK4	No	
EE1	No	Based on RBMPAs and 3rd Follow-up Report. No serious problems foreseen. Nevertheless, discussion on the need for DMPs is in progress.
EE2	No	
EE3	No	
GR01	Yes	Greek DMPs are currently in elaboration in the framework of RBMP. ⁴²
GR02	Yes	
GR03	Yes	
GR04	Yes	
GR05	Yes	
GR06	Yes	
GR07	Yes	
GR08	Yes	
GR09	Yes	
GR10	Yes	
GR11	Yes	
GR12	Yes	
GR13	Yes	
GR14	Yes	
ES010	Yes	Based on RBMPA (ES010), 3rd Follow-up Report and own assessment. There is legal requirement to approve and implement these plans. Current status is diverse from fully implemented to drafting or inclusion in the PoM (see section 6.2).
ES014	Yes	
ES015	Yes	
ES016	Yes	
ES020	Yes	
ES030	Yes	
ES040	Yes	
ES050	Yes	
ES060	Yes	
ES063	Yes	
ES064	Yes	
ES070	Yes	
ES080	Yes	
ES091	Yes	
ES100	Yes	
ES110	Yes	

⁴² Personal communication from ETC-W representative (WS&D Expert Group).

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information	
FIVHA1	No	Based on RBMPAs.	
FIVHA2	No		
FIVHA3	No		
FIVHA4	No		
FIVHA5	No		
FIVHA6	No		
FIVHA7	No		
FIWDA	No		
FRA	Yes	Based on RBMPAs and 3rd Follow-up Report. Though the existence of DMPs is well documented in the case of continental France, it is not clear for overseas territories, not included in the website Propluvia (see section 6.3)	
FRB1	Yes		
FRB2	Yes		
FRC	Yes		
FRD	Yes		
FRE	Yes		
FRF	Yes		
FRG	Yes		
FRH	Yes		
FRI	Unclear		
FRJ	Unclear		
FRK	Unclear		
FRL	Yes		
FRM	Unclear		
HU1000	Unclear		RBMPA (DMP exists) and 3rd Follow-up Report are contradictory ⁴³ . Based on RBMPAs and 3rd Follow-up Report. Specific DMP not required. Though no RBDs consider WS and D significant problems, abstraction pressures are very high in some basins, particularly IEEA (Eastern).
GBNIIENB	No		
GBNIIENW	No		
IEEA	No		
IEGBNISH	No		
IESE	No		
IESW	No		
IEWE	No		
ITA	Yes	Based on RBMPAs, 3rd Follow-up Report and further communication with Italian representatives. Existence may not apply for the whole RBD (see section 6.4).	
ITB	Yes		
ITC	Yes		
ITD	Yes		
ITE	Yes		
ITF	No		
ITG	Yes		
ITH	No		

⁴³ The answer states that there is no specific DMP, though some regional plans exist.

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information
LT1100	No	Based on RBMPAs.
LT2300	No	
LT3400	No	
LT4500	No	
LU2000	No	Based on RBMPAs and 3rd Follow-up Report. Emergency management in case of supply shortfall due to infrastructural limits.
LU7000	No	
LVDUBA	No	Based on RBMPAs.
LVGUBA	No	
LVLUBA	No	
LVVUBA	No	
MTMALTA	Yes	Based on RBMPAs and 3rd Follow-up Report: drafting ongoing.
NLEM	Yes	
NLMS	Yes	Based on own assessment, correcting RBMPAs. Though not proper DMPs are available, the Dutch operational water management during droughts (see section 6.4) has been considered an equivalent tool, since it includes the consideration of its main items.
NLRN	Yes	
NLSC	Yes	
NO1101	No	
NO1102	No	
NO1103	No	
NO1104	No	
NO1105	No	
NO5101	No	
NO5102	No	
NO5103	No	
NO5104	No	
NO5105	No	
NO5106	No	
NOFIVHA5	Unclear	
NOFIVHA6	Unclear	
NOSE1	Unclear	
NOSE1TO	Unclear	
NOSE2	Unclear	
NOSE5	Unclear	
PL1000	No	Based on personal communication from Polish Water Authority representative. In the 2nd Follow-up Report, PL reported having started monitoring droughts (by 2009) as part of the activities proposed for developing an observatory and an early warning system on droughts. The Polish Act on Water Law obliges National Water Management Authority and 7 Regional Water Management Authorities to develop Plans of Mitigation of Droughts Effects. Currently, 2 out of 7 RBD Authorities have taken actions to develop
PL2000	No	
PL3000	No	
PL4000	No	
PL5000	No	
PL6000	No	
PL6700	No	

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information
PL7000	No	drafts of such plans. ⁴⁴
PL8000	No	
PL9000	No	
PTRH1	Yes	Based on own assessment based and 3rd Follow-up Report. Concerning drought management, it was considered necessary to move from a crisis-management approach to prevention and preparedness. Thus, an early warning system is currently been developing aiming at identifying the main measures to be adopted (under normal, alert and in crisis phases) and the entities responsible for their adoption. So, planned system will include: indicators, thresholds, plan of action and organizational scheme. It is not clear if insular RBDs are included in the specific early warning system that should evolve to DMP-equivalent tool. Nevertheless, in the case of Azores, PoM includes the ELABORATION OF A DROUGHT AND SCARCITY MANAGEMENT PLAN (see section 6.6)
PTRH10	Unclear	
PTRH2	Yes	
PTRH3	Yes	
PTRH4	Yes	
PTRH5	Yes	
PTRH6	Yes	
PTRH7	Yes	
PTRH8	Yes	
PTRH9	Yes	
RO1000	No	Based on RBMPAs and 3rd Follow-up Report ⁴⁵ .
SE1	No	Based on RBMPAs and 3rd Follow-up Report. In the case of SE4 [South Baltic Sea (Sweden)], RBMPA is positive but this is not consistent with the other sources.
SE1TO	No	
SE2	No	
SE3	No	
SE4	Unclear	
SE5	No	
SENO1102	No	
SENO1103	No	
SENO1104	No	
SENO5101	No	
SI_RBD_1	No	Based on RBMPAs. No reference to the existence of DMPs.
SI_RBD_2	No	
SK30000	No	Based on RBMPAs and confirmed by 3rd Follow-up Report though some water management planning for droughts is available. ⁴⁶
SK40000	No	

⁴⁴ There are many different types of documents at national and regional level, identifying the need of dealing with droughts and proposing mitigation measures. However, there is no comprehensive document, which is perceived as DMP under Water Framework Directive (personal communication from PL representative).

⁴⁵ There is no proper DMP, though this topic is included as part of other planning documents.

⁴⁶ Since 1975 there is routine evaluation of water management balance in a relatively dense network of balance profiles in Slovak Republic, so that the balance of the last year serves as the control of the real water state. These perspective balances promote the identification of possible “over-abstraction” from rivers, leading to the adoption of measures depending on possible range and duration of river “over-abstraction”; i.e. from short-term regulation of water supply to the users, through non-investment measures (sources cooperation, operating guides), up to investment measures as construction and connection of the new sources (water construction) into water system. In principle, we can consider these measures as the Management plans for water scarcity & drought periods (personal communication from SI representative).

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information	
UK01	Yes	Based on RBMPAs and 3rd Follow-up Report. The Environment Agency (England & Wales) and water companies have drought plans in place (see section 6.6). Scottish Water continues to develop DMPs as part of a phased, prioritised implementation programme; these are being developed by Scottish Environment Protection Agency (SEPA) to underpin WFD and river basin management planning process ⁴⁷ . Finally, NI Water has a water supply drought contingency plan in place and this will be developed further following completion of its ongoing water resource management plan ⁴⁸ .	
UK02	Yes		
UK03	Yes		
UK04	Yes		
UK05	Yes		
UK06	Yes		
UK07	Yes		
UK08	Yes		
UK09	Yes		
UK10	Yes		
UK11	Yes		
UK12	Yes		
UKGBNIIENB	No	Drought dealt with in RBMPs or regional plans [not considered a key water management issue]	
UKGBNIIENW	No		
UKGBNINE	No		
Austria	No		
Belgium	No		Drought dealt with in RBMPs or regional plans. A specific DMP as such has not been set up, but actions and measures are included in RBMPs (Flanders)
Bulgaria	No		No such a plan, according to the 3rd Follow-up Report. Other sources suggest the existence of drought management planning tools.
Cyprus	Yes		Included as Annex VIII of the RBMP (section 6.1.1).
Czech Republic	Yes		Drafting ongoing. 3rd Follow-up Report clarifies that DMPs are in progress at river basin level.
Germany	No		In the 2nd Follow-up Report (2009), Germany was considering droughts as a matter to be addressed in the context of the ongoing RBMPs.
Denmark	No		No information supporting the existence of DMP(s) in Denmark.

⁴⁷ In RBMP it is stated that *SEPA will develop a national drought plan for managing abstractions during periods of extreme low rainfall. The plan will describe the actions required of those abstracting water from the water environment, such as farmers wishing to irrigate their land. The actions will be designed to ensure the protection of the water environment whilst minimising the impact of the drought conditions on economically important activities. SEPA will work with business and industry representatives in developing the plan.*

⁴⁸ In the PoM, specifically in the section regarding Abstraction and Flow Regulation pressures, a so called Drought management plan is mentioned in the framework of the Northern Ireland Water Resource Strategy 2002 – 2030. The aim is to *provide for additional demand whilst minimising environmental harm*. In any case, the scope and further developments are not clearly stated.

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information
Estonia	No	Though no serious problems are foreseen, discussion on the need for DMPs is in progress.
Spain	Yes	Separate DMPs following legal requirement to approve and implement these plans. Current status is diverse from fully implemented to drafting or inclusion in the PoM (section 6.1.2).
Finland	No	No information supporting the existence of DMP(s) in Finland.
France	Yes	Separate DMPs, well documented in the case of continental France and Corsica, but not clear for overseas territories (section 6.1.3)
Greece	Yes	Greek DMPs are currently in elaboration in the framework of RBMP.
Hungary	No	Drought dealt with in RBMPs or regional plans. According to the 3rd Follow-up Report, there is no specific DMP, but some regional plans to deal with droughts.
Ireland	No	No information supporting the existence of DMP(s) in Ireland.
Italy	Yes	Information uneven. Existence may not apply for the whole RBD. DMPs mainly in the framework of Water Balance Plans, (see section 6.1.7).
Lithuania	No	No information supporting the existence of DMP(s) in Lithuania.
Luxembourg	No	Emergency management in case of supply shortfall due to infrastructural limits (3rd Follow-up Report).
Latvia	No	No information supporting the existence of DMP(s) in Latvia.
Malta	Yes	According to the 3rd Follow-up Report, drafting process is ongoing.
Netherlands	Yes	Though not proper DMPs are available, the Dutch operational water management during droughts has been considered an equivalent tool (section 6.1.5)
Norway	No	No information supporting the existence of DMP(s) in Norway.
Poland	No	Poland has started monitoring droughts by 2009 for developing an observatory and an early warning system. Legal requirement to develop Plans of mitigation of droughts effects.
Portugal	Yes	Early warning system available. Future developments will include: indicators, thresholds, plan of action and organizational scheme, so conforming with DMP standards.
Romania	No	There is no proper DMP, though this topic is included as part of other planning documents (3rd Follow-up Report).

Table 3. Drought Management Plans at river basin and country scale

RBD / Country	Drought Management Plan	Complementary information
Sweden	No	No information supporting the existence of DMP(s) in Sweden.
Slovenia	No	No information supporting the existence of DMP(s) in Slovenia.
Slovakia	No	Drought dealt with in RBMPs or regional plans. This topic is included as part of other planning documents.
United Kingdom: Scotland	Yes	Drafting ongoing as part of a phased, prioritised implementation programme by Scottish Environment Protection Agency (SEPA) to underpin WFD and river basin management planning process.
United Kingdom: England & Wales	Yes	Separate DMPs. The Environment Agency (England & Wales) and water companies have plans in place within respective scope and competence. (section 6.6)
United Kingdom: North Ireland	No	Water supply drought contingency plan. This will be developed further following completion of its ongoing water resource management strategy.

4.5.2. Sub-zoning

According to WS DEN 2007, the scale for applying the DMP within the WFD framework should be the river basin or a sub-basin that makes a management system and the appropriate entity to promote this plan should be the one in charge of the river basin. These systems should be defined on the basis of the characterization of both management elements (resources, demands, stakeholders, supply system, operational rules and responsible agents for the application of DMP) and the environmental ones.

Eventually, sub-zoning is relevant to assess expected effects, since these may be quite different, for instance, in a rain-fed agriculture region with low population than in an area hosting a big public supply system.

Cyprus has divided its territory in nine hydrologic regions and the main supply systems have been individually analyzed in order to identify specific problems and tailored solutions.

In Spain, each RBD has to prepare its own DMP, while water exploitation systems are the basic unit to determine indicators, thresholds and measures to be adopted at the different drought stages.

French website [Propluvia](#) offered the possibility of consulting the drought status (and level of restrictions to use) at RBD, region, department level and minor system units.

In Italy the situation is uneven, since Water Balance Plans or similar tools may be adopted by different administrative units. In Sardinia, a Drought Status Indicator is evaluated and monitored for each water system.

In the UK, Environment Agency has drafted seven DMPs, one for Wales and one for each of the six Environment Agency regions in England. For each reservoir, both normal and alert operating curves are assessed to compare with observed values.

On the other hand, DMP can also be related to other emergency drought plans for specific areas or economic activities such as Emergency Plan for Supply Systems in cities or urban agglomerations of more than 20,000 inhabitants in Spain (under Law 10/2001) or Drought Plans of Water companies in England and Wales (under Water Act 2003).

4.5.3. Measures for recovery of freshwater ecosystems

As the WFD indicates in Article 4.6, the river basin authority may declare a ‘temporary derogation’ to GES, after some exceptional circumstances, one of which is prolonged drought. Measures adopted during these situations cannot compromise the future recovery of the water body, and measures to restore the water body are to be taken as soon as reasonably practicable. Both group of measures should be included in successive RBMPs (the one in which the declaration have effect and the subsequent one). A summary of effects of the prolonged droughts have also to be included within the RBMP.

Recovery measures, intended for the restoration of ecosystems, are to be applied from leaving the emergency status to getting the normal one, and should be applied to ensure a restoration of water ecosystems as quickly as possible.

On the other hand, the decrease in water inputs might endanger the minimum flows needed to preserve valuable natural areas and their ecosystems which, in turn, can translate into lower quality also affecting associated biological elements. WS DEN 2007 recommends the establishment of actions and measures that guarantee minimum flows, particularly in high ecological value areas and their associated water bodies. This aspect has been assessed at RBD scale and it represented in a similar report on environmental flows (Benítez & Schmidt 2012).

Nevertheless, this is an aspect that clearly needs further consideration and research.

4.5.4. Experience on historical droughts

WS DEN 2007 proposes that river basin’s experience on historical droughts must be a part of the DMP. Previous managing experience can be very useful to assess water resources systems vulnerability, to estimate drought impacts, the usefulness of applied measures and to identify possible mitigation actions. It also may be relevant to evaluate cost associated to the past episodes and the effectiveness of the strategies adopted. Suggested elements of this section of the DMP are:

- Drought recurrence and severity
- Socio-economic and environmental impacts
- Management systems and water bodies vulnerability
- Water supply vulnerable areas identification
- Identification of sensitive agricultural demand units
- Identification of supply shortage
- Resources conservation measures and demand management
- Drought infrastructures: available and on study
- Selection of measures to increase water availability

- Maximum temporal capacity to drought resistance

On the other hand, as previously stated, effects of prolonged droughts during temporary derogation must be appropriately documented in future RBMPs.

Two particularly interesting reports analysing past droughts events and the lessons learnt have been identified:

- [La gestión de la sequía de los años 2004 a 2007](#). [The management of the drought period from 2004 to 2007] published by the Spanish Ministry of Environment.
- [Seca 2005. Relatório de Balanço](#) [2005 Drought. Balance Report] published by the Commission for 2005 Drought.

4.5.5. Monitoring scheme of the DMP

WS DEN 2007 also establishes the basis for an adequate monitoring of DMP, which main features are:

- The establishment of an Organisational Structure, identifying responsibilities regarding, between other functions, the monitoring of the development of the drought and of the effects of DMP measures
- The continuous monitoring of water status and DMP application. Proper water resources management needs permanent collection, storing and processing of data related to precipitation, river flows, dam inflows and outflows, change of water levels in dams reservoirs and aquifers, evaporation, hydro chemical and biological elements. In addition, the WFD monitoring programmes may be used for the provision of data, eventually reinforced with additional sampling points specially oriented for the drought follow-up.
- A follow-up program with indicators in accordance to the type of DMP measures:
 - Preventing indicators: such as stored volumes in reservoirs, flows, piezometric levels or precipitation.
 - Operative indicators linked to demand and supply, or linked to the environmental protection.
 - Management and organizational indicators.
- A continuous forecast of the expected water resources.
- A continuous evaluation of water demands.
- Evaluation of effectiveness of water use and mitigation measures.
- Ex-post analysis of the performance of the DMP.
- Assessment of the economic impacts of drought episodes.

Most of the references found and presented in section 6 stress the articulation of an early warning system and the setting of indicators to monitor evolution and trigger the appropriate measures. Hardly any information is available on the relationship between water status and droughts, though the first steps are in progress in the framework of the follow-up of PoM.

In relation to measuring effectiveness an important problem arises. Assessing the performance of an operative DMP would require the comparison with a hypothetical situation of no application of DMP and it would require a simulation of the management in the no-DMP case. Other way, it is not possible to

extract robust conclusions. This kind of simulation could be possible but falls out of the scope of this Subtask.

4.6. Evaluation of the potential (expected effectiveness) of DMPs at RBD scale

An evaluation of the expected effectiveness of DMPs (high, moderate & low) has been carried out. Even though the distinction between the phenomena of water scarcity and drought is quite difficult at this level of analysis, it may be assumed that the severity of drought is higher when superimposed to a situation where shortage is a permanent problem. So, the potential role of DMPs as a tool to prevent and mitigate the negative impacts of drought events is higher in those RBDs where abstractions exert a higher relative pressure on natural resources.

The main sources and criteria for this analysis are summarized in the following points:

- The Water Exploitation Index - WEI (at national or, preferably, at RBD level) as a basic indicative of the existence of water scarcity problems. Two different limits have been set out to assess the magnitude of water scarcity:

Potential	National WEI	RBD WEI
high	WEI > 30%	WEI > 25%
moderate	30% > WEI > 20%	25% > WEI > 15%
low	WEI ≤ 20%	WEI ≤ 15%

These limits are based on previous studies. WEI data has been provided by EEA and are subject to a certain degree of unevenness since the nature of the base information can be diverse and / or correspond to different time periods.

- WISE information on % SWB with significant water abstraction pressures, also as an index related to the magnitude of pressures in relative terms. Limits have been fixed by correspondence with percentiles (75 y 50) of the series of values above absolute 0 that have been regarded as no information:

Potential	% affected SWB
high	%SWB > 18,5%
moderate	18,5% > %SWB > 8,3%
low	%SWB ≤ 8,3%

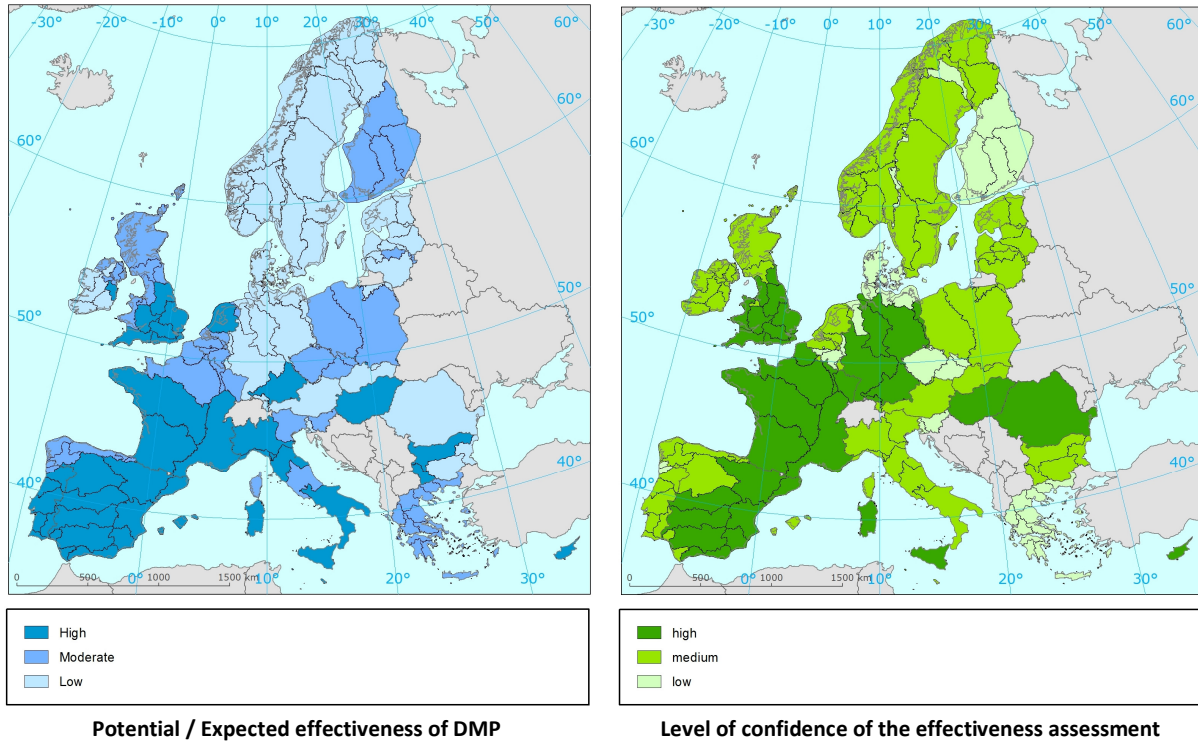
Though these ranges and percentiles are somewhat arbitrary, they are also significant in relative terms.

- Expert judgement on the relevance of drought problems, both from RBMPAs (template on strategy to deal with water scarcity & droughts) and / or from own assessment of RBMP and other information sources.

These criteria have been combined in a flexible way to render a single value of effectiveness. Results are presented with an evaluation of the level of confidence (high / medium / low), based on the

completeness of data (high meaning RBD values for WEI + WISE information on %SWB affected + consistent expert judgement) and their internal consistency at RBD level.

Fig. 9. Maps of potential / expected effectiveness of DMPs in European RBDs



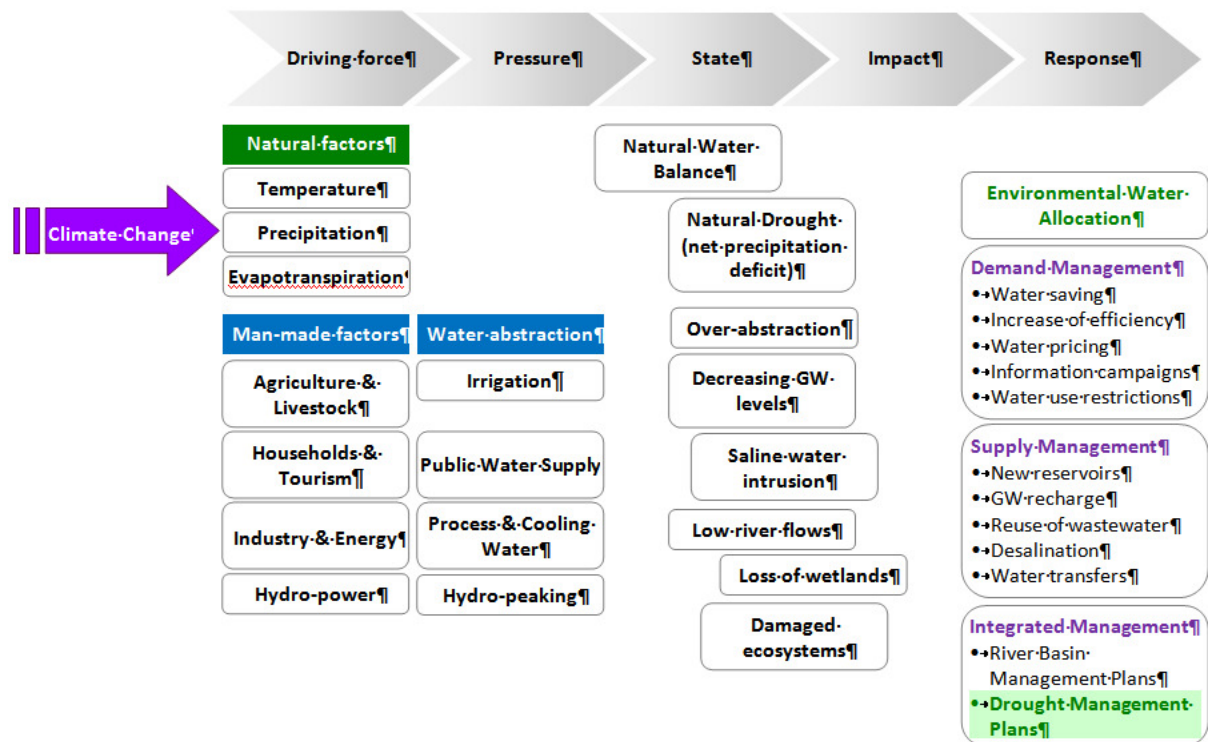
Source: own assessments

5. Linking measures with PSI storyline

5.1. Overview

The DPSIR framework is useful in describing the relationships between the origins and consequences of environmental problems and has been identified as a suitable framework for determining pressures and impacts under the WFD (Borja et al. 2006). The following figure depicts these basic relationships.

Fig. 10. Eflows & DMPs under the DPSIR conceptual framework



Source: adapted from EEA 2008

Drought events are a result of natural factors and are enhanced by anthropogenic influences (Kossida et al. 2010). The difference of drought from other natural disasters is that it has a slow onset and a usually lengthy duration, being the deficiency in rainfall the drought's primary cause, which may be aggravated by high air temperatures and evapotranspiration rates during summer and precipitation storage in ice during winter. Some of the most important human activities that enhance the severity of drought events (**Drivers**) are (WS DG 2006):

1. *Population growth increases water demand not only due to water supply needs but also due to increased water demand for agricultural purposes.*
2. *Climatic change and variability⁴⁹. Climate change under normal conditions may trigger a strong decrease of water resources, especially in the Southern European Countries.*
3. *Land use*
 - a. *Degradation of watersheds and catchments may reduce the amount of usable water available downstream.*
 - b. *Reduction of vegetation cover may result in higher runoff that in turn reduces groundwater infiltration and the storage capacity of dams and lakes through sedimentation.*
 - c. *Draining of large scale wetlands or large scale deforestation.*
 - d. *Development of "thirsty" crops.*

⁴⁹ May be considered a human driven phenomena.

- e. *Urbanisation leads to increased surface run-off, reduced infiltration and reduced base flows locally.*
- 4. *Water pollution, the concentration of pollutants in water resources increases as the quantity of water decreases thus making water sources difficult or even impossible to use. On the other hand, reducing water pollution can increase the usable water supply.*
- 5. *Poor or inadequate legislation can exacerbate the effects of water scarcity resulting in conditions of drought.*
- 6. *The use of water in international rivers of cross-boundary catchment areas by upstream countries may lead to conditions of drought in downstream countries.*
- 7. *Political realities, the temporal perspective of many politicians does not coincide with the temporal dimension of a prudent water resources management, resulting in decisions being made on the basis of short term political benefits only.*

Impacts from drought can be classified as direct or indirect (Wilhite et al. 2007). A perhaps more interesting approach derives from the successive impacts of drought as its duration and/or intensity increase. When a drought event begins, soil water is rapidly depleted thus affecting the rain-fed agriculture (agricultural drought). Other human activities and the ecosystems will feel the impacts if precipitation deficiencies continue, affecting water flows and groundwater (hydrological drought and socioeconomic drought). So drought impacts may also be divided into economic, environmental and social as follows (WS DG 2006):

1. *Economic*

a. *Mainly agriculture and other related sectors, such as forestry and fisheries. Losses in crop and livestock production, increases of insect's infestation, plant diseases and soil erosion. Increase of fire incidents.*

b. *Recreation and tourism industries are also affected.*

c. *Prices of food, energy and other products increase as supplies are reduced. Even the need to import goods may arise or to change the transportation method due to low water levels in rivers.*

d. *Hydropower production may also decrease.*

2. *Environmental*

a. *Damages to plant and animal species and wildlife habitat.*

b. *Decrease of air and water quality*

c. *Forest and range fires*

d. *Degradation of landscape quality*

e. *Loss of biodiversity*

f. *Soil erosion.*

3. *Social*

a. *Public safety*

b. *Health*

- c. Conflicts between water users
- d. Reduced quality of life
- e. Inequities in the distribution of impacts.
- f. Economic and environmental impacts have also social components

For their part, Kossida et al. 2010 have updated previous definitions (Smeets et al. 1999) to serve as the basis for establishment of suitable indicators within DPSIR framework to be applied for categorisation of both WS&D.

*Indicators for **driving forces** describe the environmental, social, demographic and economic developments in societies and the corresponding changes in life styles, overall levels of consumption and production patterns. Primary driving forces are climatic changes, population growth, migration and developments in the needs and activities of individuals. These primary driving forces exert pressure on the environment, either directly (through changing precipitation patterns) or indirectly through changes in production and consumption.*

***Pressure** indicators describe developments in release of substances (emissions), physical and biological agents, the use of resources and the use of land. They also describe pressures on infrastructure (e.g. an increased demand for infrastructure). The pressures exerted by nature (anomalies) or society are transported and transformed in a variety of natural processes to manifest themselves in changes in environmental conditions. Examples of pressure indicators are CO₂-emissions per sector, the use of rock, gravel and sand for construction and the amount of land used for roads.*

***State** indicators give a description of the quantity and quality of physical phenomena (such as temperature), biological phenomena (such as fish stocks) and chemical phenomena (such as atmospheric CO₂-concentrations) in a certain area at the time of inquiry. State indicators may, for instance, describe the forest and wildlife resources present, the concentration of phosphorous and sulphur in lakes, or the level of noise in the neighbourhood of airports. They can also describe the state of the socio-economic and technical system of interest. Unavailability of infrastructure can result to water scarcity (ie inability to meet demands) even with water available (elsewhere).*

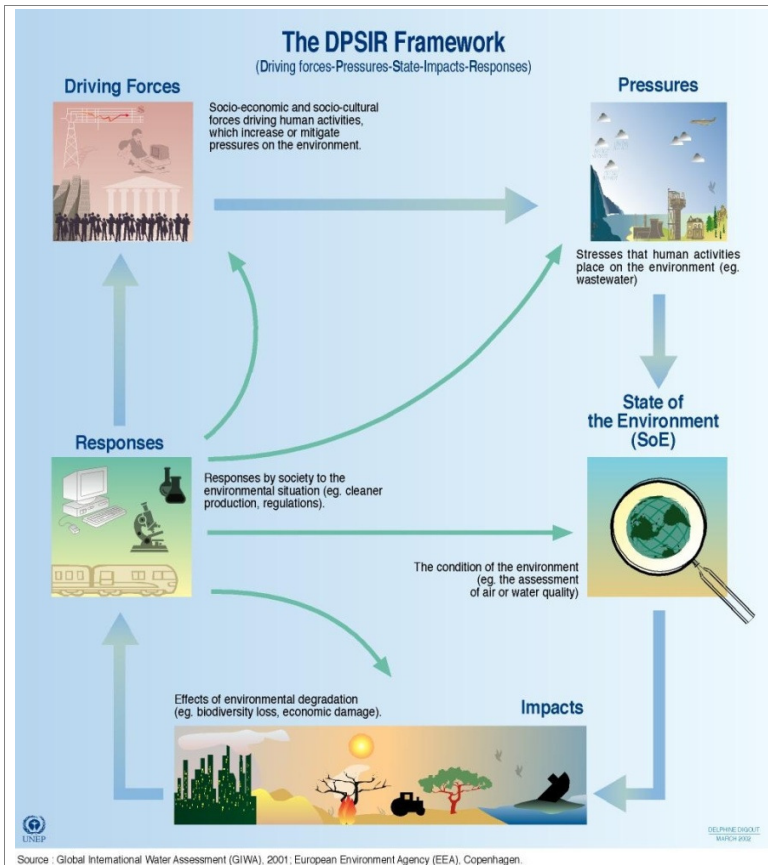
*Due to pressure on the environment, the state of the environment changes. These changes then have **impacts** on the environmental, social and economic functions, such as the provision of adequate conditions for health, resources availability and biodiversity. Impact indicators are used to describe these impacts. Over-abstraction of groundwater (a pressure) may result in saline intrusion (an environmental impact), which may in turn result in loss of crop production (a socio-economic impact). It should be noted that it is the loss of production that is the impact. The yield per se is a state indicator.*

***Response** indicators refer to responses by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate or adapt to changes in the state of the environment. It also refers to attempts by ecosystems themselves to respond (e.g. by adaptation or migration). Some societal responses may be regarded as driving forces, since they aim at redirecting prevailing trends in consumption and production patterns. Other responses aim at raising the efficiency of products and processes, through stimulating the development and penetration of green technologies. There may also be societal responses targeted at facilitating physical responses by ecosystems: increasing the connectivity of river systems, would allow species to migrate to more appropriate habitats, to respond for example to a drought situation. An often used overall response indicator is an indicator describing environmental expenditures. Indicators of Responses show what is currently in place.*

So the different dimensions relate to each other following the causal relationship pattern: Drivers lead to Pressures that change the State and have Impacts. Responses modify Impacts, which are monitored through the State. In turn, Responses can change a Driver, be a driver and mitigate Impacts. But this

should by no mean be conceptualised as a linear process (Kossida et al. 2010).

Fig. 11. The DPSIR Framework



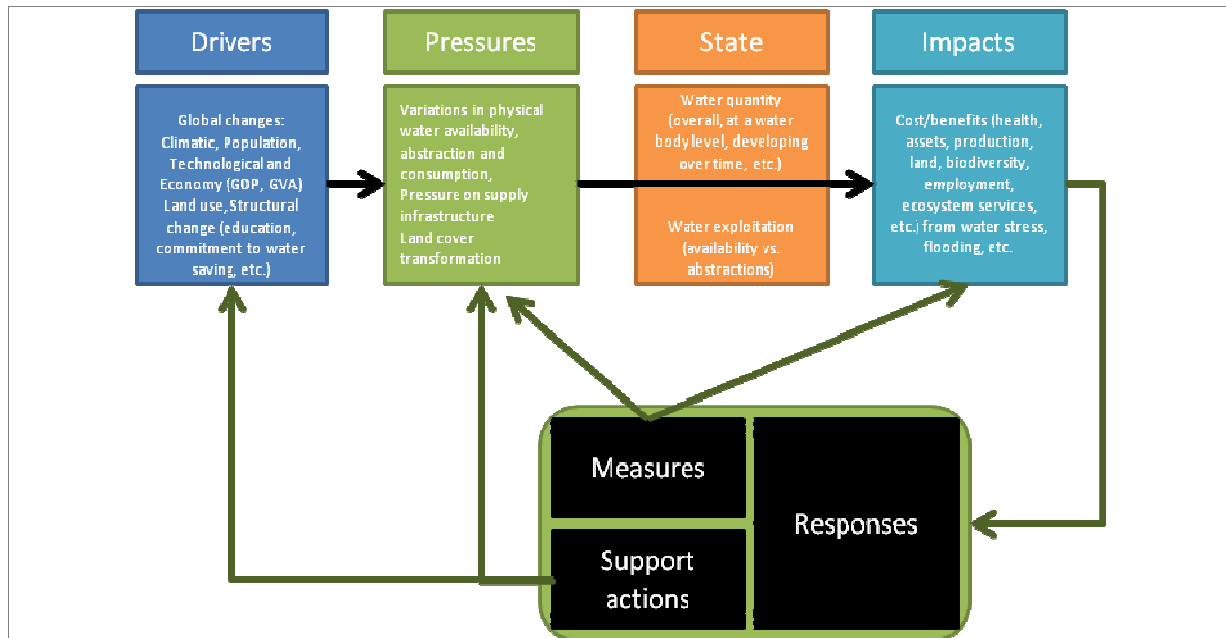
Source: Global International water Assessment – European Environment Agency

In order to understand the dynamics of DPSIR elements it is also useful to focus on the links between them.

For instance, the relationship between the 'D' and the 'P' by economic activities is a function of the eco-efficiency of the technology and related systems in use, with less 'P' coming from more 'D' if eco-efficiency is improving. Similarly, the relationship between the Impacts on humans or eco-systems and the 'S' depends on the carrying capacities and thresholds for these systems. Whether society 'Responds' to impacts depends on how these impacts are perceived and evaluated; and the results of 'R' on the 'D' depends on the effectiveness of the Response (Smeets et al. 1999).

Finally, Acteon 2012 also uses DPSIR analysis for reviewing the causes of WS&D and for assessing the adequacy of existing or proposed measures to prevent, manage or mitigate these situations. Some elements of each group (DPSIR) are proposed for assessing / monitoring:

Fig. 12. DPSIR framework for the purposes of the WS&D Gap Analysis



Source: ACTeon 2012, adapted from: Kossida et al, 2009

Drivers: changes in precipitation, demographic changes, income per capita, household size distribution, tourism activities, irrigated area, energy demand, etc.

Pressures: water demand per sector, water abstraction, water use, number of new licensed wells, number of new public water supply connections, land cover change, etc.

State: water balance (in particular basins and areas with structural and cyclical deficits), groundwater storage, reservoir Storage, streamflow, external resources over total resources used, water quality, infrastructure (e.g. irrigation systems coverage and efficiency), etc.

Impacts: useful indicators of impacts are the percentage of reduction in available surface and groundwater, inadequate ecological status for aquatic ecosystems, loss of wetlands, loss of biodiversity, desertification, water shortage & interruptions (frequency, duration, extend), population affected from water restrictions (levels and duration), cost of drought mitigation measures, income losses or additional costs due to drought and water scarcity, health problems, etc.

Response: in turn, the response can take the form of both i) "Support Actions" such as water tariffs, environmental charges, water saving programmes, investments and subsidies, drought management plans, number of programmes for raising awareness, etc., and that of ii) "Measures" such as new metering systems installation, volume of returned flows, volume of additional water resources (water imports, desalinated water, reused and recycled water), share of area under nature protection etc.

5.2. PSI storyline for DMP

WSD EN 2008 offers in its Annex 1 an extensive list of more than fifty measures to be consider in a DMP, grouped by type (strategic, operative, organizational, follow-up and recovery) and also classified according to the drought phase(s) of application. So as stated before, a large number of measures can concur in the joint structure of the DMP.

Though in the first instance, DMP can be regarded as a ‘response unit’ in terms of DPSIR scheme, some relevant distinctions within the pack of measures included can be made. While strategic, organizational and monitoring measures provides a general framework for the functioning of the DMP, operative and recovery measures are aimed at more specific objectives. Particularly, the kind of operative measures included in the DMP may shed light on its general approach and on the nature of the pressures and impacts that are addressed.

In the next table, operative measures proposed in the above mentioned document have been classified with indication of the drought phase(s) of application.

Table. 4. Suggested operative measures under the framework of DMP

Type	Measure	Normal	Pre-alert	Alert	Emergency
Water saving - voluntary	Voluntary water saving campaigns in urban supply, information, and social awareness		X		
Water saving - voluntary	Voluntary water saving campaigns for irrigation, refocusing irrigation campaigns			X	
Water saving - mandatory	Water volume reduction for irrigation purposes			X	X
Water saving - mandatory	Prohibiting uses (watering gardens, swimming pools, street cleaning, high water demand crops, golf courses etc.)				X
Alternative supplies	Checking functioning of drought infrastructures		X		
Alternative supplies	Finishing infrastructures for planned droughts (drought wells, desalination plants, reuse systems) -when other possibilities have been taken into account and preventative measures have been applied			X	X
Alternative supplies	Increasing groundwater abstraction -when future recovering ensured-			X	X
Alternative supplies	Activate and increase waste water potential reuse			X	X
Alternative supplies	Activate and increase the use of desalination plants -already constructed and in-use			X	X
Alternative supplies	Resources transfers within the basin			X	X
Alternative supplies	Activating the water rights Exchange centres for ensuring urban supply				X
Environmental	Ensuring water quality and environmental objectives under WFD criteria	X	X	X	X
Environmental	Activating water rights exchange centres to avoid damages on water bodies				X
Environmental	Maintenance, as a general criterion, of hydrological environmental requirements established in the RBMP-first priority is population supply			X	X
Environmental	Restrictions on environmental hydrologic requirements, established in the RBMP, when it is necessary to ensure urban and social supply, as far as restrictions do not damage ecosystems, habitats, and vulnerable species to droughts (Natura 2000 Network and RAMSAR)				X
Environmental	Maintaining outputs equal to inputs in reservoirs that feed aquatic habitats of Natura 2000 Network and RAMSAR wetlands				X
Environmental	Avoid the direct use of water from wetlands vulnerable to drought situations	X	X	X	X

Table. 4. Suggested operative measures under the framework of DMP

Type	Measure	Normal	Pre-alert	Alert	Emergency
Environmental	Avoid the use of minimum volumes in reservoirs presenting eutrophication or in risk			X	X
Environmental	Increasing the control for discharges, wastewater treatment plants, agricultural practices and water quality			X	X
Environmental	Establishing an environmental watch plan on water bodies of Natura 2000 Networks, RAMSAR wetlands, water bodies feeding vulnerable wetlands and reservoirs	X	X	X	X
Environmental	Increase Water Police and control of the water public domain to strengthen surveillance, sanctioning procedures and selective monitoring				X
Environmental	Capture and relocation of endangered fauna and creation of special areas to maintain aquatic species				X

Source WSD En 2008 and own

WSD EN 2008 also highlights the importance of a clear prioritisation of main uses, particularly in case of a prolonged drought leading to a temporary exemption on reaching GES / GEP, assuming it might be impossible to completely stop all water uses, even if some restrictions are undertaken.

In the following table, the links between operative measures and the PSI storyline are basically outlined. Both the deterioration of the status and the magnitude of the impacts will become more significant as drought prolongs and phases trigger.

Table. 5. DMP and PSI Storyline

Measure	Pressures addressed	State (altered)	Impacts
<ul style="list-style-type: none"> • Water savings, voluntary (pre-alert phase) • Water savings mandatory (alert & emergency) • Alternative supplies (drought wells, desalination plants, reuse systems, water rights exchange, intra-basin transfers). • Prioritization of main uses. 	<p>Abstractions of surface water and also groundwater.</p>	<p>Reduced water availability leading to lack of enough water supplies for economic activities, population and the environment.</p>	<ul style="list-style-type: none"> • Lack of sufficient supply guarantee to population. Eventually, decline of quality for human consumption. • Affection to energy production (hydropower and cooling) and industrial facilities, even forcing temporary closure in the absence of emergency supplies. • Losses in irrigated agriculture⁵⁰ with possibility of catastrophic years (no or anecdotic supply). • Damage to tourism and recreation activities and facilities (golf, fishing, aquatic parks, pools & green areas). Loss of scenic and recreational values. • Affection to navigation. • Social impacts associated with economic ones. Lack of security for new investments. • Environmental damage (see below).
<ul style="list-style-type: none"> • Specific environmental measures 	<p>Damage to aquatic and water dependent ecosystems due to progressive decrease in flows and/or groundwater and decline of water quality. If prolonged drought, exemption on GES / GEP can be necessary: restrictions on environmental hydrologic requirements to ensure human supply.</p>	<p>Damage to aquatic and water dependent ecosystems due to progressive decrease in flows and/or groundwater and decline of water quality. If prolonged drought, exemption on GES / GEP can be necessary: restrictions on environmental hydrologic requirements to ensure human supply.</p>	<ul style="list-style-type: none"> • Degradation of river ecosystem, leading eventually to mortality of fish and other species. • Damage to wetlands under RAMSAR, and other water dependant ecosystems under Natura 2000 Network. Also in other terrestrial areas depending on the aquatic system (riparian and aquifers dependant ecosystems). Detrimental effects may lead to loss of biodiversity, eventually with introduction of invasive species. • Deterioration of physical and chemical quality due to lower dilution capacity. • Eutrophication of reservoirs and lake type water bodies.

Source: own

⁵⁰

Losses in rain-fed agriculture not included since they may not be mitigated through changes in water system management. For similar reasons, the increase in forest fires risk is not mentioned within environmental impacts.

6. Case studies

6.1. Cyprus

Cyprus is a country of Mediterranean climate with relevant problems associated with drought and water scarcity. The serious water shortages that periodically affect the economic, social and environmental Cypriot sectors have made the fight against drought probably the most important water policy issue in the country.

Government action has led to the preparation and implementation of drought mitigation plans in order to meet the essential water demands, while minimizing the negative effects of these phenomena. These plans are prepared by the Water Development Department [WDD] of the Ministry of Agriculture, Natural Resources and the Environment, main governmental agent for water policy.

The implementation process starts each year early in August when a water balance and water supply scenario is prepared taking into account the existing water resources at the time, the probable inflow to the dams and groundwater reservoirs, and the projected water demand. This scenario is updated every two months, and the needed data for all the procedure are collected by the WDD in its monitoring program.

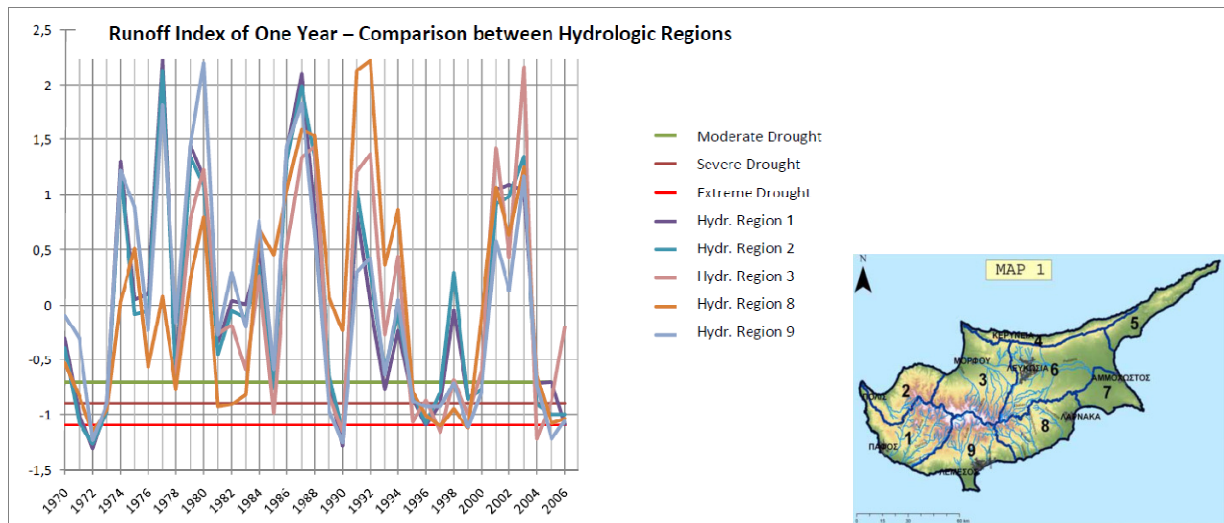
Although not severity levels have been previously defined, in the framework of this process adverse effects of the potential occurrence of water scarcity conditions are estimated next to preliminary proposals for their mitigation. If technical measures are not enough to address the situation, additional decisions including water cuts or rationing may be adopted. Additional resources allocation or and compensation measures must be taken by the Council of Ministers based on proposals of the WDD. All these actions are taken under the General Disaster Laws, because no other existing legislation does provide anything on drought preparedness plans.

Recently, as a result of the hydrological planning process undertaken under WFD, WDD has drawn up a DMP, alongside the RBMP, the PoM and a Water Policy Report. Cyprus adopted their RBMP on June 9, 2011.

The main objective of the Cypriot DMP is the establishment of a system for detecting the presence of drought in time to take in each supply system the management measures needed to limit the adverse effects of these situations. To do this, it is proposed an index system able to inform about the presence and the intensity of drought for all sectors that depend on water resources, which in Cyprus are both, water supply and irrigation, as well as the environment. The system developed consists of six indices:

1. The meteorological index SPI is the basic tool for detecting drought and monitoring its intensity.
2. The hydrological runoff index of one or more hydrologic years gives the capability of checking the SPI conclusions.

Fig. 13. Runoff Index of One Year. Comparison between Cypriot Hydrologic Regions



Source: Final Drought Management Plan- Report 8th [Summary]

3. The dam storage index has direct management significance, since it is related to the abstractions policy.
4. The wet period runoff index contributes to the early detection of drought.
5. The river regime index is only used during drought and contributes to the early detection of increased pressures on the riverine ecosystems.
6. The groundwater bodies' index, is focused as an organized system, by making use of the hydrogeological data, able to assess, independently from the rest of the aforementioned indices, whether each groundwater body is under particular pressure due to drought. The index proposed depends on the monitoring of the level in selected locations per water body, and the comparison of change between decision making dates.

The DMP also includes criteria for defining "prolonged drought" as contemplated in WFD. Limit values for declaration of prolonged drought were proposed for the SPI, runoff and dam storage indices. Also, it is proposed that the water body monitoring system, in place per the provisions of Directive 2000/60, is used to assess any downgrading of bodies. Finally, the shortage in meeting irrigation demand from government schemes, expressed as a percentage of demand, is proposed as an index of the social consequences of drought.

Moreover, the main supply systems are individually analyzed in order to identify in each case the situation regarding the monitoring needs, infrastructures and other actions necessary to ensure the supply and improve environmental conditions especially during periods of water shortage.

6.2. Spain

In the framework of former Water Act (1985) exceptional measures were applied during unusual drought, with regard to filling and emptying reservoirs and aquifers, according to the rights of the different users and the existing hydrological situation, and eventually the building of emergency infrastructures, as for instance drought wells.

A more preparedness oriented regulation has been set up by the National Water Plan Act, which states that the Ministry of Environment must establish a global Hydrological Indicators System (HIS), and River Basin Authorities (Confederaciones Hidrográficas) must prepare **Drought Management Plans** (Planes especiales de Actuación en Situación de Alerta y Eventual Sequía) and submit them for approval. Municipalities (or aggregations) with more than 20.000 inhabitants should also elaborate **Emergency Plans for urban water supply** in order to ensure water services under drought situations. General Guidance Documents were developed to facilitate the process of developing these Plans,

DMps must integrate the following elements: indicators and thresholds providing drought status early enough to act according to the forecasts; knowledge of the resources system and its elements' capability to overcome scarcity situations; knowledge of demands and their vulnerability towards droughts; structural (new pumping wells, new pipes, use of new desalination plants ...) and non-structural (water savings by applying restrictions to the users, increase in the use of groundwater ...) measures to reduce impacts, at each drought stage; cost of implementing measures; administrative structure for its follow-up and coordination; public participation involving interested parties to avoid social conflicts.

For inter-communitarian basins (those whose territory is divided among several autonomous communities), DMPS were approved by [Orden MAM/698/2007](#)⁵¹:

[Demarcación hidrográfica del Cantábrico](#)

[Demarcación hidrográfica del Miño-Sil](#)

[Demarcación hidrográfica del Duero](#)

[Demarcación hidrográfica del Tago](#)

[Demarcación hidrográfica del Guadiana](#)

[Demarcación hidrográfica del Guadalquivir](#)

[Demarcación hidrográfica del Segura](#)

[Demarcación hidrográfica del Júcar](#)

[Demarcación hidrográfica del Ebro](#)

The plans for the internal basins of Andalusia have yet been submitted to public consultation but are still not approved⁵²:

[Plan especial de sequía del Distrito Hidrográfico Mediterráneo](#)

[Plan especial de sequía de los Distritos Hidrográficos Guadalete-Barbate y Tinto-Odiel-Piedras](#)

Also Balearic Islands Authority has also prepared a DMP, still not approved:

[Plan Especial de actuación en situaciones alerta y eventual sequía](#)⁵³

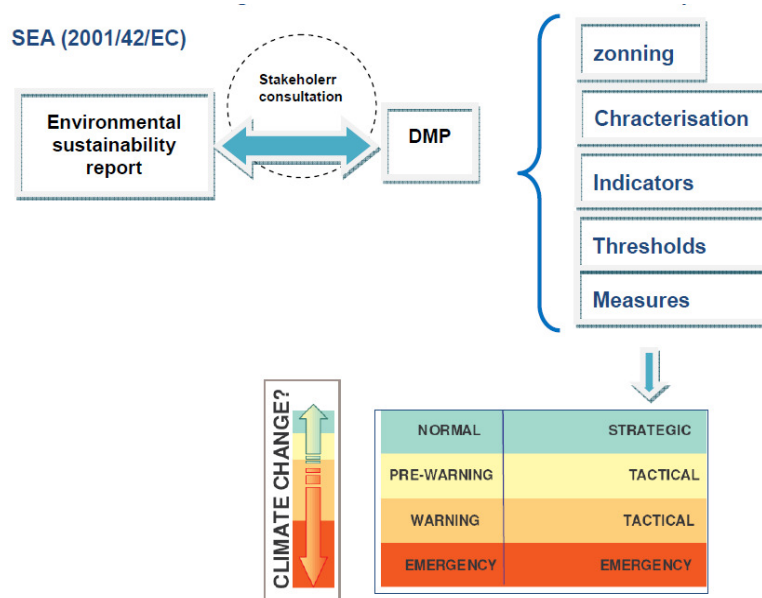
⁵¹ <http://www.magrama.gob.es/es/agua/temas/observatorio-nacional-de-la-sequia/planificacion-de-la-gestion-de-la-sequia/planes-especiales-de-la-sequia/>

⁵² http://www.juntadeandalucia.es/medioambiente/site/portalweb/menuitem.6ffc7f4a4459b86a1daa5c105510e1ca/?vgnnextoid=7c50f77ee20a5310VgnVCM2000000624e50aRCRD&vgnnextchannel=75b3e6f6301f4310VgnVCM2000000624e50aRCRD&vgnnextfmt=default&lr=lang_es

Drafting is ongoing in Galician Coast, Catalan River Basin District and Basque County Internal Basins.

The main scheme of the Plans elaboration process is reflected in the following figure:

Fig. 14. Drought Management Plan characteristics in Spain



Source: Spanish Ministry of Environment (from WSDEN 2007)

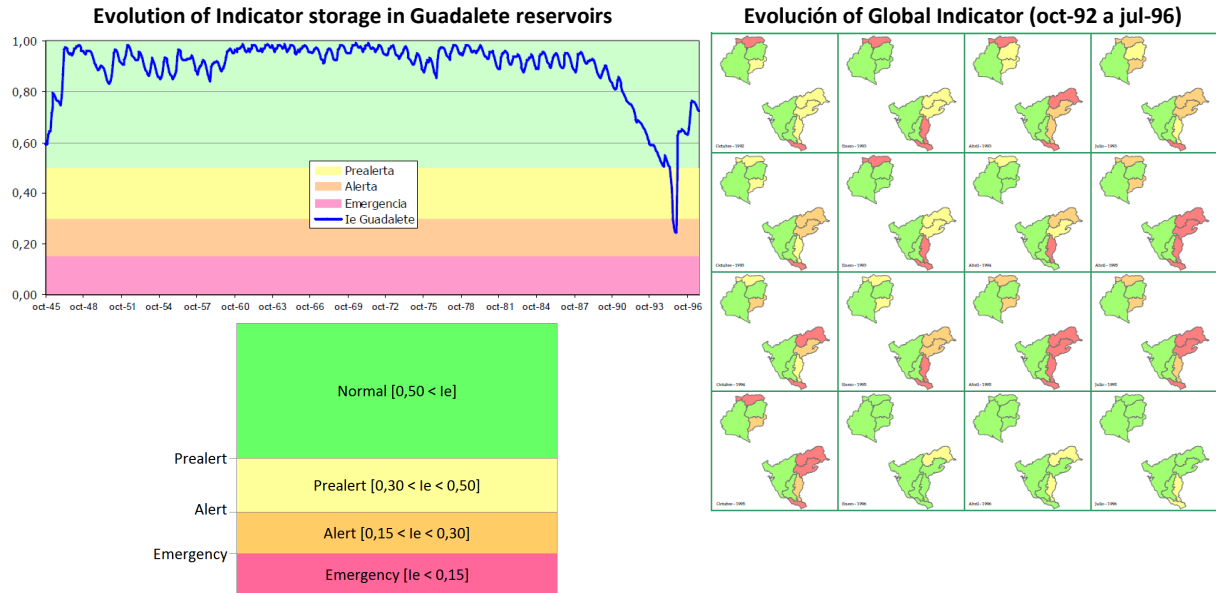
Drought indicators are key elements of these DMPs. The methodological framework used for their selection and analysis is as follows:

1. Definition of demand units or (better) management systems.
2. Selection of the most representative indicator(s) of the evolution of available supply in control points of each unit. Depending on the system, suggested indicators may be: Volume stored in surface impoundments; groundwater levels in aquifers; discharge at river gauging stations; rainfall in representative stations; snowpack in areas where significant result in relation to resource availability.
3. Compilation of hydrologic time series associated with each of the indicators.
4. Definition of threshold values for characterising drought phases and its severity is based on the analysis of historical droughts and hydrological simulation techniques, confronting resources and demands and taking into account available management infrastructures.
5. If more than one, weighting of different indicators to get numerical results representative of the situation of drought in each of the operating systems to construct a single Global Indicator (Indice de estado – Ie).
6. Continuous monitoring of the evolution of the indicators.

The values are standardized between 0 and 1, the lowest corresponding to drought conditions and the value of 0.5 to the average situation. Consequently thresholds are established and validated by

simulation and, according to the established intervals, indicator values allow to classify the status of the management system in four categories, from normal status to emergency.

Fig. 15. Example: evolution of Drought indicators in Atlantic Andalusian Basin

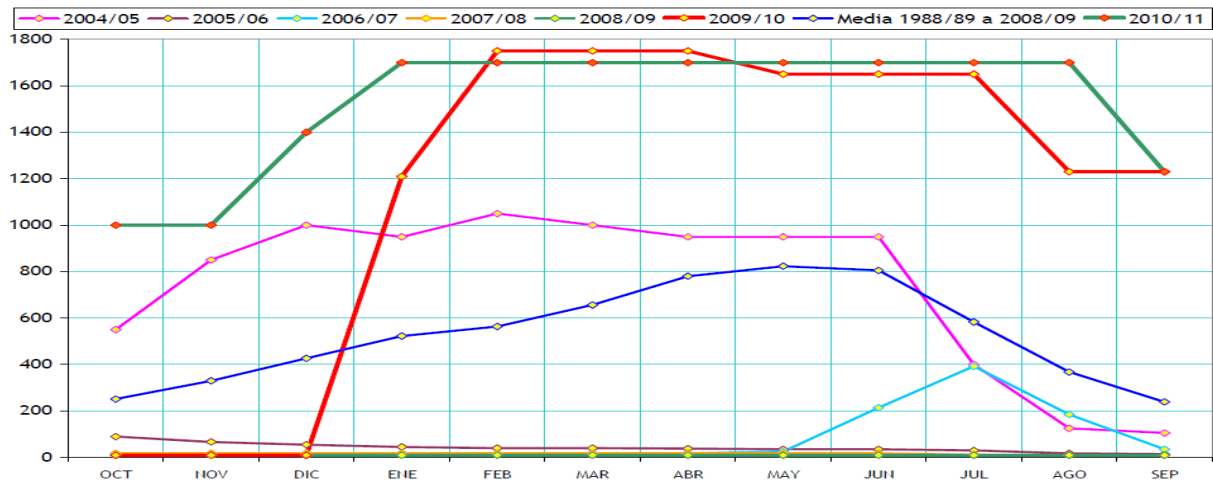


Source: Special Plan of action in situations of alert and possible drought. Atlantic Andalusian Basin)

At national level, the Global Hydrological Indicator System has been developed integrating the monitoring of indicators in the different intercommunity basins, dependent on the Ministry of Environment. Periodic progress reports on hydrological drought are released by the National Observatory on Drought (Observatorio Nacional de la Sequía) at weekly, monthly and annual basis.

Annual reports are the most complete ones, including analysis of a variety of drought elements and its evolution throughout the year at national, RBD and water exploitation system scale: rainfall, river discharges and cumulated resources in reservoirs, GWBs and as snowpack. Particular attention is dedicated to trans-boundary basins under Albufeira Convention and to the situation of some singular wetlands (Las Tablas de Daimiel and Albufera de Valencia). The evolution of global indicators is also presented in a series of national maps and further analysed, describing the main problems experienced by the different users (human supply, irrigation) and the environment, as well as the measures adopted both at management and infrastructural level.

Fig. 16. Evolution of water table surface in Las Tablas de Daimiel



Source: [Annual Report on the Hydrological State In Spanish Basins \(hydrological year 2010-2011\)](#)

6.3. France

The main regulatory provision currently in effect for drought management is the 'Circular of 18 May 2011 concerning emergency measures to limit or suspend use of water in dry periods' specifies the conditions to be respected for taking exceptional measures to limit or suspend use of water in dry periods, the tools available for monitoring and communication in times of drought and the mechanisms to improve interdepartmental coordination. It is based on the following provisions: Directive 2006/2000 of 23 October 2000 [Water Framework Directive]; the Law 2006-1772 of 30 December 2006 on water and the aquatic environment; and the Code of environment and includes in its annexes all the provisions in this regard since 1992.

The **main actors in the management of drought** in France are Prefects and Hydrological Monitoring Committee.

- a) *The PREFECTS*: Placed in command of each of the 96 departments in which is administratively divided France the prefects set locally the thresholds that trigger water restrictions and are responsible for enacting the 'decrees of drought'. There is also a prefect responsible for coordination in each river basin.
- b) *Hydrological Monitoring Committee*: Responsible at national level, the committee meets as required by the hydrological situation. It is a place of exchange and information about the water situation and is concerned with the impact caused by the droughts on the environment and on the different water uses. Finally transmits the information and proposals the Prefects. It consists of:
 - Seven representatives of the State: the waterways, industry, agriculture, tourism, local authorities, health and environment;
 - Four representatives of territorial communities: a member of the Loire Breton basin, a member of the Rhone-Mediterranean Basin Committee, the Association of French Mayors (AMF) and the National Association of governed communities and licensors (FNCCR);

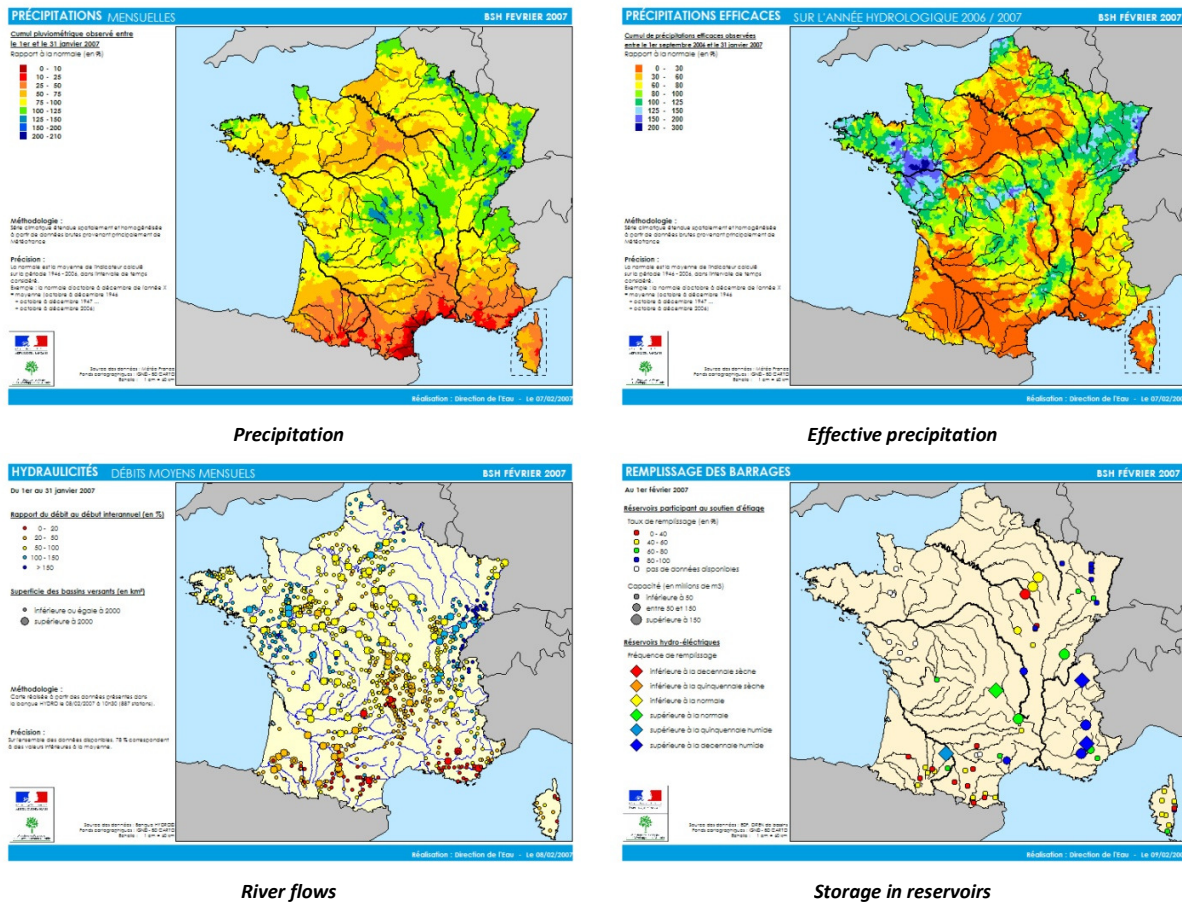
- Twelve representatives of users: water companies Federation (FP2E), Assembly of Chambers of Commerce and Industry (ACFCI), EDF, National Federation of rural private property (FNPPR), Permanent Assembly of Chambers of Agriculture (APCA) France nature and Environment (FNE), National Center for prevention and Protection (CNPP), National Federation of fisheries of France (FNPF), National Association of food industries (ANIA), UFC, National Union of family Associations (UNAF) representatives of associations of mariculture
- Experts: National Agency of water and aquatic environment (ONEMA), Bureau of Geological and Mining Research (BRGM), Météo-France, waterways of France (VNF), nuclear safety agency (ASN).

Drought management must ensure **service priority uses**, especially health, civil security, potable water supply and preservation of aquatic ecosystems, in full observance of equality between users and the necessary solidarity upstream - downstream watersheds. Four levels are defined: vigilance; alert: slight limitation of withdrawals; crisis: partial ban on withdrawals; reinforced crisis: total ban on withdrawals (according to use).

These decrees can only be prescribed for a limited time and in a specific area. However, on this point, there may be a misuse of the decrees of drought due to confusion between drought and structural deficit. The 'Circular of 18 May 2011' mention this issue: '*... in regions where water needs exceed available resources regularly, especially in dry season, the resource to the decrees of drought is often systematic, even in wet years ... administrative acts must be the answer to the impacts of droughts which are unpredictable phenomena, and not to constitute a remedy for structural deficits between needs and resources ...*'.

Drought monitoring in France includes remote sensing technologies, hydrological bulletins, water resources situation reports, hydrological yearbooks, national or regional drought portals, water information systems ... The website [Bulletin national de situation hydrologique - Eaufrance](#) provides every month (every two weeks in the summer) data on precipitation, effective precipitation, water in the soil, groundwater, reservoirs, runoff and base flows. Data are compared to the average of the last fifty years or calculated in terms of frequency. Announcements made by the ministries at the beginning of years identified as dry have enabled farmers to adjust their choice of crops. This information on climate and weather conditions, forecasts and monitoring and rapid warning data is used to mitigate the effects of drought.

Fig. 17. Information presented in web eufrance monthly values (february 2007) referred to average



Source: [eufrance](http://eufrance.fr)

Also, a **Drought Early Warning System** is implemented in France. There are two main networks:

- ROCA [Réseau Départemental d’Observation des Ecoulements], available since 2004 and managed by the National Agency of water and aquatic environment (ONEMA), which collects data flows and groundwater levels. Their activation and shutdown is ordered by the prefects, but can be ordered by the prefects coordinators or by the national ministry.
- RDOE [Réseau d’Observation de Crise des Assocs] available in some regions to detect situations of intermittent flow or dry riverbed.

Moreover, ONEMA is working on a harmonization and improvement of both networks and the creation of a National Observatory of Low Flows (ONDE).

Other relevant tools are:

Plan de Gestion de la Rareté de l’Eau, adopted by the Council of Ministers in October 2005, consists of a series of legislative, regulatory, research, communications and other initiatives structured in three axes: reinforce the legal priority given to drinking water; Economy and water allocation; seek better sustainable use of water (reused water, desalination and rainwater ...). The purpose of this plan is to

sustainably reduce France's exposure to drought, by providing additional safety margins (particularly with respect to the drinking water supply) and by reconciling the various uses while preserving the quality of aquatic environments.

PROPLUVIA is a new tool that allows access through an internet portal to agents and the general public to information concerning restrictive measures decided in all basins of metropolitan France. Since June 2011, the prefects must register their drought orders on PROPLUVIA, allowing an accurate real-time view of the situation of drought at an infra-departmental scale (specific areas within a department).

Fig. 18. Image from the web site propluvia

The screenshot displays the PROPLUVIA web interface. At the top, there is a header with the logo of the Ministry of Ecology, Sustainable Development and Energy, and the Ministry of Agriculture, Food and Forestry. The main title is "PROPLUVIA La consultation des arrêtés de restriction d'eau". Below the header, there are navigation links: "Accueil", "A propos", "Quelles sont les origines de la sécheresse ?", and "Comment sont décidées les mesures de restrictions ?".

The main content area is divided into several sections:

- Navigation:** Includes filters for "France métropolitaine", "Bassins versants" (set to "ADOUR-GARONNE"), "Régions" (set to "- Non renseigné -"), and "Départements" (set to "- Non renseigné -").
- Carte des Arrêtés par bassin versant (ADOUR-GARONNE) au 20/11/2012 (arrêtés publiés le 19/11/2012 minuit):** A map showing the Adour-Garonne basin with various zones of restriction highlighted in colors (yellow, orange, red). Major cities like Limoges, Clermont-Ferrand, Bordeaux, Toulouse, and Montpellier are marked.
- Editions de carte:** Options to view "Carte des restrictions", "Carte des restrictions superficielles", and "Carte des restrictions souterraines".
- Voir les arrêtés en vigueur à la date:** A date selector set to "20/11/2012" and a "Changer la carte" button.
- Gestion des zones de restrictions:** Checkboxes for "Restrictions spécifiques aux eaux superficielles" and "Restrictions spécifiques aux eaux souterraines".
- Légende de la carte:** A legend defining symbols for "Principales villes", "Cours d'eau", "Bassins Versants", "Départements", and color-coded zones for "Restrictions spécifiques aux eaux superficielles" (Vigilance, Alerte, Alerte renforcée, Crise) and "Restrictions spécifiques aux eaux souterraines" (Vigilance, Alerte, Alerte renforcée, Crise).
- Avertissement:** A warning box stating: "Vous pouvez retrouver la liste des arrêtés en bas de la page. Dans tous les cas, il convient de se référer à la version complète de l'arrêté pour disposer de tous les détails."

At the bottom, there is a table titled "Liste des Arrêtés (cliquer sur le numéro de l'arrêté pour accéder à son contenu) : ADOUR-GARONNE".

Numero d'arrêté	Niveau max	Restriction maximum du département	Département	Zones d'alerte	Début de validité	Fin de validité
121199	[Red box]	Crise	Dordogne	Beune, Céou aval, Céou amont, Enéa, Nauze, Couze, Couzeau, Louyre, Caudéau	13 novembre 2012	30 novembre 2012

Below the table, it indicates "1 élément(s) présent(s) par 10." and a page navigation "[1]".

At the very bottom of the page, there are small icons, the text "MEDDE - MAAF", "VERSION 2.2.5", and "« MENTIONS LÉGALES »".

Source: [Propluvia - Accueil](#)

6.4. Italy⁵⁴

Article 64 of Legislative Decree 3 April 2006, n.152 provides the distribution of the national territory into eight river basin districts, and lists the watersheds into them:

Distretto Idrografico Alpi Orientali	Distretto Appennino Centrale
Autorità di bacino nazionale dell'Adige	Autorità di bacino nazionale Tevere
Autorità di bacino nazionale AltoAdriatico	Autorità di bacino interregionale Tronto
Autorità di bacino interregionali Lemene, Fissare Tartaro Canalbianco	Autorità di bacino interregionale Sele
Autorità di bacino regionali Bacini del Friuli-Venezia Giulia e del Veneto	Autorità di bacino regionali bacini dell'Abruzzo
Distretto Idrografico Padano	Autorità di bacino regionali del Lazio
Autorità di bacino nazionale del Po	Autorità di bacino regionali di Potenza, Chienti, Tenna, Ete, Aso, Menocchia, Tesino e bacini minori delle Marche
Distretto Appennino Settentrionale	Distretto Appennino Meridionale
Autorità di bacino nazionale Arno,	Autorità di bacino nazionale Liri-Garigliano e Volturno
Autorità di bacino interregionale Magra	Autorità di bacino interregionale Sele
Autorità di bacino interregionale Fiora	Autorità di bacino interregionale Sinni e Noce
Autorità di bacino interregionale Conca Marecchia	Autorità di bacino interregionale Bradano
Autorità di bacino interregionale Reno	Autorità di bacino interregionali Saccione, Fortore e Biferno
Autorità di bacino regionali Bacini della Liguria	Autorità di bacino interregionale Ofanto
Autorità di bacino regionali della Toscana	Autorità di bacino interregionale Lao
Autorità di bacino regionali dei fiumi Uniti, Montone, Ronco, Savio, Rubicone e Uso	Autorità di bacino interregionale Trigno
Autorità di bacino regionali Foglia, Arzilla, Metauro, Cesano, Misa, Esino, Musone altri bacini minori	Autorità di bacino regionali Bacini della Campania
Autorità di bacino regionali Lamone	Autorità di bacino regionali della Puglia
Autorità di bacino regionali Bacini minori afferenti alla costa Romagnola	Autorità di bacino regionali della Basilicata
Distretto Pilota del Serchio	Autorità di bacino regionali della Calabria
Autorità di bacino del Serchio	Autorità di bacino regionali del Molise
Distretto della Sardegna	Distretto della Sicilia
Autorità di bacino regionale della Sardegna	Autorità di bacino regionale della Sicilia

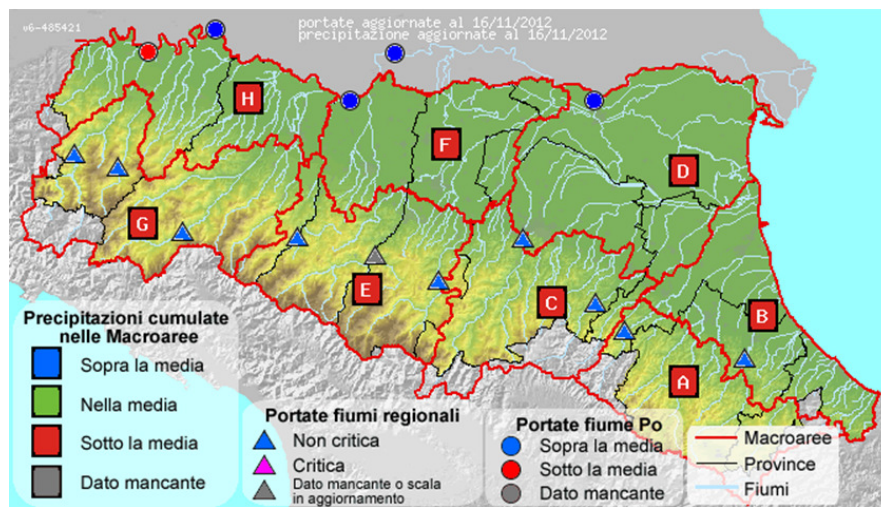
The complexity of river management scheme hinders the screening of measures and its geographical scope of application, even more the assessments of management tools that may have been generated in a wider context than RBMP. In any case, water scarcity and droughts seem to be relevant in all Italian RBDs, but not always characterized as major concerns nor clearly identified / separated phenomena. RBMPAs have identified DMPs only in **North Apennines** and **Central Apennines** RBDs, though drought also affects the rest of the country and may become more critical due to climate change. Water exploitation indexes suggest that water scarcity is a relevant problem in the southern RBDs of **Sardinia** and **Sicily**.

⁵⁴ Based mainly in different communications from Italian representatives within the framework of WS&D EG and other related works.

The **Emilia Romagna Region** (falls into three RBDs, the Po, the Northern Apennines and the Central Apennines) uses drought monitoring tools in order to identify the vulnerable areas. In fact, the Italian Legislation (Decree n. 152/99) assigns to the Regions and the Basin Authorities the check on the presence of areas subject to or threatened by drought and the adoption of specific protection measures. The vulnerable areas are indicated in the Water Protection Plan (Piano di tutela delle acque).

Quantitative information on the spatial variability of the precipitation and related anomalies (SPI for different time scales, soil humidity, groundwater and the water in rivers and reservoirs) are monitored for an overall control of the territory.

Fig. 19. River flows and precipitation in Emilia-Romagna

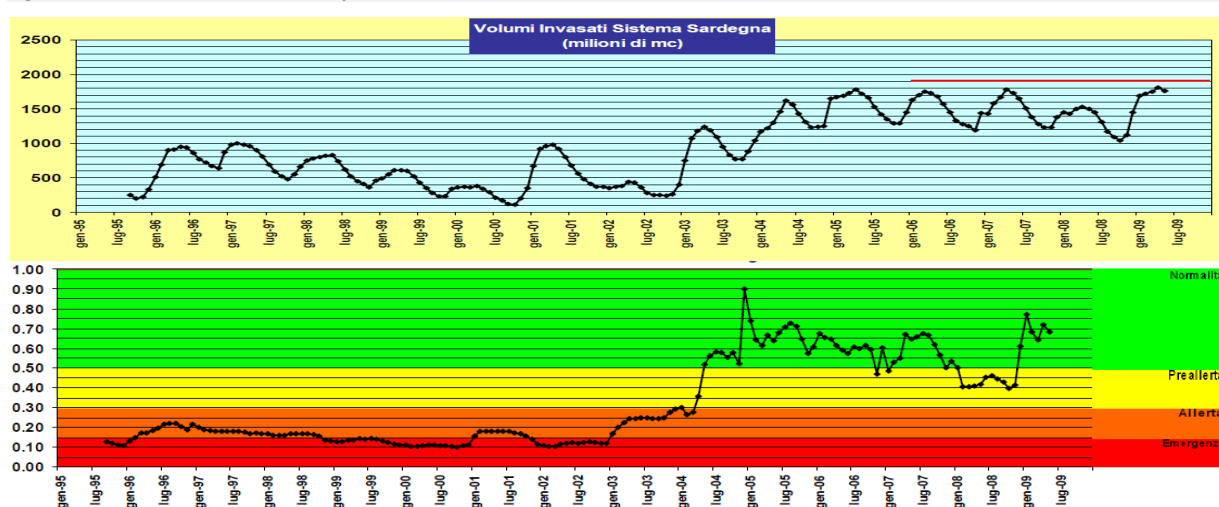


Source: [Arpaweb](http://www.arpaweb.it)

The **Region of Sardinia** has begun drought monitoring using a series of indicators. Since 2007 Directorate-General of the RBD publishes these indicators and the results of a model able to characterize scenarios-resources-demands, ongoing and predictable in the short and medium term in the different river systems, so helping to assess the risks and introduce drought planning to initiate proactive management (<http://www.regione.sardegna.it/j/v/25?s=106397&v=2&c=116&t=1>). Three types of measures are activated: restriction and reduction of supplies; activation of the strategic reserves and the combined use of surface and groundwater resources; implementation of a number of mitigation measures. The following table establishes the thresholds and the level of the decision about activating (or not) the procedures set out in the Crisis Management Plan - Piano di Gestione delle crisi).

ORDINARY REGIME (normal) I = 0.5 to 1	Management according to the guidelines of the overall planning
LEVEL OF SUPERVISION (early warning) I = 0.3 to 0.5	Monitoring of climatic parameters needed to estimate the onset of fluctuations, while checking the consumption leading them to a first level of reduction that does not cause disadvantages to users.
LEVEL OF DANGER (alert) I = 0.15 to 0.3	Supply should be reduced on average, according to the priority of uses, to proactively manage the possible persistence of the dry period; mitigation measures may be activated as well.
LEVEL OF EMERGENCY I = 0 to 0.15	This level should be avoided with measures adopted in previous stages. Further restrictions may be adopted. Statistical parameters of the series may be further modified and so thresholds.

Fig. 20. State indicator for the System Sardinia



Source: Piano di gestione del Distretto Idrografico della Sardegna

The calculation of the SPI and quantitative monitoring of the occurrence of drought conditions in the region are also carried out in Sardinia.

In the **Padan District** a Water Balance Plan [WBP- Piano di bilancio idrico] is being prepared as a consequence of having been identified as a priority measure in the PoM⁵⁵ (<http://www.adbpo.it/on-multi/ADBPO/Home/PianodiBilancioldrico.html>). This Plan is structured in two main sections, including both proactive and reactive measures. The reactive ones face drought crisis and emergency situations and respond to the contents and structure proposed in WSDEN 2007. There are also measures to promote water saving in agriculture and other efficiency-oriented actions.

The Drainage and Irrigation District Romagna Occidentale adopted in 2007 a DMP (WSDEN 2007). A number of scenarios and measures are set at different levels of meteorological and hydrological

⁵⁵ *Piano del Bilancio idrico a scala di distretto, con identificazione delle criticità quantitative e delle misure per ridurre intensità e incidenza e per il mantenimento e/o miglioramento dello stato ambientale dei corpi idrici* (Water Balance Plan for the district, with the identification of “water quantity criticalities” and of measures aimed at reducing incidence and intensity and at the maintenance of environmental status of water bodies).

emergency drought status and identifies procedures and interested subjects (in the energy and agriculture sectors specifically), with progressive reduction of abstractions according to gravity and seasonality; technical measures to save water resources are identified and supported, and regulation bodies are requested to reduce water permits duration (WSDEN 2007).

6.5. The Netherlands⁵⁶

In most years the discharges of the rivers Rhine and Meuse are large enough to deal with all the needs. Using a system of river branches, man-made lakes and canals, and by using weirs, sluices and pumps the water can be stored and distributed. If the river discharges are sufficient, all demands can be met. However, when snowfall has been limited in the past winter, and spring and summer have been dry, the river discharges may be too low to fulfil all demands.

In the Netherlands drought is handled as a societal crisis, in which crisis management takes place and (crisis) measures might be taken which overrule normal water management. During a drought the water of these rivers is distributed conform the so-called priority sequence. This priority sequence has been laid down legally. It is based primarily on societal considerations, and secondly on economical ones.

Table 6. Priority sequence

Category 1. Safety and prevention of irreversible damage	Category 2. Public Utilities	Category 3. Small-scale use with high added value	Category 4. Other demands (assessment on economical / societal arguments)
1. Stability of dikes 2. Soil subsidence (peat) 3. Nature (when dependent on soil conditions)	1. Drinking water 2. Energy production	<ul style="list-style-type: none"> • Temporary sprinkling of capital-intensive crops • Process water 	<ul style="list-style-type: none"> • Shipping • Process water • Agriculture • Nature (no irrev. damage) • Industry • Water recreation • Inland fishing

Source: Dealing with Low Flows in the Netherlands

1. Demands for safety and the prevention of irreversible damage have the highest priority. In the western part of the country one finds as bottom material peat. Even dikes along waterways are made of peat. Drying out will subside the bottom, which is an irreversible process. It may also cause the collapse of dikes. In this category also nature has been listed, but only when irreversible damage is prevented.
2. The public utilities form the demands in the second category. Compared to the other needs, the amounts of water needed for drinking water are relatively small. Water for energy production is used for cooling water, the warmer water returns into the water system. During times of high water temperatures this is not allowed, then cooling towers are used.

⁵⁶ Based on “Operational Water Management during Droughts Discussion paper” (Herbert Berger and Gerard van Vliet, 6 February 2012) and “Dealing with Low Flows in the Netherlands” (H.E.J. Berger). Both documents provided by Ir. Max Linsen (Rijkswaterstaat Centre for Water Management).

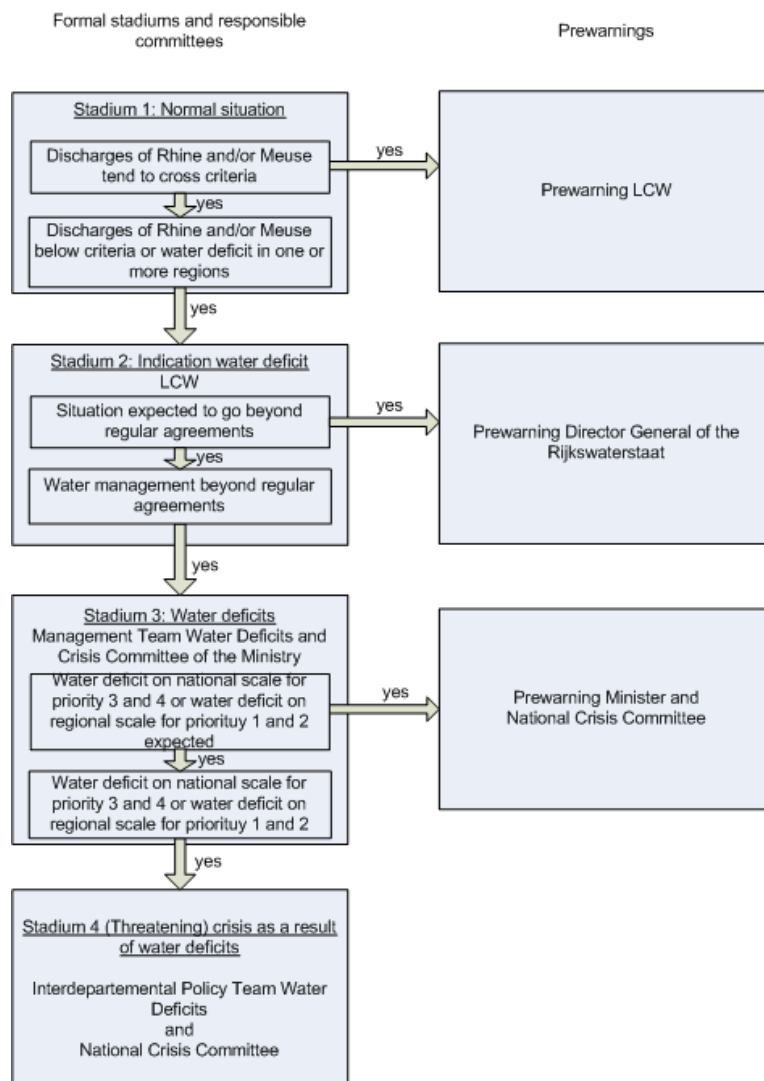
3. In this category the water demands are listed that require small amounts of water and yield a high added value. Demands are temporary sprinkling of capital-intensive crops and industrial process water.
4. The last category contains the other demands. Many of them can be evaluated in an economic way, but societal arguments will also play a role in the decision process. In this category, agriculture and shipping are the two interests with great economic importance. The river Waal is an intensively navigated river and its water levels are dependent on discharge only, so water withdrawals will influence the water depth and therefore the shiploads.

During normal conditions the water is distributed in accordance with the water agreements. However, if water quantity or water quality are insufficient, the National Coordination Committee on Water Distribution (LCW) will assemble and take action. LCW consist of representatives of the water management institutes –both Rijkswaterstaat (Ministry of Infrastructure and the Environment) and water boards–, the provinces, the departmental crisis coordination centre, the meteorological institute and communication specialists. Its tasks are:

- To collect and distributes information about the actual situation, including the measures taken,
- To compose the actual national water survey
- To formulate advices about the measures to be taken
- To coordinate the execution of these measures

Dependent on the seriousness of the drought the committee responsible for the decisions with the problem will be higher in the governmental organization. The scheme used is depicted in subsequent Figure.

Fig. 22. Scheme for Operational Water Management during Droughts in the Netherlands



Source: *Dealing with Low Flows in the Netherlands*

It is shown that pre-warnings are issued to the (head of) the committee that will be in charge during the next stadium, some time before that committee takes over the responsibility. Decisions of the responsible committee will be made in accordance with the priority sequence.

After crisis management has put into operation the decisions about the important measures are taken by the head of Rijkswaterstaat or the State Secretary.

It should be noted that only a few measures are submitted to the higher level. Most measures are common, and are taken by the waterboards themselves or by the regional services of Rijkswaterstaat. Only measures with a significant impact or measures concerning the priority sequence require a decision on the higher level.

In practice, the most effective measures seem to be the preventive measures, i.e. the measures that are taken before a water shortage occurs. Therefore the LCW monitors the available water reserves continuously and develops long term discharge forecasts.

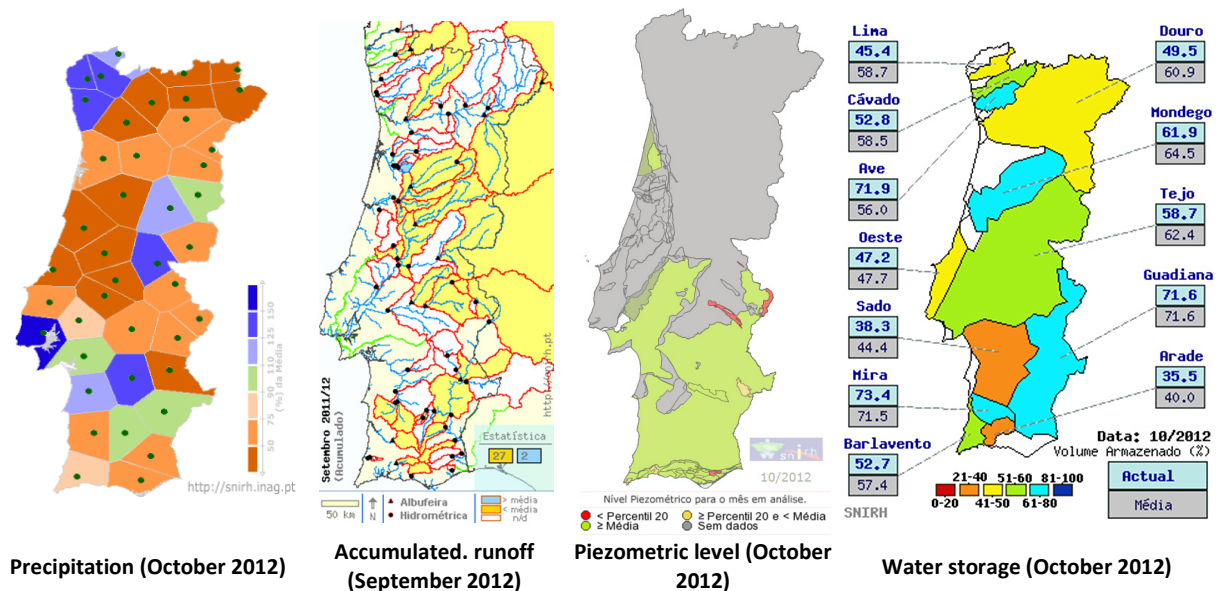
The application of the priority sequence is not as easy as one may think at a first sight. Not all the water can be distributed anywhere, for some purposes the water is after the use still available (for example shipping), for some purposes the water is closely connected with other purposes and for some purposes also the chloride content is important. Therefore a good overview of the Dutch water system and the actual needs is important. It is noted that models can give only roughly the information required.

6.6. Portugal

Drought monitoring is based in hydrological and meteorological indicators.

The **Water Institute** in Portugal (Instituto da Água - INAG) is the national body responsible for the management of water resources, including drought events. INAG operates the SNIRH (Sistema Nacional de Informação de Recursos Hídricos - National Information System of Water Resources) provides monthly bulletins highlighting the most relevant information for assessing the drought situation in Portugal. The information, using the monitoring networks, is presented online (www.snirh.pt) as charts, graphs and tables: monthly rainfall (42 stations) river flows (58 stations), water storage (by river basin and individualized by 54 reservoirs) and piezometric levels (27 piezometers in aquifers along Algarve, Alentejo, Lisbon and Tagus Valley and Central regions). Indicators are generally defined by a percentile of long-term monthly average data and also monthly and accumulated data are presented.

Fig. 23. Synthesized data on hydrological indicators

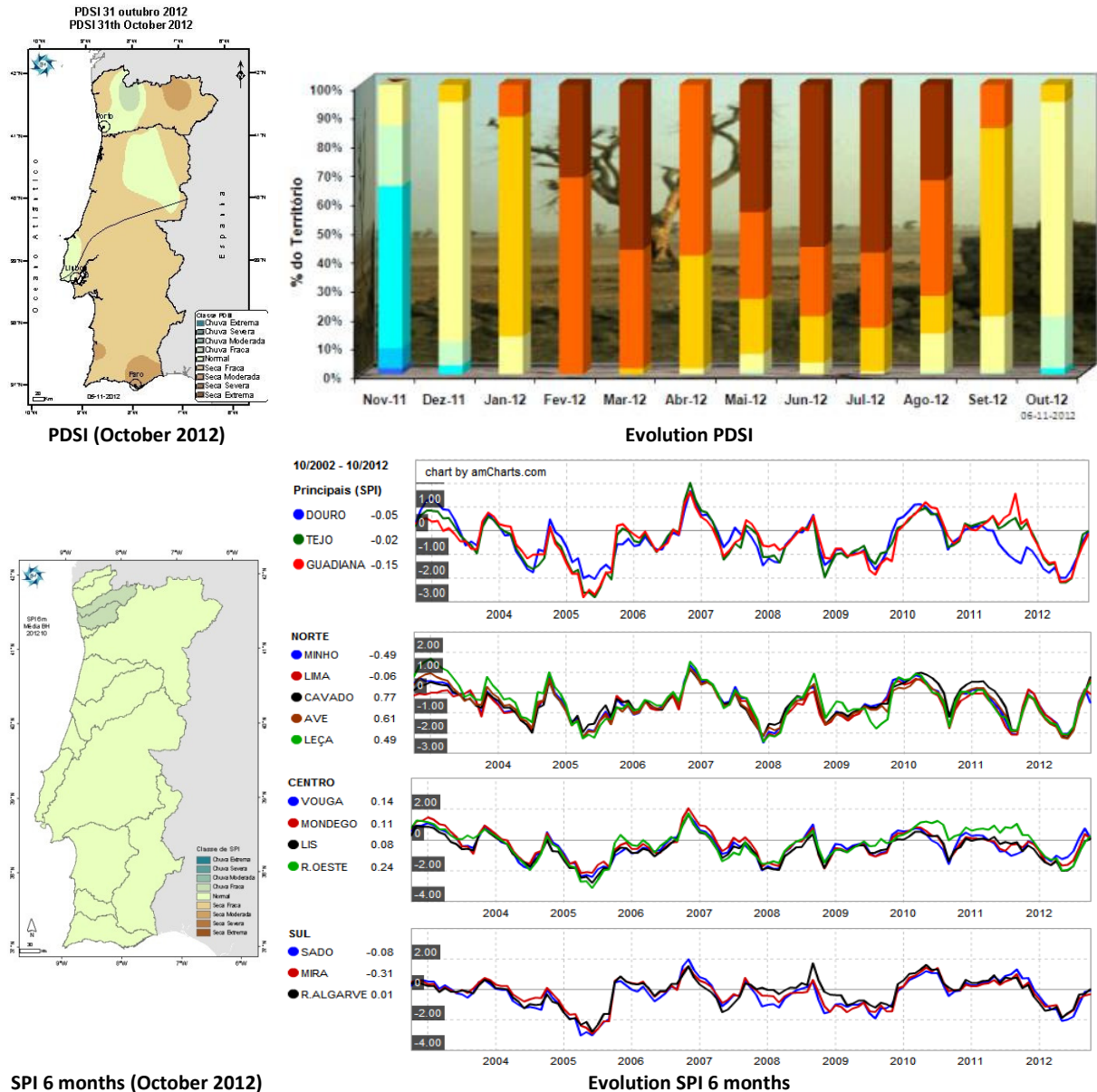


Source: SNIRH

The **Institute of Meteorology**, (Instituto de Meteorologia - IM) monitors the weather in mainland Portugal and in particular drought events (<http://www.meteo.pt/pt/oclima/observatoriosecas/>). The evaluation is done applying the Standardized Precipitation Index (SPI) [3, 6, 9 and 12 months], the Palmer

Drought Severity Index (PDSI), with monthly precipitation data. . The spatial distribution of the drought indicators are classified by drought classes.

Fig. 24. Synthesized data on meteorological indicators



The **National Commission for Reservoir Management** (Comissão de Gestão de Albufeiras - CGA) follows the situation through periodical meetings and regional sub-commissions. CGA includes the main users and water state organizations.

The successful procedures applied in the monitoring and management of the very extreme drought occurred in 2005 (which return period as been set to approximately 200 years) has been set as a national reference.

If indicators reveal the onset of a meteorological drought, IM informs the CGA which analyze the situation, based essentially on the water storage in some reservoirs, particularly multi-purpose ones and the imbalance between water available and water demand prediction. According to the results Commission may propose to the Government that a state of drought should be declared and a Drought Monitoring and Impact Mitigating Programme should be drawn up.

After declaration of Drought, an organizational structure is set, comprising two action levels:

- The **Drought Commission** composed by the main stakeholders, including the national and regional state organizations and the water users. Its activities included between others: the establishment of drought impact severity levels; the communication systems to contact stakeholders and population and promote awareness-raising campaign (mainly via web); the analyses and establishment of measures to be implemented, as well as the responsible entities; the launch of legislative and budget-related initiatives; the setting of specific measures to support the agriculture in affected areas; the identification and proposal of urgent and extraordinary public works
- The **Technical Secretariat** that should provide a fortnightly report on the evolution of the situation and a draft decision to the responsible entity.

The drought evolution is evaluated at real time. Water availability in rivers, reservoirs and groundwater are subject to special monitoring, and confronted with water quantities requested by the different users and different levels of priority and eventual restriction. Incentives to the issue of permits for the survey and abstraction of groundwater during this period are analyzed. When indicators turn back to normal situation levels (precipitation and reservoir storage), CGA should propose the end of Drought.

The last task of the Drought Commission is the elaboration of the **Drought Balance Report**, with the main results obtained and lessons learnt⁵⁷. This report proposed the development of a Drought Management System, since it was considered necessary to move from a crisis-management approach to prevention and preparedness. Thus, an early warning system is currently been developing aiming at identifying the main measures to be adopted following the drought severity levels including different levels of action, as well as the entities responsible for their adoption.

The early implementation of actions that must be adopted during a drought imply that those measures must be planned and standardized. The development of **Contingency Plans for drought periods** (Planos de resposta às situações de Seca) at RBD level is included in the Programme of Measures of the National water Plan (Plano nacional da água).

6.7. United Kingdom

Over the past 40 years England and Wales have suffered different drought episodes, of which the most notable were in 1975-76, 1989-1992, 1995-96, 2005-07 and 2010-11. Previously, widespread droughts are known during the 1880s, and in the periods 1933-34 and 1920-21.

⁵⁷

<http://www.inag.pt/inag2004/port/divulga/actualidades/seca/relatorioBalanco.pdf>

That of 1975-76 has been one of the most extreme, as a result of the continuous high temperatures as well as lack of rainfall. Many restrictions on water use were introduced, including rota cuts and standpipes in parts of England and Wales. Many trees were affected by moisture stress and the hot temperatures led to fires on moorland and heath land. More recently, the 2005-07 drought was felt severely in the south east of England where hosepipe bans affected over 15 million people. In 2010, the north west of England experienced a short spring/summer drought following the driest spring on record in this region; this led to the water company implementing a hosepipe ban affecting over 6 million people. Lastly, in 2011 the Anglian region had the driest spring on record affecting especially farming and the natural environment in Lincolnshire and East Anglia.

Because of the importance of the problem and its potential economic, social and environmental impacts throughout the territory, the legislation includes several provisions to manage these situations and to minimize its effects. Institutional responsibility for legislative development on issues of water resources is from the Department for Environment, Food and Rural Affairs [DEFRA] in England and the Welsh Assembly Government in Wales, while Environment Agency is the statutory body that has a duty to manage water resources in England and Wales. Other important agents in water management, and thus involved in drought management situations are water supply companies. Otherwise the main tools used to address these situations are the National drought plan, the Regional drought plans and the water companies drought plans.

The main agents involved in managing droughts are:

- a) **DEFRA and Welsh Assembly Government:** besides the responsibility for the establishment of regulations to cope with droughts-hosepipe bans, drought permits, drought orders works-, during drought these institutions works closely with the Environment Agency and the water companies to ensure a balance between public water supply and the respect of environmental conditions.
- b) **Environment Agency:** is responsible for monitoring, reporting and acting to manage the impact of drought on the environment, business and people. It works closely with abstractors to find ways to reduce the impact of drought on their businesses whilst balancing the needs of the natural environment.

The EA has developed drought plans to cover different scales of operation and different drought stages. These plans are published on the internet⁵⁸ and were subject to public consultation. These are operational plans that set out drought monitoring, the temporary organizational changes that will be made during a drought, and the steps that will be taken to manage the water environment.

- [National drought plan](#) managed by the Environment Agency Head Office Drought Plan.
- Seven more Environment Agency drought plans, one for Wales and one for each of the six Environment Agency regions in England.

[Anglian region drought plan](#)

[Midlands region drought plan](#)

⁵⁸

<http://www.environment-agency.gov.uk/homeandleisure/drought/default.aspx>

[Yorkshire and North East region drought plan](#)

[North West region drought plan](#)

[South East region drought plan. Appendices to the South East region drought plan](#)

[South West region drought plan](#)

[Environment Agency Wales drought plan. Appendices to Wales plan](#)

These plans involve monitoring a range of environmental and hydrological indicators that determine the actions are needed to take to achieve the aim of reconciling the need for public water supply and other abstractions, and the protection of water ecosystems.

- c) **Water companies:** are responsible for maintaining water supplies to meet the needs of customers, without damaging the environment whilst considering the needs of other water users. All water companies have drought plans, which is a requirement of the Water Act 2003. Also, following the Floods and Water Management Act 2010, from October 2010 water companies have a wider range of temporary use restrictions that they can implement during a drought, which previously were mainly limited to the hosepipe ban powers. Such restrictions do not require the approval of Government or the Environment Agency. However, water companies should work closely with the Environment Agency and under its supervision and in accordance with the provisions of their drought plans. Also, in case of a major drought emergency they have to liaise in advance with local authorities, emergency services and local resilience forums to coordinate the needed response actions.

Some of the tools / measures included in these plans are:

- **Temporary Use Bans (commonly known as hosepipe bans).** Bans on using hosepipes for garden watering and car washing are usually the first restrictions that are put in place to cope with dry periods. They are implemented by water companies and do not require the approval of the Government or the Environment Agency. The Environment Agency also has the power to restrict or ban agricultural spray irrigation if this is necessary to protect the environment.
- **Drought orders and drought permits.** In an escalating drought water companies may have to take additional steps by applying to the Environment Agency for a drought permit or to the Secretary of State for Environment, Food and Rural Affairs for a drought order. *Drought permits* enable companies to take water from new sources, or to alter restrictions on existing abstractions. *Drought orders* can go further and restrict the non-essential use of water. The Drought Direction lists uses of water which can be banned under a drought order. Permits and orders can only be made if the Environment Agency or Secretary of State is satisfied that the need exists by reason of an exceptional shortage of rain. They are made only for specified periods and may be renewed only for further limited periods.

Environment agency drought plans

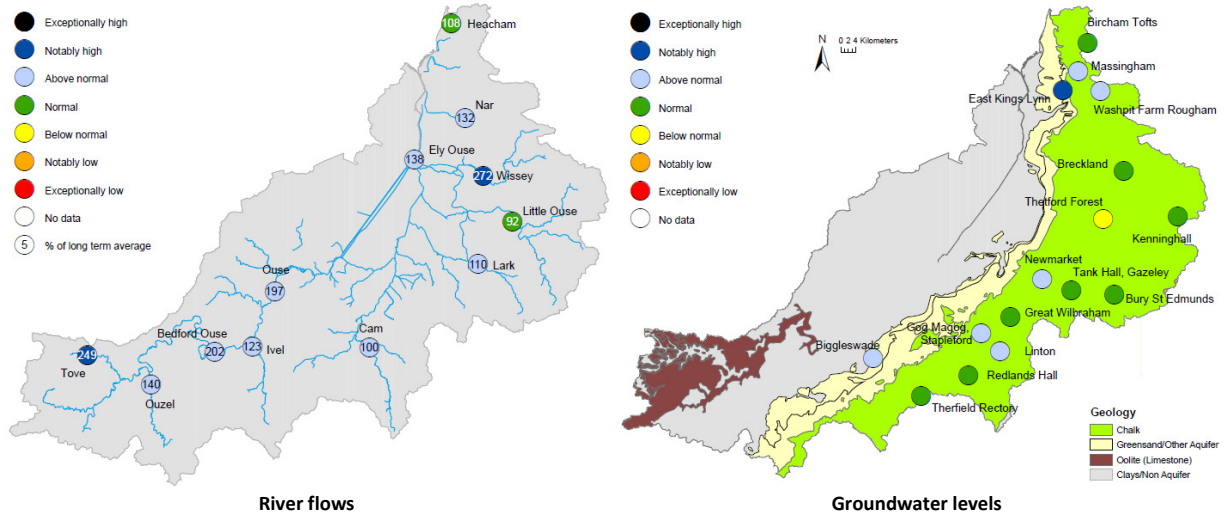
Environment Agency drought plans set out the management structure and actions for drought management. They cover drought monitoring, triggers for drought status, the way that decisions will be made during a drought, any changes to management structure that are necessary, and communications

work. Also, provide a framework for liaison with water companies, awareness campaigns and determination of drought permits.

The plans cover different scales of operation and different drought stages and they are published on the internet⁵⁹ and subjected to public consultation. The four stages are:

- *Normal conditions*: there are no particular drought actions other than monitoring hydrological and environmental conditions.
- *Potential drought*: actions required to prepare for drought following a prolonged period of dry weather if things does not change
- *Drought*: Actions required for managing drought once drought conditions impact on people, business and the environment.
- *Post drought*: Actions required to monitor and manage the recovery of water resources conditions and to review our response.

Fig. 25. Some drought monitoring indicators in Central Anglian Region (October 2012)



Source: Environment Agency: Anglian Central Area monthly water situation report

Depending on the stage of drought, actions triggers are defined on the basis of different indicators, for example cumulative rainfall, soil moisture deficit, groundwater levels or surface water flow comparison with long-term average flows.

Therefore, a monitoring programme is needed to provide data for detecting the onset and end of a drought and the impacts during a drought. This normally includes data from: Rainfall totals; Indicator flow gauging station network; Groundwater level monitoring network; National ecological drought surveillance network; Surface or ground water quality monitoring networks; Reservoir storage data. In addition, supplementary hydrometric, ecological or other data may be collected during a drought when appropriate.

59

<http://www.environment-agency.gov.uk/homeandleisure/drought/default.aspx>

Finally, the Environment Agency publishes an Early Drought Prospects report when drought threatens and throughout the drought. They identify the hydrological situation, the area likely to be affected by drought, and recommended actions for water companies, farmers and people.

Water companies drought plans

Water supply companies have a statutory duty to prepare a 25-year water resources management plan, revised every 5 years. These plans are designed to allow public water supply to continue through a repeat of the worst droughts of the last hundred years with only restrictions on non-essential water use in the worst droughts. They also have to prepare drought plans every 3 years and revised yearly. These show the operational steps that water companies plan to take to manage a developing drought. They identify the triggers for action and the steps that will be taken to make sure that water supply continues while minimising environmental damage.

The Environment Agency provides detailed guidelines for water companies on the content of drought plans and timings for the completion of each stage of the process. These plans outline a series of actions to take to effectively manage the water resources available during a drought. Depending upon the severity of the drought this might include campaigns to encourage reduced consumption by the public, hosepipe bans, enhanced leakage control and pressure reduction. Increasing severity may lead to the use of drought orders or permits to increase abstraction or change discharge regimes, to prevent other abstractions that could deprive the public supply of supplies or to restrict non-essential uses of the public supply. The plans include an assessment of the environmental impact of different drought management options. The plans are subject to public consultation and are submitted to Ministers.

Emergency planning

Water companies and Environment Agency drought plans cover the actions required up to the classification of an emergency. At this stage water companies will activate their own emergency plans to deal with a loss of supply. Meanwhile, the Environment Agency, in addition to its other responsibilities, also supports any multi agency arrangements that are set up to deal with the wider impacts. The Agency local drought teams work with local and regional resilience forums to make sure that water companies have assessed the risk of drought properly and take the right steps to avoid emergency restrictions.

7. Main references

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