Final Report

Gap Analysis of the Water Scarcity and Droughts Policy in the EU

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Abbreviations

DPSIR	Driver-Pressure-State-Impact-Response
EcF	« Economy first » story line scenario
EEA	European Environment Agency
EUSF	EU Solidarity Fund
JRC	Joint Research Centre
LISFLOOD	GIS-based hydrological rainfall-runoff-routing model
MS	Member state(s)
PoM	Programme of Measures
RBD	River Basin District
RBMP	River Basin Management Plan
SEIS	Shared Environmental Information System
SF	Structural Funds
SoE	State of Environment
SU	Sub-unit
WaterGap	Water - Global Analysis and Prognosis model
WEI	Water Exploitation Index
WFD	Water Framework Directive
WISE	Water Information System for Europe
WS&D	Water Scarcity and Drought

1. Introduction

1.1 Background

A growing concern has been expressed throughout the European Union regarding water scarcity problems and drought events. Whilst efforts made to address water scarcity and drought at different decision-making scales are recognised, they are considered insufficient to adequately address water scarcity and droughts. This threatens the sustainable management of water resources and of aquatic ecosystems in Europe.

In response to calls for a more integrated approach to European water policy and following technical and policy steps taken since 2006, in particular its 2007 Communication on water scarcity and droughts in the EU[1], the European Commission proposes to address WS&D in the context of its forthcoming 2012 *Blueprint to Safeguard Europe's Water*.

1.2 Objectives of the *Gap Analysis* project

The overall objective of the project entitled ***Gap analysis of the Water Scarcity and Droughts Policy in the EU*** (shortened to Gap Analysis) is to identify new policy options that would help address Water Scarcity and Droughts (WS&D) in the EU. The study contributes to the on-going European Commission effort to move WS&D through the policy agenda, feeding in particular into the *Blueprint to Safeguard Europe's Water* (or EU Water Blue Print).

To address this overall objective, the Gap Analysis project:

1. Provides a sound **overview of the magnitude of the WS&D** problem in Europe, **today and by 2030**, accounting for global changes such as socio-economic developments and climate change;

2. **Assesses the adequacy of measures** (at national, river basin district or local levels) already envisaged by individual Member States (MS) to prevent, manage or mitigate WS&D;

3. **Identifies remaining gaps** (i.e. WS&D problems that remain unsolved even with all planned measures already implemented) and **suggests possible new measures** (or mix of measures) to fully address WS&D in the EU;

4. Assesses qualitatively the **environmental, economic and social impacts** of these new measures, along with their **feasibility.**

[1] Communication from the Commission to the Council and the European Parliament - Addressing the challenge of water scarcity and droughts, COM(2007) 414, 18 July 2007

1.3 Overall methodology of the project

The methodology of the Gap Analysis project was initially structured around four main tasks as indicated in Figure 1.

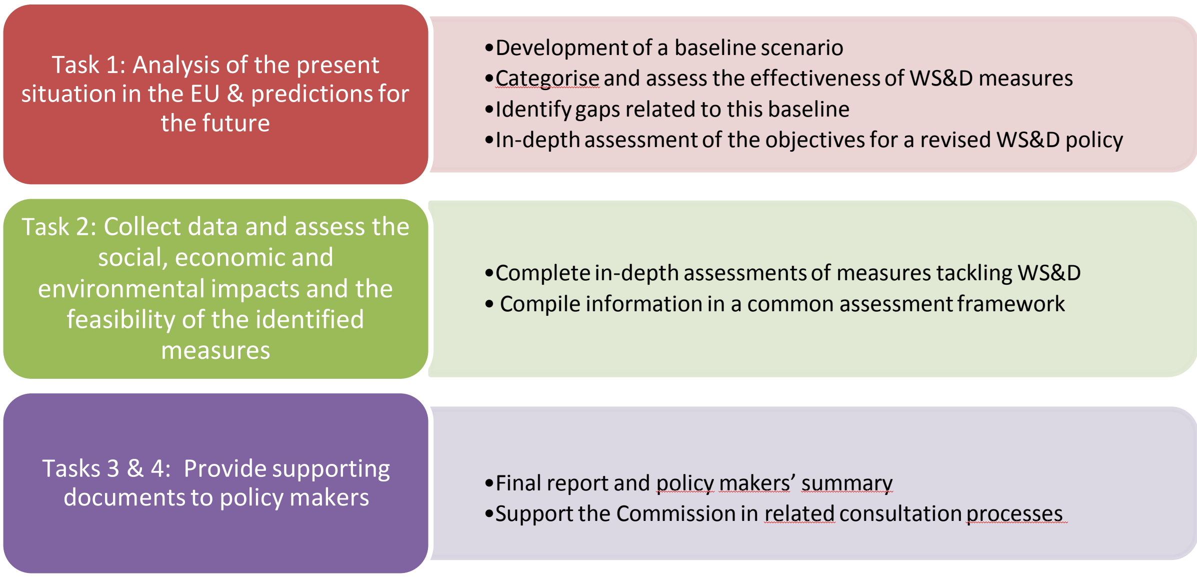

Figure 1. Overall methodology of the *Gap* Analysis project

Operationally, the project was developed in two consecutive steps. The first step (Task 1) is the *gap analysis* itself. Building on the review of current knowledge on a) the magnitude of WS&D in Europe, and b) the policy responses already developed to tackle WS&D, it proposes a dual *ex-post* assessment of:

- The **existing (being implemented and recently approved) measures** that address WS&D and that are proposed in the River Basin Management Plans (RBMPs)[2] of individual Member States (MS).

- The implementation of the **recommendations of the 2007 EC Communication on WS&D**, and of policy instruments developed in Europe as answers to the key issues identified in this Communication.

The second step (Task 2) focused on the identification of new policy responses resulting from the gap analysis, and on the qualitative assessment of these policy responses. Though initially foreseen, no specific stakeholder consultation process on WS&D was organised by the Commission, WS&D issues being embedded in the wider stakeholder consultation organised in support of the development of the EU Water Blueprint.

[2] Note that to this date, not all RBMPs have been approved yet, as indicated by the latest update (10-06-2011) on the River Basin Management Plans 2009-2015 availability by country. http://ec.europa.eu/environment/water/participation/map_mc/map.htm

1.4 The content of the report

This report is the final report of the Gap Analysis study. It aims to distribute the results of the assessment in terms of:

- The **gap in existing policies** implemented in Europe at different scales for addressing WS&D;
- The **potential impacts of new policy areas and options** that could be proposed for tackling WS&D more comprehensively in Europe.

The report is structured following a set of key policy questions:

- Question 1 – What is the magnitude of today's WSD problem in Europe**WS&D**?
- Question 2 - What will be the magnitude of **WS&D problems in Europe by 2030**, taking into account global (socio-economic and climatic) changes?
- Question 3 – Are **all proposed policy instruments** (support actions and measures) to prevent, manage or mitigate WS&D situations in individual Member States sufficient to tackle WS&D problems?
- Question 4 – What are the **main sources of uncertainty** underlying the different assessments – and what is the robustness of results presented to address Questions 1 to 3?
- Question 5 –What are the **main gaps in water policy** that need to be addressed to fully tackle WS&D in the EU?
- Question 6 – What are the potential **policy areas** and **policy options** that could help "fill in the gaps" and ensure WS&D is addressed in a cost-effective manner in Europe?
- Question 7 – What could be the **potential social, economic and environmental impact**s of the proposed policy areas and options?

The answers to each policy question are presented in the individual chapters of this report (Chapters 4 to 10). These are complemented by three separate transversal chapters summarising: a) the concepts, definitions and understanding of the causes and consequences of WS&D (Chapter 2); b) the methodology applied to obtain the results presented (Chapter 3); and, c) the conclusions of the report (Chapter 11).

2. Water Scarcity and Drought (WS&D): the basis for common definitions and understanding of key issues

Over the past few decades, concern about drought events and water scarcity has grown within the European Union, especially with regard to long-term imbalances of water supply and water availability in Europe in a context of climate change. Over the past thirty years, droughts have dramatically increased in number and intensity in the EU, the number of areas and people affected by droughts increasing by almost 20% between 1976 and 2006. A significant part of the EU population and territory has experienced water scarcity in recent years (EC, 2007))[3] and recent trends highlight the significant geographic expansion of water scarcity problems across Europe.

2.1 Basic concepts for understanding WS&D

The concepts of water scarcity and droughts are closely interrelated to the following basic concepts of water management:

- **Water supply** satisfies **water demand** by providing water from different sources, whether by: withdrawals from natural hydrological regimes (surface and groundwater abstraction); rain water harvesting; water imports from other basins; and non-conventional water sources such as the desalination of brackish water/seawater or reuse of urban or industrial waste waters (with or without treatment) that can reduce the overall use of water extracted from natural sources). Non-conventional water sources are accounted for separately from natural renewable water resources[4].

- **Water abstraction** is the process of taking water from a natural hydrological regime (ground or surface water) either temporarily (e.g. for cooling purposes) or permanently (e.g. for drinking water). Abstraction is performed by a wide range of sectors such as drinking water services, manufacturing, mining, energy generation, etc.

- According to the European Union Water Framework Directive (WFD), **Water use** means *water services together with any other activity identified under Article 5 and Annex II having a significant impact on the status of water*. Water use can refer to the use of water by agriculture, industry, energy production and households, including in-stream uses such as fishing, recreation, transportation or waste disposal (EC, 2007).

- **Water consumption** can be defined as the share of water abstracted that is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, been consumed by man or livestock, been discharged directly into sea, or otherwise removed from freshwater resources. Water losses during transport of water between abstraction and water use locations are excluded.[5]

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[3] The Water Exploitation Index was the most commonly used indicator but is currently being updated and revised . The main aspects of this discussion are accounted for in this report in Section 2.2.2. The general magnitude is provided here as an initial reference point as to the magnitude of water scarcity, one that has oriented decision making so far at EU level.

[4] http://www.fao.org/ag/agl/aglw/aquastat/water_res/indexglos.htm.

[5] http://glossary.eea.europa.eu/EEAGlossary/W/water_consumption.

2.2 The challenge of apprehending WS&D

2.2.1 Distinguishing Water Scarcity from Droughts:

Despite the established concepts of water use, consumption and supply; water scarcity and droughts remain complex issues. There is still debate about their precise definition, in particular regarding droughts (Mishra and Singh, 2010). As both relate to water quantity issues and can have similar effects, water managers, policy makers, public and media often use both terms in an indistinct manner. This can lead to confusion in policy documents and (additional) uncertainties when establishing causal relationships. This confusion can be illustrated by the River Basin Management Plans (RBMPs) developed under the WFD that recognize either drought, water scarcity or both phenomena as relevant across the whole RBD or in their sub-basins. Averall, 20% of RBMPs do not clearly distinguish drought from water scarcity, or show current water (quantitative) status (i.e. whether enduring water scarcity or not) in contrast to other sources and references (TYPSA, 2011a).

From a policy point of view, in particular for defining adequate policy responses, it is necessary to clearly distinguish between both concepts based on their causes and on potential opportunities for actions. In line with the 2007 European Commission Communication on Water Scarcity and Droughts, and as agreed by the EU MS[6]:

- *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*.

- *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.*

The table below proposes a common set of distinctions between water scarcity on one side, and droughts on the other side, as agreed by EU MS under the Common Implementation Strategy process[7] (for more differences between water scarcity and droughts, see Annex I).

Table 1. Timescale and causes of water scarcity, drought and related concepts

		Timescale		
		Short-term (days, weeks)	**Mid-term (months, seasons, years)**	**Long-term (decades)**
Causes	**Natural**	Dry Spell	Drought	Aridity
	Man-made	Water shortage	Water scarcity	Desertification

As indicated above, there are similarities and differences between drought and water scarcity. It appears quite evident that the two terms are highly interlinked, as the severity and frequency of

[6] INTECSA-INARSA, S.A., based on a previous draft by TYPSA (2012). Working definitions of Water scarcity and Drought Report to the European Commission.

[7] INTECSA-INARSA, S.A., based on a previous draft by TYPSA (2012). Working definitions of Water scarcity and Drought Report to the European Commission.

droughts can lead to water scarcity situations as a result of overexploitation of available water resources (EC, 2007). The difference between both phenomena is visible only if detailed investigations are made: 1) drought causes economic damage mostly in the peak spring or summer season when the irrigation demand is highest, the effects of winter drought often being less notable; 2) water scarcity poses a permanent limit to the economic development of a region or to the ecological status of ecosystems, whereas drought poses only a time-limited (potentially significant) water shortage; 3) drought may occur in different water-scarce conditions, droughts under high water scarcity requiring specific treatment from a risk management perspective.

2.2.2 Measuring water scarcity

How to apprehend and measure water scarcity (understood as a ratio between water demand and water availability) and droughts (the temporal variation of water availability) remains a key challenge and the focus of many expert debates. To assess the state of water availability against water demand and identify water stressed areas, many indicators bearing a "water scarcity context" have been proposed by the literature. Such indicators have been developed for different purposes and settings. Some were developed for ranking countries based on their freshwater resources, relating water availability to population and relating water availability to how the resource is actually used. Others were created relating water availability to exploitation, such as Intensity of use of water resources, OECD; Water Stress Index (WSI) per source, EWP Water Stewardship Programme; Falkenmark Water Stress Indicator quoted by UNEP/WMO; Water availability index WAI, etc. The spatial and temporal scale of all indicators along with their respective methods of calculation, are determinant. Given such characteristics the interpretation of the indicators should be cautious so to avoid biased conclusions. Referring to multiple indicators can ease the interpretation and facilitate the communication of a more comprehensive message.

The Water Exploitation Index (WEI – see Cosgrove and Rijsberman, 2000), that is used today by the European Environmental Agency (EEA), has for many years been the only common reference indicator for water scarcity. This indicator combines the "annual abstraction of fresh water divided by the long-term available freshwater resources" (EEA, 2011). Initially assessed at the MS level, it has been progressively revised at the river basin scale. And the comprehensiveness and quality of records have improved over the years. However inconsistencies between the levels (i.e. country *versus* river basins), recording procedure and accuracy have raised questions about this indicator (CIS Expert Group WS&D, 2011):

- National estimates of WEI do not reflect the extent and severity of water scarcity in sub-national regions (See example in Box 1); the high level of aggregation between areas of stress and non-stress and prevents a clear identification of the phenomenon.

- The temporal scale (Long Term Annual Average) of the water availability calculations prevents the detection of developing trends and the identification of inter-annual or seasonal variability.

- The calculations do not account for return water. Return water is an important component which can mitigate the pressure exerted on the system through abstraction. Considering returned water in the water balance can reduce the stress, especially in the cases of large cooling water abstractions (where most of the cooling water is returned to the system if not lost in evaporation towers)
- The calculations do not account for the minimum requirements of environmental flows. Environmental and other legal water requirements (i.e. as defined by transnational treaties)

need to be considered since they in fact limit the available water that can actually be exploited and used for consumptive purposes. Evidence exists that the 20-50% of the mean annual river flow in different basins needs to be allocated to freshwater-dependent ecosystems to maintain them in fair condition (Smakhtin et al., 2004).The WEI does not reflect shortages resulting from drought situations, at times when there is increased pressure on the systems;

- Changes in storage are not accounted for, thus if calculations are attempted in a finer temporal resolution the results are problematic.

Furthermore, the WEI indicator does not reflect "what is the resource" (EC, 2012) or the "true" volume of water which is available for exploitation". It does not help identify the volumes of water that can be mobilized at one point and place in time.

Fully acknowledged by EU MS, the weaknesses of the WEI indicator have led to the recent adoption of an improved "WEI+" indicator to be used in the EU. The proposed WEI+ aims at redefining the actual potential water to be exploited (i.e. availability), since it incorporates returns and accounts for changes in storage, tackling many of the limitations of the WEI (e.g. temporal and spatial disaggregation, integration of environmental requirements), as identified below.

2.3 The main causes and consequences of WS&D: review of evidence

2.3.1 Water scarcity

The driving forces of water scarcity (being the "imbalance between water supply and water demand") include climate change, population growth and migration, land use changes or changes in economic activities and thereby changes in societal needs. These drivers exert pressure on the aquatic environment, either directly (through changing precipitation patterns) or indirectly through changes in production and consumption, which result in impacts on water resources and on the aquatic environment.

One of the most important drivers in water scarce regions is land use change in the agricultural sector. While agriculture only represents 24% of total water use at EU level, its share can reach up to 80% of water use in Southern Europe (EEA, 2009) as a result of the high reliance on irrigation. Irrigation has expanded significantly in southern Europe faster than in Northern Europe[8]. The expansion of irrigated areas increased dramatically due to: improved irrigation techniques, the introduction of high yield varieties and the increased use of fertilisers. This expansion has been achieved at the expense of negative environmental impacts, namely over-pumping of fragile aquifers, water logging and increased soil salinity. This trend has however, been stabilised in many regions as a result of significant investments in irrigation systems, the widespread uptake of water-saving irrigation technologies, changes in market opportunities and the application of environmental regulation. It is important to stress that agricultural land use can be driven by financial support linked to the Common Agricultural Policy. Indeed, a WWF and SEO/Birldlife (2010) study highlighted that the level of subsidies allocated to the agricultural sector in a region was inversely correlated to its environmental situation (in terms of overexploitation of aquifers or nitrate pollution originating from agriculture), as most subsidies are allocated to intensive farming that imposes higher pressures on the environment.

[8] Although this may be subject to change with increasing variation in climatic effects

Household water demand (mainly from public water systems) also can lead to water scarcity. Factors that influence public water demand include population growth, the dissemination of water saving technologies, income levels and levels of ecological awareness. The EU-27 population has increased by around 100 million people in the last 50 years (EEA, 2009), a trend which has driven domestic water use considerably. This has been further exacerbated by changes in the distribution of household types, with an increase in the relative importance of single households that record higher per person water demand[9]. Finally, as income and GDP increase, the proportion of households connected to public water supplies and water demand increases (ibid).

Water scarcity can also originate from significant differences in water demand over the year, in particular as a result of increases in summer water demand from the tourism sector. The visiting tourist population during the summer season, for example, is very high in the Mediterranean region. Moreover, tourist water consumption is about three times higher than local demands (Iglesias, 2007). The number of international tourist arrivals increases every year; in Spain, Greece, and France, the number exceeds each countries' total population by about one third (ibid).

As a result of historical developments and availability of raw materials and energy supplies, or due to cultural and personal and for profit orientation, high water demand industries can also create water scarcity. In general, industrial processes and related support services have a large demand for water. Very often, however, the non-consumed fraction is high and returned to nature or to sewage systems. Industrial water demand is generally much smaller than the agricultural demand and often of the same order of magnitude as domestic demand, except a) in areas with highly developed tourism that boosts domestic water demand, or b) in highly industrialised regions with high industrial water demand. The significance of industrial water uses also results from the fact that they occur in highly populated areas, are in direct competition with domestic uses, and very often are supplied by the same urban networks.

Water used in energy production is generally not consumed, as for hydropower. However, consumption occurs for evaporative cooling and production of biofuels by agriculture. However, in the latter case the disposed water may have a higher temperature than required for some uses, or indeed as pertains to natural river ecosystems.

Although there has been some stabilisation in water abstraction and water consumption in parts of Europe in recent years, overall water withdrawals and water consumption is expected to continue to increase in Europe (see Table 2), putting water scarcity high on the policy agenda. The relative importance of industry is expected to decrease slightly; demand from the agricultural sector in relative terms will likely remain stable; and the share of water abstraction and water consumption from the domestic sector will likely increase.

Table 2. Past and future trends in water withdrawals and consumption by economic sectors in Europe

Water	1950			1995			2025 (forecast)		
	Agr.	Ind.	Dom.	Agr.	Ind.	Dom.	Agr.	Ind.	Dom.
Withdrawal (%)	32.2	25.4	41.2	37.4	14.7	44.8	37.2	14.0	**45.8**
Consumption (%)	67.7	12.6	15.6	71.4	5.6	15.3	66.8	4.3	**22.3**
Withdrawal (km^3/year)	136			455			**559**		
Consumption (km^3/year)	**50.5**			**189**			**256**		

Source: Shiklomanvo and Rodda, 2003.

[9] On average, larger households use less water per capita than smaller households: while a 4-person household consumes around 145 litres/person/day, a single person household consumes around 200 litres/person/day.

Assessing the **socio-economic impacts** of water scarcity is inherently difficult as it is difficult to distinguish them from the impacts of droughts. Very few studies exist that analyse either social or economic impacts of water scarcity (see an illustration in Box 1).

Box 1. The costs of water scarcity imposed on the domestic water supply sector in Cyprus

The analysis performed by Zachariadis (2009) focused on the residential sector, accounting also for tourism and industry. Using a simple demand function, Zachariadis computed total scarcity costs in Cyprus for the entire period 2010–2030 for three scenarios of future water demand. As indicated in the table below, results show that the present value of total costs due to water shortages in this period would amount to €72 million (at 2009 prices). If future water demand would increase at a higher rate, these costs may reach €200 million (2009 prices). Let's note that the water quantities refer to water actually consumed by households, i.e. not including water distribution losses. Also, the present value of costs is computed with a discount rate of 4%.

	Scenario 1: Constant per capita water use		*Scenario 2: Per capita water use grows 1% p.a.*		*Scenario 3: Per capita water use grows 2% p.a.*	
Year	Water demand (mio c.m.)	Cost (mio Euros'2009)	Water demand (mio c.m.)	Cost (mio Euros'2009)	Water demand (mio c.m.)	Cost (mio Euros'2009)
2010	54.8	0.21	54.8	0.21	54.8	0.21
2015	57.0	0.75	60.0	1.95	63.0	3.84
2020	58.5	1.27	64.6	5.15	71.3	12.81
2025	59.5	1.73	69.1	9.86	80.1	29.12
2030	60.1	2.01	73.3	15.84	89.3	54.80
Total economic loss, 2010-30		**25.57**		**130.69**		**381.97**
Present value of economic loss, 2010-30		**15.20**		**71.96**		**204.21**

Source: http://works.bepress.com/cgi/viewcontent.cgi?article=1015andcontext=theodoros_zachariadisandsei-redir=1#search=%22economic%20losses%20due%20water%20scarcity%22

The most comprehensive review of the economic impacts of water scarcity is the 2007 DG Environment Second Interim Report on Water Scarcity, stressing the following impacts for different sectors:

- Deficiency of public water supply with implications in related sectors like tourism (see illustration box below);
- Loss of production in various water using industries[10] due to water shortage;
- Loss of tourism due to water use bans and water shortages, for examples cancellation of tourist reservations, closure of water-demanding leisure facilities (such as water parks, golf courses) or compensation of damages in tourist resorts;
- Decrease of energy due to high river water temperatures is limiting use as a coolant and water reservoirs levels dropping below an efficient level for hydropower facilities;
- Loss or reduction in crop yields and production ;
- Increased costs for domestic supply.

While the assessment of the economics remains challenging, to assess the **social impacts** of water scarcity is even more difficult. The Water Scarcity and Droughts In-depth Assessment. Second Interim Report (EC; 2007) briefly mentions potential decreases in employment in the agricultural sector, the migration of water-intensive industry to more water secure areas as well as conflicts due to the implementation of higher pricing. However, no concrete studies are currently available that back up these potential social impacts.

[10] Including energy.

There are many **environmental impacts** of water scarcity that result from heavy water use in key economic sectors. These include (after Kossida, et al., 2009) seawater intrusion, jeopardised minimum water flows in rivers, deterioration and loss of wetlands and degradation of water quality (as less dilution increases the concentration of pollutants).

- Saltwater intrusion has already become a problem in large parts of the Mediterranean, affecting Italy, Spain and Turkey, due to groundwater over-abstraction for public water supply, agricultural water demand, and tourism related abstractions (MedWSD, 2007).

- In summer, many rivers are dependent on the groundwater base flow contribution for their minimum flow. Lower groundwater levels due to over-exploitation may, therefore, endanger river dependent ecological and economic functions, including surface water abstractions, dilution of effluents, navigation and hydropower generation. Excessive abstraction can also impact ecosystems. Groundwater pumping near wetlands lowers the groundwater table, reducing the level of saturation. This can dry out wetlands and severely damage their ecosystems. Heavy water abstraction for tourism and agriculture in Spain, for example, contributed to the destruction of wetland grasses and the subsequent invasion of scrub vegetation.

- Water quality issues such as pollution by nutrients and pesticides can be intensified due to low water quantity. If water is abstracted at too high a rate, there may not be enough water to dilute excess nutrients and pesticides that have leached into water bodies. Higher concentrations of nutrients and toxic substances can negatively affect fish spawning and increase algal blooms. In lakes, falling water levels result in less light for phytoplankton due to increased turbidity (Lind and Dávalos-Lind, 2002).

While water scarcity is often not discussed in Central Europe, even the Alps with their seemingly vast water resources can experience water scarcity over short periods of time and in localised areas. A number of sectors are then affected by water scarcity including drinking water supply, agriculture, artificial snow-making, and tourism and hydropower generation. According to a 2010 study on water scarcity and droughts in the Alps, drinking water supply is seen as the most vulnerable sector in Austria, whereas in Italy the most affected sectors are thought to be agriculture and hydroelectric power generation.

2.3.2 Droughts

Droughts are naturally occurring phenomena. The driving forces of droughts relate mainly to meteorological aspects, which can be categorized into three main environmental areas (Douben, n.d.):

- **Atmospheric circulation pattern,** particularly the location and persistence of high-pressure centres that have a major influence on rainfall and temperature. High-pressure systems are generally characterised by low precipitation.

- **Rainfall deficiency** that is the primary driving factor for drought. It directly influences soil moisture, groundwater recharge and river flow, although the hydrological system will often delay its effects. The severity of a drought is not simply a function of the size of the rainfall deficit but depends on its timing, for example rainfall deficiencies can have different hydrological impacts depending on the preceding levels of storage) and on its duration.

- **Temperature** that is an important driving force on drought throughout the year. Summer droughts are normally associated with clear skies, sunshine and high temperatures, which increase evapo-transpiration to the extent that little or no rainfall is available for recharge. Winter droughts, which receive less attention than summer droughts, are caused by air temperature continuously below 0°C. During this period, precipitation stored in the form of snow and ice is unavailable to recharge rivers and aquifers until temperatures rise and melting begins. Winter droughts are most prevalent in mountainous areas, mixed droughts in upland basins, while lowland areas have most severe droughts in summer (Kašpárek and Novický, 1997). This clearly reflects temperature differences associated with altitude.

As indicated above, and despite some confusion with water scarcity, drought is a natural but temporary imbalance of water availability, consisting of a persistent lower-than-average precipitation of uncertain frequency, duration and severity, and of unpredictable or difficult to predict occurrence. This results in the diminished availability of water resources, and the reduced carrying capacity of ecosystems. Deficient precipitation reduces water stocks and flows and affects water accessibility. It causes interruptions in replenishment with subsequent changes of: i) physical environment (soil moisture, water and air attributes); and, ii) physiological conditions of plants and animals. Individually or in combination, these might result in successive processes such as intrusion of saline water in coastal aquifers or in increased risk of wild fire as a result of accumulated combustibles. The effects of deficient precipitation are often amplified by atmospheric conditions (temperature, wind) that favour evaporation and further increases in water demand.

Besides climate change that is often cited as causing droughts, the main pressures for droughts is water demand and water resource availability. In many countries, public water (supply) demand rises as a result of population growth and increased standards of living. Assessments of (future) water demands result in different, geographically defined, trends. In Europe for instance, a clear stabilisation of demand is revealed, while in many developing countries, demand is increasing. The seasonal water demand variability as well as the local variability in a country makes some areas particularly vulnerable to the effects of a drought. Droughts can also affect areas where annual demands are well supplied with current water resource schemes, but temporal pressures can unbalance the equilibrium between demand and supply on occasions of dry periods. Droughts can also occur geographically when the distribution of water resources does not coincide with the population distribution. The hydrological impacts of a meteorological drought can sometimes be exacerbated by the overexploitation of resources. This happens particularly with groundwater resources, leading to the lowering of the groundwater table, drying up of springs and upper-river reaches, reduction in river flows, destruction of wetlands and salt intrusion (coastal areas).

Economic impacts of droughts can result, directly or indirectly, in[11]: loss of income in agriculture and related sectors, such as forestry, fisheries or the food process sector; loss of energy coming from renewable crop resources due to loss of crops; loss of hydropower capacity if water levels decrease; shutting down of thermal power plants due to lack of cooling water; impaired navigability of rivers and subsequent increases in transportation costs due to a switch to rail or road transport; loss of income in various water reliant industries, e.g. brewery sector; property damage. Assessments of

[11] Economic impacts depend on the magnitude of the event, which is influenced by a drought's intensity, spatial and temporal coverage and their resilience of water users and markets (Markandya, et al, 2009). Short (4-9) month intense spring/summer deficiencies can threaten water supplies in areas dependent on surface water, as experienced in northern England in 1984 and 1995 (Marsh, et al, 2007). Longer droughts (those over 18 months) reduce groundwater recharge and can significantly impact economic water users reliant on groundwater. On a spatial scale, drought impacts communities differently, and economic losses for some may mean increased benefits for others, for example higher prices for agriculture goods positively impact farmers outside of drought affected areas (Markandya, et al., 2009).

the socio-economic impacts of droughts are inherently difficult in themselves due to the uncertainties and their complexity stemming from methodological challenges and different conceptualisations of losses (Markandya and Mysiak, 2010). There are few studies analysing the extent of economic losses from droughts. The 2006-2007 survey from the DG Environment estimated the economic impacts of droughts over the past 30 years at €100 billion across the EU (see table below), with annual costs at over €6.2 billion. This was equivalent to 0.05% of GDP in 2006.

Table 3. Economic costs of selected droughts in Europe

Year(s)	Country or territory affected by drought	Economic cost (€ billion)
1992-1995	Spain	>3.7
1999	In Spain: Andalucia, Aragon, Castillo, Catalonia, Estramadure, Murcia, Valencia	>3.0
2000	Bulgaria, Czech Republic, Germany, Greece, Hungary, Poland, Romania, Turkey, Western Balkans	>.5
2003	Austria, Belgium, Bulgaria, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Poland, Portugal, Romania, Switzerland, Spain, UK, Western Balkans	>11,6[12]
2005	France, Portugal, Spain, UK	>2.0
2006	Southeast UK	>0.15
2007	Greece, Moldova and the rest of south-eastern Europe	>1.5
2008	Portugal, Spain	.15
2011	UK, France, Germany and Poland	TBD

Source: Updated from Demuth, 2009

Many of the impacts specified as economic and environmental have social components as well. If a full economic account of drought-inflicted losses is difficult, social impacts are even harder to trace and report.

Social impacts as a result of drought events include: public safety concerns; loss of life and increases in health problems; conflicts between water users; reduced quality of life; enhanced social inequalities in the distribution of impacts and disaster relief migration. The ripple effects of droughts impinge on almost all aspects of individual and social life, including nutrition, education, life satisfaction and well-being, social cohesion and order, relationships, population displacement, and public safety. Fatalities from heat waves are sometimes considered impacts of droughts, although, meteorologically speaking, they are considered distinct events (see below for European casualties due to the 2003 heat waves). Even in the absence of apparent health consequences, droughts cause discernible effects on well-being, satisfaction and the quality of life, whilst increasing risk levels for

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[12] In 2003, a major drought in Europe severely impacted the agricultural sector, resulting in significant crop losses. The main agricultural sectors hit by the extreme climate conditions were the green fodder supply, the arable sector, the livestock sector and forestry. Potato and wine production were also seriously affected. The fodder deficit varied from 30% (Germany, Austria and Spain) to 40% in Italy and 60% in France. The fall in cereal production in EU reached more than 23 million tonnes (MT) compared to 2002. This low cereal harvest will have to be topped up by more than 6 MT of imports under the mandatory quotas and more than 10 million tonnes available from carry-over stocks. The crop losses had serious financial implications. It is estimated that the financial impact for Austria mounted to €197 million, for Spain €810 million, for Germany €1.5 billion and for France €4 billion. Italy was the most hit financial speaking, losing an estimated €4-5 billion. The 2003 drought led to many major rivers (e.g., the Po, Rhine, Loire and Danube) being at record low discharge levels, resulting in disruption of inland navigation, irrigation and power plant cooling.

family break-down and social isolation - often with adverse mental health outcomes (Stain et al. 2008). These impacts, amplified by factors such as the decline of rural populations, deficit of job opportunities and a drop in social cohesion, make rural communities and farm families particularly vulnerable. On the contrary, the emotional impacts of changes to family and community life are moderated by positive attitudes towards a country lifestyle (Dean and Stain 2007).

Box 2. The health impacts of the 2003 Drought

With a death toll estimated to exceed 30,000, the heat wave of 2003 is one of the ten deadliest natural disasters in Europe for the last 100 years and the worst in the last 50 years. Elderly people were most affected. France reported 14,802 casualties using a method from the National Institute of Health and Medical Research (INSERM, France). This figure was reached by counting the number of deaths over and above what would normally be expected for the month of August. Italy followed the same formula and counted more than 4,000 elderly casualties during the month of August in Italy's 21 largest cities.

Human Casualties from the 2003 Drought in Europe

Country	Number of Casualties
France	14,082
Germany	7,000
Spain	4,200
Italy	4,000
UK	2,045
Netherlands	1,400
Portugal	1,300
Belgium	150

Source: UNEP, 2003.

Environmental impacts from drought result from damages to plant and animal species, wildlife habitat, air and water quality, forest fires, degradation of landscape quality, loss of biodiversity and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes and vegetation. However, many species will eventually recover from this temporary aberration. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape[13].

[13] For more details on the environmental impacts of droughts, to refer to the comprehensive literature review of the environmental impacts of droughts of the EU-funded FP7 project “Xerochore”.

3. Selecting a methodology for undertaking the Gap Analysis?

3.1 Approach

As indicated above, the objective of the overall gap assessment is to establish an overview and a clear baseline scenario of water scarcity and drought problems in Europe accounting for direct and indirect effects of climate change today up to 2027/30[14]. Where feasible, the gap analysis assesses the baseline trend in water exploitation in various large basins and/or EU areas as the basis for assessing whether additional WS&D measures are required or not. Proposed additional policies are then assessed from the environmental, social and economic points of view.

Water scarcity and drought policy instruments have been first divided into two main categories:

- "Measures": This refers to technical, green infrastructure and land-use based measures that bring about actual water savings and reduce droughts.
- "Support Actions": 'This refers to administrative controls, financial instruments, regulations, management plans, voluntary initiatives, and educational activities (research and awareness-raising) that support the implementation of "measures". These actions do not bring about concrete water savings themselves, but rather facilitate and support measures that do so.

The different assessments carried out in the context of this study have been based on:

- The **combination of the LISFLOOD[15] and WaterGAP[16]** models for assessing water availability, water demand and the resulting water stress under different scenarios[17];
- The use of the (conservative) storyline of the **SCENES "Economy First" scenario as the baseline socio-economic scenario** (3), which assumes a low concern for environmental goals and for the effective implementation of regulation (e.g. the Water Framework Directive), please refer to Box 3 below for details on the scenario;
- The development of a **structured catalogue or database of policy instruments (support actions and measures)**, building on an important information gathering effort to extract and catalogue relevant sectoral information from WFD baseline scenarios, review RBMPs for existing WS&D measures, the Call for Evidence, literature review and research for measures, and Member States' annual reports on WS&D. This catalogue includes all measures to prevent, manage or mitigate WS&D that exist and are already proposed by individual Member States;
- The **analysis of all existing support actions and measures** stored into the database, with two complementary streams of analysis being performed:
    - **Confronting the information on proposed measures with Information on Drivers, Pressures, State and Impacts**. This helps assess whether the efforts proposed by

[14] Bearing in mind that the time span to 2025 is limited in comparison to climate time scales, so only a limited influence is expected from climate change in the projections.

[15] See http://floods.jrc.ec.europa.eu/lisflood-model for further details

.[16] See Section 3.2 and Annex 1 for further details on the model.

[17] No consistent picture could directly be extracted from the reported water scarcity indicators for the baseline scenario gathered from the following three main sources: i) water exploitation index (EEA,2012); ii) some indications found in the some river basin management plans; iii) MS self-reporting (EC 2007). This brief review of alternative sources justified the use of a model used in the assessment and that it is compatible with most reported sources, although not always. The details are provided in Annex 3.

Member States appear as sufficient and well targeted (focusing on the right sector and water management issues) as compared to WS&D problems.

- For selected individual river basins in six countries, **assessing the expected impact of proposed measures on water stress**, by adapting specific parameters of the WaterGap model to account for the implementation of these measures.

- Experts views and selected sensitivity analyses for identifying the **main sources of uncertainties** (detailed in Annex 3) and of the robustness of the results obtained, discussing in particular the adequacy of the WaterGap model for assessing WS&D along with assumptions made for key model parameters and variables .
- The consortium expertise complemented by Interactive discussions with DG Environment policy officers to a) identify the **main policy gaps** that would need to be tackled to fully address WS&D in Europe, and b) selecting **a limited set of policy areas and policy options** with high potential.
- The review of existing literature (in Europe and elsewhere) combined with experts' judgement for applying the impact assessment guidelines of the EC and capture *ex-ante* the potential **social, economic and environment impacts** of the proposed policy areas and options. Specific use was made of GIS and of the results of the WaterGap model for estimating the relative importance of the EU territory and population that would be potentially impacted by individual policy areas and policy options.

Figure 2 summarises the main steps of the assessments carried out in the context of this study, the key methodological steps and assumptions being further developed in Annex I of the report.

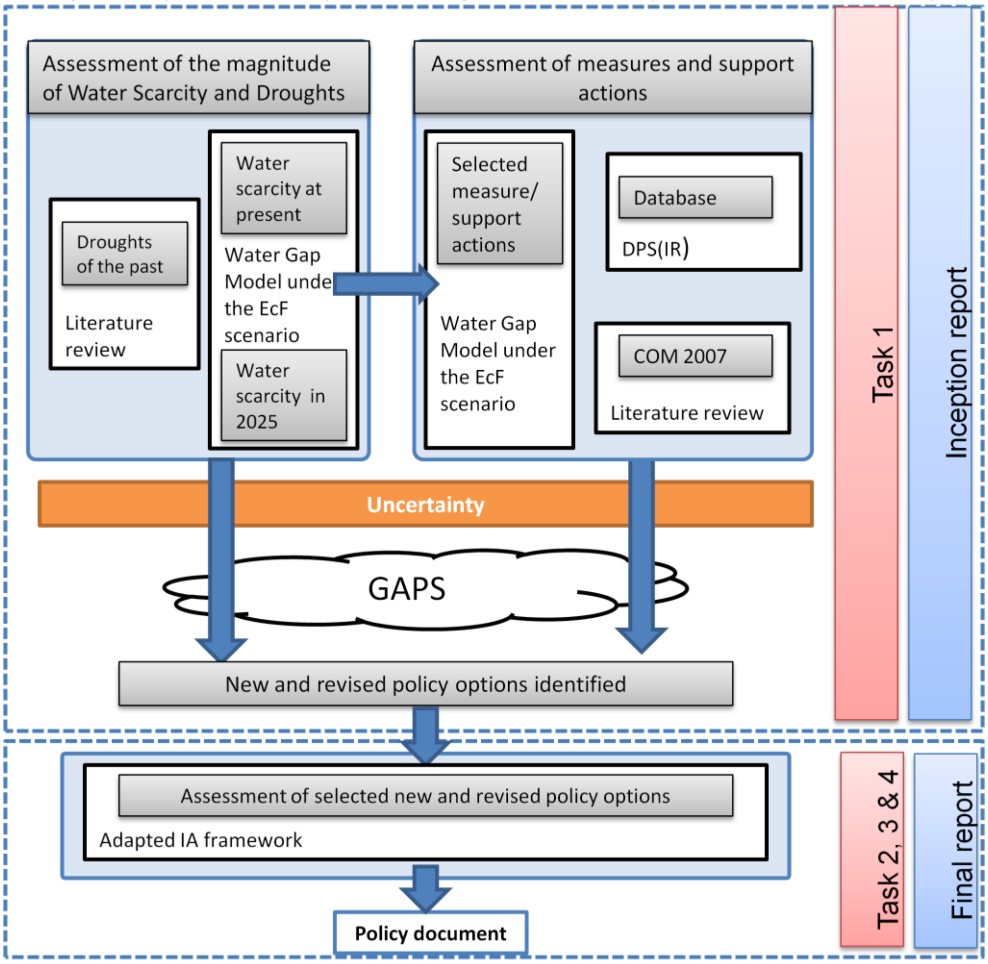

Figure 2. The building blocks of the methodology applied in the *Gap* Analysis study

3.2 Scenario and modelling

A key input into the WaterGap model is the socio-economic baseline scenario that captures expected future (baseline) changes in key economic sectors and in the economy, and be the basis for assessing the marginal impact of "baseline measures" dealing with WS&D and estimating whether current efforts made by Member States are adequate to tackle WS&D in the medium term.
The development of a full socio-economic baseline scenario being out of the scope of the present project, one of the four SCENES[18] socio-economic scenarios resulting from a rigorous process and are already validated and used for parallel studies and assessments on climate change and adaptation was used instead. SCENES elaborated various storylines, with varying assumptions about economic growth and general policy orientations of the future, including specific attention given to the Water Framework Directive (WFD), Floods Directive & other water quantity Directives, Water Quality Directives, CAP reform & other agricultural policies, Biodiversity policies. For the purpose of this assessment and the development of the baseline scenario, the so-called **Economy First storyline**[19] (EcF) forms the basic assumptions about a view of the future in order to provide a conservative estimate about the ability of regulator of implementing environmental regulation. This choice provides a clearer distinction of the potential marginal effects of support actions and measures expected to influence water demand and availability from today to 2025.

Box 3. Key elements of the Economy First scenario (EcF)

Globalization and liberalization is embraced in order to reduce the barriers to trade and create new enterprises and opportunities. Technological and business innovations spread quickly, both within the region and around the globe. Economic growth rates are promising but income inequality grows over time due to massive cutbacks in social security systems. Fewer people can afford high level university education (including private universities), which results in shortages in the high-skilled labour force. This trend is exacerbated further by the ageing population. The steadily increasing immigration over all three periods fills gaps in the workforce but creates social and ethnic tensions. The ability of governments to regulate markets and respond effectively to societal and environmental problems diminishes. European integration remains restricted to the completion of the internal market; and regulatory competencies are cut back. In this context, multinational companies dictate environmental standards/ progress.

With growing income inequalities, a relatively few rich people enjoy their lives while it becomes harder for the majority to keep their living standards. In the first half of the scenario, there is a rapid diffusion of knowledge and innovations around the globe, but basic research in some areas struggles with lack of funds. High levels of education are achieved, but there is some targeting of opportunities to people who can afford to pay; this is seen in part by the increasing number of private universities. There are no equal opportunities for education. Europe experiences a brain drain to other regions later in the period.

In this storyline, governments rely mainly on market based instruments (voluntary agreements, tax incentives) rather than legislation. Along other EU policies, the WFD is expected to only be weakly implemented. It is also important to highlight here that the storyline inherently incorporates existing water management policies as part as its trend form its starting date 2005 in the case of this model.

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[18] The "*Water Scenarios for Europe and for Neighbouring States*" FP6 research project (SCENES) details can be found at http://www.1stcellmedia.de/customer/uni/cms/

[19] Source: Adapted from www.environment.fi/syke/scenes

The storyline is supported by several quantified parameters which included general "Drivers" of water use and availability to structure the evolution of the storylines. For the general trend the following variables were used:

Gross Domestic Product (GDP)	Precipitation
Gross Domestic Product per capita (GDP/cap)	Structural change
Gross Values Added (GVA)	Technological change
Irrigation project efficiency	Temperature
Livestock numbers	Treatment level and connection rates
Population	Precipitation

In addition SCENES also examined specific sectoral water drivers indicators in five sectors: **domestic, agricultural, industrial, energy** and **environmental**.
In turn, these "Drivers" translated into "Pressures" that were used to model their impact on key indicators for water:

BOD loadings	Land use changes
Irrigated area	Thermal electricity production

In turn and for the purpose of this analysis, the WaterGap model was informed by translating the measures identified from each RBMP into the potential percentage evolution to 2025 of the following parameters[20]:

Structural change = change in behaviour derived from commitment to change behaviour with respect to water consumption (in domestic sector); change in cooling system (in thermal electricity production sector)

Irrigation efficiency [EFproj] (agricultural sector): " *Irrigation efficiency reflects the state of irrigation technology within each country. Hereby, irrigation field efficiency and irrigation project efficiency have to be differentiated. Irrigation project efficiency is more applicable compared to irrigation field efficiency as it additionally considers conveyance losses, field sizes and management practices, while irrigation field efficiency mainly results from the irrigation practice (e.g. surface, sprinkler, micro irrigation) EFproj typically ranges between 0.3 and 0.8, whereas 0.8 means that 80% of the water delivered to the crop is actually absorbed by it."* (aus der Beek et al., 2010, p. 80)

Extent of irrigated land: Include additional irrigated land

Alternative water resources included desalination, rainwater harvesting, wastewater. This information about potential contribution to supply also informed the baseline. After the WaterGap modelling, additional supply was added to the existing results from the available LISFLOOD model. A few saving measures with given estimates were also introduced after the modelling. When that was the case, these are indicated in the tables that were used.

[20] For the details of on the measures and expected effects through the coefficients used, please refer to ANNEX 7. Measures and tables for model.

Methodologically measures and support actions identified as related to water scarcity management were projected as single actions. However in several cases, given the degree of uncertainty about their actual (potential) effects, they were combined as a set of actions likely to influence water demand. Note that water supply measures were more easily handled as they offer more accurate additional water volumes compared to the more elusive water savings that are made at a district river basin.

The WaterGap model uses a calculated WEI indicator that is compared to specific thresholds for indicating water scarcity. Despite having identified the WEI as a questionable concept, it was not possible to adapt the WaterGap model within the scope of the study and to use alternative indicators that could be seen as better grasping water scarcity. Thus, data available for all relevant basins were used to produce the WEI keeping in mind the limitations of this indicator. It is important to stress, however, that the calculations were made at the river basin scale, this being a clear improvement as compared to earlier versions of the Water Gap model.

4. Question 1 - What is the magnitude of today's WS&D problem in Europe?

4.1 Water scarcity

The WaterGap model was used to assess the current state of water scarcity in individual river basins, the overall results being presented in Table 4, Figure 3, and Figure 4 below. The modelling results helped differentiate between river basins that are water-stressed all year round, and those for which water-stress is limited to the summer period.

Table 4. Water scarce river basins at present

River basin code	Name	North /South	Stress during the summer	Stress all year round	Surface (Km^2)
BE_Escaut_BR	Scheldt (Brussels Area)	North	X	X	162.05
BE_Escaut_RW	Scheldt	North	X	X	3771.11
BE_Meuse_RW	Meuse	North	X	X	12286.26
BEMaas_VL	Meuse	North	X	X	1592.40
BESchelde_VL	Scheldt in Flanders	North	X	X	12029.38
BG3000	East Aegean Region Basin District	South	X	X	35237.00
BG4000	West Aegean Region Basin	South	X	X	11946.73
CY001	Cyprus*	South	X	X	11023.22
DE4000	Weser	North	X	X	49057.52
DE7000	Meuse	North		X	3996.99
DK3	Bornholm	North	X	X	602.89
ES020	Duero	South	X		78889.41
ES030	Tagus	South	X		55771.78
ES040	Guadiana	South	X		55461.20
ES050	Guadalquivir	South	X		57527.00
ES070	Segura	South	X	X	18986.59
ES080	Jucar	South	X	X	42989.00
ES091	Ebro	South	X	X	85553.90
FRB1	Meuse	North	X	X	7809.84
FRB2	Sambre	North	X	X	1101.53
GR06	Attica	South	X	X	3159.98
GR07	Eastern Sterea Ellada	South	X		12223.89
GR08	Thessalia	South	X	X	13137.31
GR09	Western Macedonia	South	X		13618.22
GR10	Central Macedonia	South	X	X	10164.57
GR11	Eastern Macedonia	South	X	X	7325.19
GR12	Thrace	South	X	X	11250.70
GR13	Crete	South	X		8274.46

River basin code	Name	North /South	Stress during the summer	Stress all year round	Surface (Km²)
ITC	Northern Appenines	South	X		38453.85
ITE	Middle Appenines	South	X	X	36201.15
ITF	Southern Appenines	South	X		67537.55
ITH	Sicily	South	X	X	25719.28
LU7000	Meuse	North	X	X	69.62
MTMalta	Malta	South	X	X	332.41
NLEM	Ems	North	X	X	2478.24
NLMS	Meuse	North	X	X	7474.38
NLRN	Rhine	North	X	X	28917.22
PTRH3	Douro	South	X		19213.25
PTRH4	Vouga, Mondego and Lis	South	X		12637.73
PTRH5	Tagus and Western Basins	South	X		29997.56
PTRH6	Sado and Mira	South	X		12147.01
PTRH7	Guadiana	South	X		11611.72
UK04	Humber	North	X		26138.13
UK05	Anglian	North	X		27889.79
UK06	Thames	North	X	X	16145.45
Total Surface (Km²)			987914,5	460521,9	

*This was not modelled in the original series and subsequent modelling was developed for the Gap Analysis so to assess the policy instruments recently introduced in Cyprus. The lack of baseline in the general model is due to the incompatibility between the geographical/physical data available for a global model such as WaterGap and the political configuration of Cyprus.

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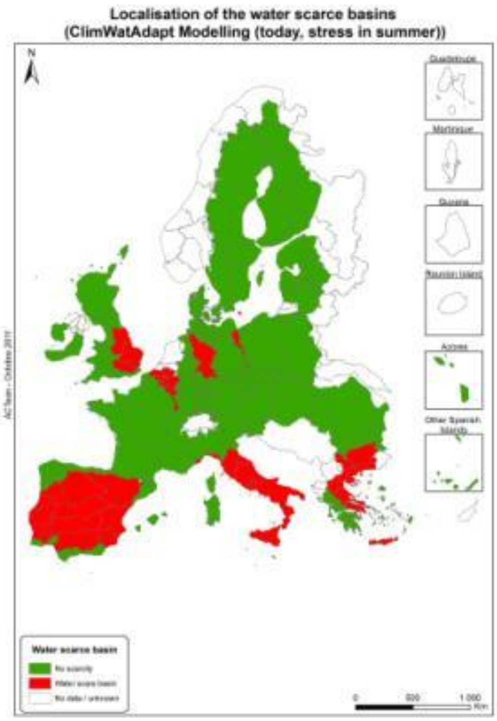


Figure 3 and Figure 4. Localisation of water scarce basins (Water Gap Modelling) today a) the year round and b) for the summer period

The total area under water stress today as estimated by the WaterGap model is equal to 10.7% year round and reaches 23% for the summer period. As illustrated in the maps, the basins that are under water stress the year round do not show any specific spatial pattern. A clearer North/South divide emerges however when looking at basins that are water scarce in the summer. Southern European basins are more likely to experience water scarcity during the summer months. This is the case for Spain, Italy and Greece for which peak agriculture and tourism water demands take place during the summer when the natural water resource available is at its lowest (EEA, 2009). In the North, the UK would also seem to experience more extensive manifestations of this seasonal water scarcity.

4.2 Droughts

The magnitude of droughts in Europe is captured by the location and characteristics of the major droughts that affected Europe during the period 2000-2009 (see table below). Overall, droughts are not a rare occurrence. South-eastern Europe is increasingly facing extended periods of droughts. But both Northern and Western Europe have been affected in more recent years. As the table below suggests, drought events may be increasing in both their frequency and their spatial coverage, a larger number of countries being affected by more recent droughts than in the past.

Table 5. Location and characteristics of major drought events in Europe

Year	Region	Main characteristics of droughts (if relevant)
1973	Austria, Germany + former Czechoslovakia	Very dry winter/spring resulting in low snow melt and subsequent water shortages
1976	Northern Europe (Scandinavia to France	
1984	North and west UK	Very dry spring and summer
1988-92	Most of Europe	Anomalous circulation pattern caused rainfall deficits over a large area interspersed with short wet periods
1992	Germany, Hungary, Bulgaria, and much of western Russia	
1990-1995	Spain, Portugal	Prolonged drought across entire Iberian peninsular
1995	Ireland, UK, Norway and Sweden	
1999	Finland, Spain	Hot dry summer resulted in very low water levels in rivers and groundwater
2000	Bulgaria, Czech Republic, Germany, Greece, Hungary, Poland, Romania, Turkey, Western Balkans	
2003	Large parts of Western and Central Europe	
2008	Portugal, Spain	
2011	UK, France, Germany and Poland	Very dry spring

Source: adapted from Lloyd-Hughes, 2003.

5. Question 2 - What will be the magnitude of WS&D problems in Europe by 2030?

Without modification to the current institutional and policy measures already implemented under a given socio-economic scenario, water scarcity by 2030 was assessed using the WaterGap model highlighting potential developments of water scarcity in places where it is not currently the case. The results of the WaterGap modelling are illustrated in Table 6, Figure 5 and Figure 6, presenting water scarcity (using the WEI indicator) for the summer months and all year round by 2030.

Table 6. Water scarce basins, summer and all year round – by 2030

Code	Name	North /South	Stress during the summer	Stress all year round	Surface (in Km^2)
AT2000	Rhine	North	X	X	2365.65
AT5000	Elbe	North	X	X	909.38
BE_Escaut_BR	Scheldt (Brussels Area)	North	X	X	162.05
BE_Escaut_RW	Scheldt	North	X	X	3771.11
BE_Meuse_RW	Meuse	North	X	X	12286.26
BE_Rhin_RW	Rhine	North	X	X	768.05
BE_Seine_RW	Seine	North	X	X	80.64
BEMaas_VL	Meuse	North	X	X	1592.40
BEScheIde_VL	Scheldt in Flanders	North	X	X	12029.38
BG1000	Danube Region Basin District	South	X	X	42820.51
BG2000	Black Sea Basin District	South	X	X	20981.49
BG3000	East Aegean Region Basin District	South	X	X	35237.00
BG4000	West Aegean Region Basin	South	X	X	11946.73
CY001	Cyprus*	South	X	X	11023.22
CZ_RB_5000	Elbe	North	X	X	50014.34
DE2000	Rhine	North	X	X	105777.26
DE4000	Weser	North	X	X	49057.52
DE5000	Elbe	North	X	X	99490.77
DE7000	Meuse	North	X	X	3996.99
DK3	Bornholm	North	X	X	602.89
ES020	Duero	South	X		78889.41
ES030	Tagus	South	X		55771.78
ES040	Guadiana	South	X		55461.20
ES050	Guadalquivir	South	X		57527.00
ES060	Andalusia Mediterranean Basins	South	X		17956.09
ES070	Segura	South	X	X	18986.59
ES080	Jucar	South	X	X	42989.00
ES091	Ebro	South	X	X	85553.90
ES110	Balearic Islands	South	X		5005.28
FRB1	Meuse	North	X	X	7809.84
FRB2	Sambre	North	X	X	1101.53

Code	Name	North /South	Stress during the summer	Stress all year round	Surface (in Km^2)
FRC	Rhine	North	X	X	23718.30
FRG	Loire, Brittany and Vendee coastal waters	North	X		156856.40
FRH	Seine and Normandy coastal waters	North	X	X	94289.78
GR06	Attica	South	X	X	3159.98
GR07	Eastern Sterea Ellada	South	X		12223.89
GR08	Thessalia	South	X	X	13137.31
GR09	Western Macedonia	South	X		13618.22
GR10	Central Macedonia	South	X		10164.57
GR11	Eastern Macedonia	South	X	X	7325.19
GR12	Thrace	South	X	X	11250.70
ITB	Po Basin	South	X	X	70254.56
ITC	Northern Appenines	South	X		38453.85
ITE	Middle Appenines	South	X	X	36201.15
ITF	Southern Appenines	South	X	X	67537.55
ITH	Sicily	South	X	X	25719.28
LU2000	Rhine	North	X	X	2530.17
LU7000	Meuse	North	X	X	69.62
MTMalta	Malta	South	X	X	332.41
NLEM	Ems	North	X	X	2478.24
NLMS	Meuse	North	X	X	7474.38
NLRN	Rhine	North	X	X	28917.22
NLSC	Scheldt	North	X	X	3262.66
PL5000	Elbe	North	X	X	226.65
PTRH3	Douro	South	X		19213.25
PTRH4	Vouga, Mondego and Lis	South	X		12637.73
PTRH5	Tagus and Western Basins	South	X		29997.56
PTRH7	Guadiana	South	X		11611.72
RO1000	Danube	South	X	X	238385.12
UK04	Humber	North	X	X	26138.13
UK05	Anglian	North	X		27889.79
BUK06	Thames	North	X	X	16145.45
UK07	South East	North	X		10202.43
UK09	Severn	North	X		21609.66
Total Surface (Km2)			1934998,2	1288885,1	

*This was not modelled in the original series and subsequent modelling was developed for the Gap Analysis to assess the policy instruments recently introduced in Cyprus. The lack of baseline in the general model is due to the incompatibility between the geographical/physical data available for a global model such as WaterGap and the political configuration of Cyprus.

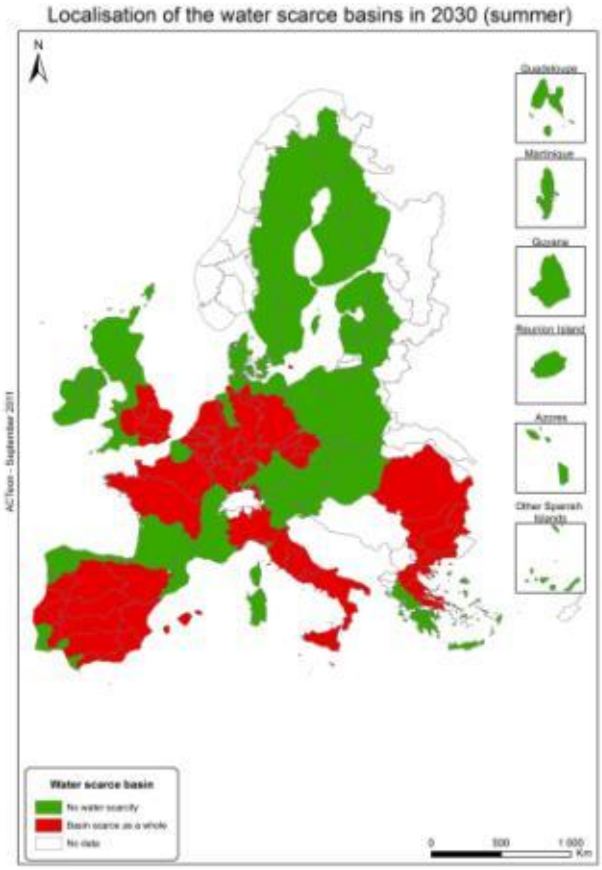


Figure 5 and Figure 6. Location of the water scarce basins (WaterGap Modelling – Projection) a) all year round and b) for the summer period

Overall, the total area under water stress by 2030 as estimated by the WaterGap model has significantly increased as compared to today's situation. It is equal to 30% and 45% for the year round and for the summer period, respectively. The results stress the increasing number of river basins, and of Northern river basins in particular, that could become water stressed over time if the socio-economic baseline scenario applied is a good approximation of future development. During summer months, the more developed imbalances confirm the trends identified in the current seasonal scenario, with the addition of a few basins from France and Spain. The second geographical trend involves a growing number of Eastern basins along the Black sea which should be monitored carefully. As the Southern basins have confirmed, more data is needed on the situation in the Northern basins that tend towards water stress in the period studied.

The modelling results stress indeed the importance of seasonal indicators for water stress. The areas affected today and potentially affected in the near future are presented in Table 7 as follows.

Table 7**. Water scarce areas in and percentage of the EU surface in summer and all year round – today and by 2030**

	Today		2030	
	Summer	Year round	Summer	Year round
Total surface in Km2	987914,5	460521,9	1934998,2	1288885,1
Percent of EU surface (est. 4.3 M Km2)	23,0	10,7	45,0	30,0

- River basins under water stress the year round increase from 26 to 47 between today and 2030, respectively. This evolution would increase the potential area under stress from around 460,000 Km2 to 1,290,000 Km2. However, investigating seasonal water scarcity increases drastically the number of problematic river basins up from (today) 43 to 63 (2030). In terms of affected surface, scarcity would extend from about 990,000 Km2 to 1,935,000 Km2 .

- Today, 17 river basins under water stress in the summer are in the North, representing 37% of all river basins under stress. This percentage will reach 50% by 2030, stressing the increasing importance of (seasonal) water scarcity for Northern Europe. Such evolution would mean that areas facing scarcity are expected to growth from around 201,522 Km2 to 773,625 Km2.

6. Question 3 – Are the proposed measures to prevent, manage or mitigate WS&D situations in individual Member States sufficient to tackle the problems?

To assess the relevance and effectiveness of water management policy instruments (i.e. measures and support actions) in addressing WS&D, including those identified as a priority in the framework of the 2007 Communication[21]; different approaches were developed. The first consisted in classifying and describing the reported policy instruments ("Measures" and Support Actions") for each European River Basin Districts. Descriptive data from the classification aimed at identifying general trends in what is the current practice in water management and how the key messages of the 2007 Communication had been considered and translated in to operational and concrete actions. The second approach used the WaterGap model to assess the effects of recently or yet to be implemented policy instruments on the WEI indicator for selected river basins. Overall, the different policy instruments and measures proposed by MS were assessed through the following assessment questions:

- Have the measures favoured in the 2007 Communication on Water Scarcity and Drought been implemented or selected in priority so far?
- When WS&D is identified as an issue in a RBD, is action proposed or already taken?
- To what factors from the DPISR framework are the policy instruments (i.e. support actions and measures) responding to? And, what are the main characteristics of the policy instruments mobilised to tackle water scarcity?
- When responding to already planned policy instruments, are actions sufficient to significantly reduce future water stress by 2025-30?

6.1 What have been the results of the measures favoured in the 2007 Communication on Water Scarcity and Drought so far?

The review of policy instruments helped identify whether MS followed the priority in terms of type of actions and measures suggested by the 2007 Communication of the European Commission (EC, 2007), and whether the objectives of the Communication in promoting specific instruments were being achieved. The following table summarises the assessment carried out, with more complete information with specific results for individual Member States being found in the accompanying stand alone report of the evaluation of the 2007 Communication.

[21] The specific assessment of this group of seven policy areas are also specifically assessed in a standalone document Annexed to the report.

Table 8. EU level summary of the achievements of the 2007 Communication on WS&D

Policy area	Sub-policy area	Have initiatives been undertaken?	Which results have been reached so far?
Putting the right price tag on water		In 2008 MS were commended to develop a water tariff policy by 2010, in line with the requirements of the EU WFD. Very limited initiatives have however been taken by MS in this field.	Despite efforts taken at EU level, water pricing is slowly being implemented in MS. It seems that neither the objectives of full implementation of the WFD in terms of water cost recovery or the implementation of the 'users pay' principle have been reached so far. However, recent analysis (Garrido and Calatrava, 2010) concluded that policy makers should expect less change from water pricing in agriculture, because demand is somewhat inelastic to water pricing. However water demand is responsive nonetheless to agro-environmental policies and farm prices.
Allocating water and water-related funding more efficiently	Improving land-use planning	Many initiatives were taken at the EU level aimed at improving land use planning, especially in the context of the set of legal proposals designed to make the CAP post 2013 a more effective policy; other sectors of intervention include biofuels and climate change adaptation (White Paper).	Progress has been made to better incorporate water quantity issues into the CAP, although this progress is uncertain to continue considering the current proposal for the CAP. Concerning biofuels, the objective has technically been achieved, but more effort could be made to incorporate water management issues into biofuel development.
	Financing water efficiency	Several initiatives have been taken to incorporate financing to water savings in EU policies (e.g. Regional and Cohesion Funds, CAP and legal proposals for direct payments). Moreover, the European Investment adopted a new lending policy for the water sector	All three funds have taken steps to enhance effective water management. However, with respect to regional and cohesion funds it is still unclear whether objectives have been met.
Improving drought risk management	Developing drought management plans	The objectives of the initial supporting action have been met to some extent. Whereas a good progress has been achieved both at EU and MS levels.	It is difficult to assess the economic and environmental impacts of these supporting actions promoted by the 2007 Communication. All three actions contribute to reducing the economic losses and environmental hardship caused by droughts.
	Developing an observatory, an early warning system on droughts and the EUSF	Good progress was made so EDO is to become fully operational by 2012. However, the EUSF is not well deployed to face droughts.	
Considering additional water supply infrastructures		The objectives have been met since all the MS that replied to the questionnaire of 2008 to 2010 indicating enactment of legislation/regulations, Environmental Impact Assessment (EIA) studies, and for some, application of Strategic Environmental Assessments (SEA) on new water supply infrastructure plans.	Almost all MS refer to some new water infrastructure (desalination plants, dams, tunnels, etc.) for which all MS state that adverse effects linked to the infrastructure are fully taken into account in EIAs and occasionally in SEA studies.
Fostering water efficient technologies and practices		The focus of policies and response actions aimed at improving irrigation systems and strategies mainly focusing on technical measures aimed at improving techniques and practice.	Encouraging the development of water-efficient technologies and products stimulates the market and increases the competitiveness of European industries which is a positive economic impact. Tangible jobs can be directly traced and have been estimated (e.g. 60000 in DE). The current approach reveals a focus on saving water, instead of aiming at reducing the pressure on ecosystems under a more comprehensive approach.
Fostering the emergence of a water-saving culture in Europe		Despite a number of activities launched at the EU level, and fully acknowledging the indirect impacts on water use achieved by Ecodesign label of energy related products, no labeling or certification scheme is directly related to water.	Part of the information and awareness-raising campaigns is information provision (i.e. state of the water resources in Member States) and public access to the River Basin District Management Plans.

Policy area	Sub-policy area	Have initiatives been undertaken?	Which results have been reached so far?
		In addition, attempts to initiate a water scarcity related scheme in the framework of the European Alliance on Corporate Social Responsibility (CSR) have not been further pursued. Certification and labeling schemes based on good water stewardship are currently being developed and applied in a wide range of industry driven initiatives	Experiences with *Water Footprinting*, have been limited, and this is mainly due to issues still concerning the clarity, transparency and reliability of such indicator. Certification and labeling schemes appear to be a more appropriate approach to promote sustainable water management than Water Footprinting..
Improve knowledge and data collection	A water scarcity and drought information system throughout Europe	Efforts taken at EU level (GMES services, WSDiS, EEA WQ Waterbase, JRC EDO, Water Accounts, Research and Regional programmes) are all concurring in creating a wide and reliable information base. Progress towards the development of common indicators has been made through the EEA, JRC and the CIS EG ESD.	Despite efforts, the objective to obtain reliable information on WS&D has not been fully reached yet. Data gaps still exist, especially when it comes to impacts and effectiveness of responses, impeding thus comprehensive assessments. On the other hand, even the data on state and pressures which are streamlined for collection at EU level have significant gaps: data on water availability are mostly lacking, as well as data on environmental requirements associated with water stress conditions. Similarly, the integration of all these information sources in WISE is still lacking.
	Research and technological development opportunities	Major research efforts which have been promoted and financed at the European level	Water scarcity was not the object of a single, articulated research project, but it was rather tackled, together with other issues, by different projects within the 6th and 7th Framework Programme and European Territorial Cooperation programmes. It is not clear, at this stage, whether this apparent fragmentation has led to coherent, integrated and exhaustive results, nor whether the necessary linkages among projects were established and provided input to the policy needs.

6.2 Do measures and support actions proposed by MS target the right issues?

6.2.1 When WS&D is identified as an issue in a RBD, is action taken?

A parallel initiative by TYPSA (2011a) found that although WS&D is an issue in the EU, much more clarity is needed to understand the phenomena and their causes. More than 2/3 of the WFD RBMPs screened as part of this initiative recognised some issue related to WS&D. However, assessment is not performed in a consistent and systematic manner. In general, most basins benefit from some type of policy instrument that aims at tackling in some way water scarcity and less often droughts. In some cases, measures are aimed at other water management issues, and are expected to deliver benefits in terms of reducing WS&D as secondary benefits[22]. The information provided in the RBMPs, however, does not help us understand whether the proposed actions are sufficient for tackling WS&D.

[22] The final updated version of the initiative by TYPSA (2011a) has been produced and will be published shortly. The data presented here should then be considered as preliminary results of the RBMPs assessment, even though the general trends identified here can be considered as a solid reference of the actions taken by MS regarding WS&D.

6.2.2 To what factors from the DPISR framework are the policy instruments responding to? And, what are the main characteristics of the policy instruments mobilised to tackle water scarcity?

As Drivers-Pressures and Impacts can be hierarchically established, positioning an instrument to successfully tackle a specific driver is expected to be more overreaching, resilient through time and sustainable. Conversely, savings achieved through managing impacts are only expected to be of short-term implications (potentially not cost-effective) as main drivers will continue to exert influence over total levels of water use. The information on the measures database was then used to investigate:

- The basic responses to WS&D issues, whether targeting Drivers, Pressures and/or Impacts (the DPI components of the DPSIR framework);
- The main focus of the actions proposed, in particular whether priority is given to supply-based measures or to demand-based measures;
- The type of measures and instruments that are proposed for tackling WS&D;
- The main water use sectors targeted by the measures and policy instruments.

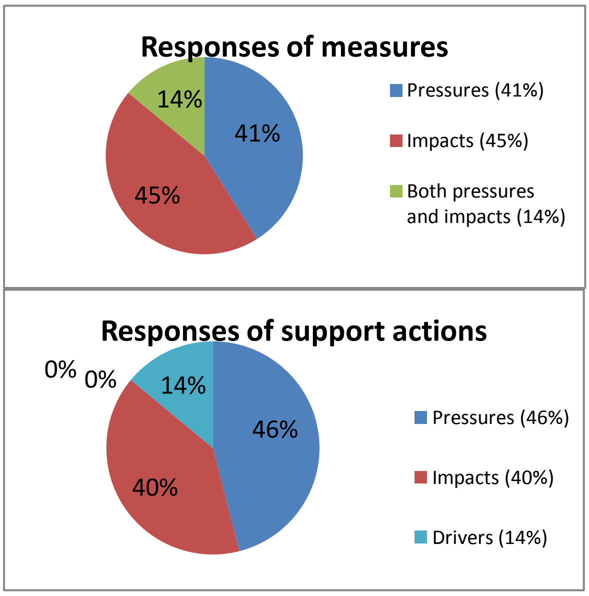


Figure 7. Measures and support actions response to Drivers-Pressures-Impacts of the DPSIR framework.

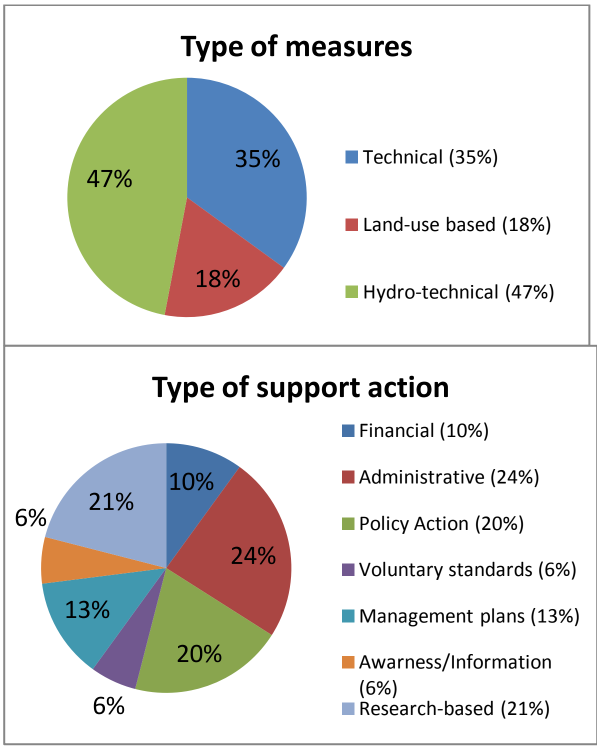


Figure 8. Type of measures and support actions aimed at addressing WS&D

The basic responses to DPI

The assessment of measures shows that none of the 58 measures currently proposed by MS and recorded in the database target drivers. Overall, these measures target pressures and impacts nearly equally, with some measures targeting both at the same time. Thus, a wide range of policy actions and measures currently proposed by MS focus on the symptoms of WS&D rather than on the origins of water stress. Despite the possible bias from the catalogue of measures developed under this study, this proportion is expected to be representative of the general practice and philosophy followed by MS.

The pressure most often addressed is water demand, with 38% of the measures aiming at reducing water demand. Reducing the pressure from water supply networks follows (15% of the proposed measures). Measures targeting impacts address water availability problems, promoting for example alternative water supply options or, to a lesser extent, direct actions for restoring stream flows and stabilising groundwater levels.

The assessment of support actions proposed by MS stresses that support actions address all three levels of the DPI(SR) framework. The majority of the 264 support actions proposed by MS addresses pressures (54%), with support actions targeting drivers and impacts accounting for 17% and 47%, respectively[23]. The main drivers targeted are water consumers (whether domestic, industry or agriculture) with specific awareness raising campaigns or economic instruments (changes in water tariffs e.g.) being proposed for changing their behaviour/perception. Pressures are the focus of measures that aim at promoting water saving technologies (e.g. through regulations or fiscal incentives) or of specific management plans. Monitoring, management plans and research-based activities target impacts in priority, and pressures to some extent.

The main focus of the proposed actions

As in other areas of resource management, policy instruments are aimed either at demand management or at improving supply of a given resource. Independently of the nature of the policy measure, both measures and support actions are shared evenly in terms of number of actions aimed at addressing water supply or water demand. This however informs more about the diversity of actions proposed by MS than about the relative importance of measures in terms of their actual (expected) influence on water resource management and water balance. In general, measures support initiatives for increasing supply (53% of all proposed measures) while support actions target demand management in priority (58% of all proposed support actions).

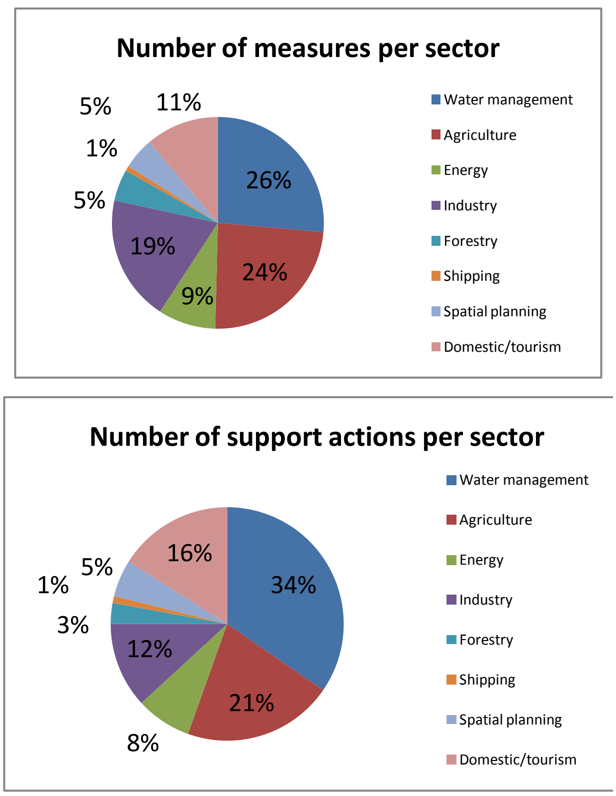


Figure 9. Types of measures per sector

As indicated in the figure below, measures are of a more limited type than support actions which offer a wider range of intervention. Despite the importance of water abstraction and consumption by agriculture, land use

[23] The sum of percentages is higher than 100%, as some policy actions target drivers, pressures and/or impacts simultaneously.

based measures are rarely used by MS (accounting for only 18% of the proposed measures). And administrative measures (e.g. establishing a new abstraction limit) are chosen first as policy actions, although questions on the effective implementation of these measures can be raised.

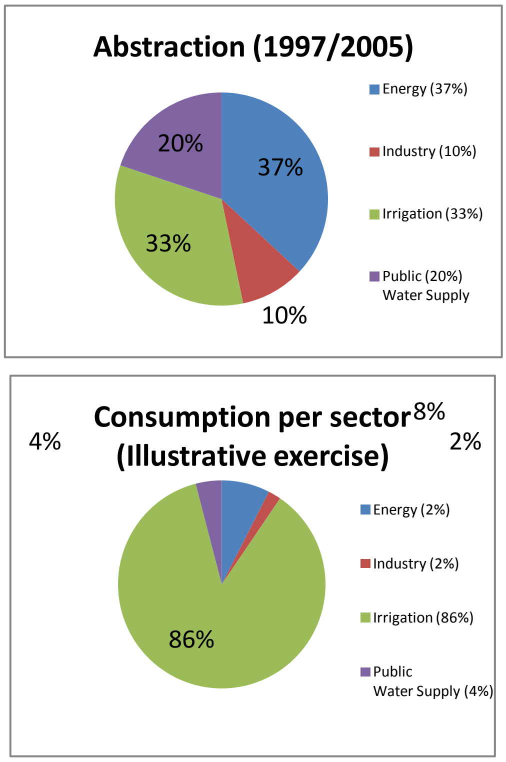


Figure 10. Relative share of water abstraction and consumption per sector (source: WaterGap model, today)

To identify the area of influence of the policy instruments, the basic NACE classification was used in developing the database, complemented as needed with the specificities of water management by adding sectors such as water Management, shipping and navigation and domestic/tourism as reflected in the figure 9 above.

Measures and support actions have a very similar sectoral distribution, providing some hints about the priorities given to sectors. Measures focused on agriculture, water management, industry and domestic water use represent the bulk of both measures and support actions. The comparison between the relative importance of sectors in terms of number of measures/policy actions, water abstraction and water consumption (see below), stresses however a misfit between the low importance given to the agricultural sector in terms of measures/policy actions as compared to its (high) share in terms of water abstraction and more importantly consumption.

Conclusions

The assessment of measures and support actions proposed by the EU MS for addressing WS&D stresses the lack of coherence between the current status of WS&D in Europe and proposed policy responses. Overall:

- Most measures and policy actions proposed by MS focus on pressures and impacts. Only a small share of support actions are targeting the drivers of water scarcity, stressing the priority given to alleviating problems and effects instead of addressing directly the fundamental causes of the phenomenon. While this approach might help address WS&D issues in the short term, it is unlikely to represent a cost-effective approach to addressing WS&D sustainably in the long-term;

- The types of instruments proposed by MS are varied, in particular for support actions. However, the qualitative assessment proposed cannot assess whether this diversity represents a sound and cost-effective approach to WS&D accounting for cultural, institutional and organisational differences between MS.

- At the aggregate EU level, the relative importance of sectors targeted by measures and policy actions does not reflect the relative importance of these sectors in water abstraction and water consumption. Clearly, to draw conclusions based on this aggregated comparison is difficult, as water management issues are best investigated and understood at more localised (e.g. river basin) scales. However, the aggregated figures stress the relatively low importance given to the agricultural sector that represents slightly less than 10% of the total number of measures and support actions, while accounting for a third of water abstraction and more than 80% of water consumption.

- Different factors might explain the choices made by MS for addressing WS&D. In some cases, existing water management practice and policy making might explain the priority given to a sector or to a component of the DPSI framework. In other cases, the absence of sound assessment of WS&D, including the use of imperfect indicators, could explain the proposed measures and policy actions.

The analysis of information on proposed measures and support actions stressed the difficulty of fully understanding the scope and the purpose of some of the measures proposed by MS. In addition, very little information on costs and impacts of measures and support actions was found, with information on costs (investment, operation and maintenance and administrative costs) being found for only a few support actions and measures. Specific information on impacts and other indirect costs was also available for only a few measures. Concrete, quantifiable data is, however, largely lacking with information provided being mostly of a descriptive nature[24].

6.3 Are the actions taken expected to significantly reduce future water stress to the horizon 2025?

6.3.1 Modelling the impact of existing measures on future water stress

Measures and policy actions addressing WS&D in selected RBMPs and MS were revisited to identify their potential impact with the framework of the baseline scenario to the year 2025. A sample of river basins from Cyprus, France, Germany, Italy, Malta, Spain and United Kingdom were selected, these river basins representing a wide diversity of contexts and water management situations. The impacts of the measures and policy actions proposed in these river basins were modelled using the WaterGap model, assuming that the policy instruments implemented prior to the period 2006-2007 were already embedded into the Economy First Scenario (EcF) storyline of the baseline. The results are presented country by country in the following paragraphs.

[24]Only 19 measures have information on investment costs,18 on operational costs and 3 on social costs. 19 support actions have information on investment costs, 22 on operational costs, and 5 on social costs. With respect to impacts, 19 measures give information on economic impacts, 14 on social impacts and 25 on environment impacts. 22 Support actions give information on the economic impacts, 23 give information on social impacts and 31 on environmental impacts.

Spain

Spain was chosen to be included in the model to identify the contribution of the current policy instruments and measures that would influence water management by 2025. The **table below** provides an overview of the measures that are proposed by Spain and that were considered in the WaterGap modelling exercise.

Table 9. Measures and support actions identified for Spanish River Basins and accounted for in the WaterGap modelling

Basin	Basket of instruments
Cuencas Internas de Catalunya	Awareness campaigns
Islas Baleares	Measures for savings/ better use of the resources for Urban/ Domestic supply include: a) Installation of water saving devices, b) Specific legal regulations (water saving devices, waste-water reuse…etc), c) Water tariffs system for urban uses, d) Improvement in the efficiency of the water supply networks, e) Awareness campaigns on responsible use of water, f) Volumetric control of abstraction/ use of water resources, g) Reuse of reclaimed water for urban uses
Cuencas Mediterráneas de Andalucía	Improvement of urban networks, and increased efficiency in buildings, and awareness raising
Cuencas Internas País Vasco	Improvement of urban networks
Duero	Measures for domestic savings include the following; a) Actions on improvement of Drainage networks and water treatment (plants and/or infrastructure) , b) Actions for the improvement of the Supply network (optimization), c) Actions of improvement of the regulatory infrastructure systems (reservoirs, pipelines, channels...etc)
Guadalquivir	Measures of domestic savings which Include the following: a) Building regulation and installation of lower consumption gadgets for reducing urban water demand (On, ordinances, etc.).., b) Awareness campaigns in responsible urban water use. c) Application of water recirculation systems in industrial processes (not significant) d) Measures related with modified water tariffs. e) Measures related with efficiency of the supply network
Cuencas Atlánticas de Andalucía	Improvement of urban networks, and increased efficiency in buildings, and awareness raising
National policy	Recent and future Sustainable Irrigation Plans have also been implemented since 2002. Their influence in rising water saving in agriculture is expected to plateau around 2015.

Under the baseline scenario, all river basins are expected to be experiencing water scarcity according to the 20% threshold all year round, indicating that summer months will be critical. This projection signals the urgent need for decisive action which according to the model has not been clearly seen yet.

As indicated in the figures below, the measures proposed for addressing WS&D contribute marginally to reducing pressures and the water balance all year round. However, the proposed measures have a clear effect on summer water stress. The modelled measures seem also particularly advantageous to the Catalan and Basque RBDs, reducing stress by almost half although still beyond a ratio of 2. All the other basins are expected to be positively influenced but not decisively so by water saving measures. Although the intensity of water stress is reduced in all cases, it is only in the cases of the Balearic Islands and the Mediterranean Andalusia that water stress is reduced to a ratio close to 1. This is achieved mainly, however, through the introduction of desalinisation plants.

Finally, and an important factor that influences all the basins in the Spanish (MMA, 2011) case is the consecutive irrigation plans (Irrigation and Special "*Choque*" plans 2002-2008/2006-07). Indeed, these plans have had a recorded influence on water abstraction that was reduced by about 11% between 2004 and 2009. They have been pursued and will continue up to 2015. All in all, irrigation water abstraction is expected to decrease by 18% from 2004 to 2015.

The United Kingdom.

The measures proposed for the United Kingdom and taken into account in the WaterGap model are summarised in the table below. These measures are predominantly demand side interventions designed to reduce consumption, reduce leakage and encourage the uptake of water efficient products.

Table 10. Measures and support actions identified for several UK River Basins

Basin	Basket of instruments
Severn, North West, Dee, South East, Northumbria, Thames, South West, Western Wales, Anglian, Humber, Neagh Bann	Building regulations, Code for sustainable homes, Market transformation, Water network leakage reduction, water efficiency products, water metering, product labelling. These actions a completed by: Water efficiency measures, market transformation, tariffs
Scotland, Solway Tweed, North Western (NI), North Eastern (NI)	Building regulations, Water network leakage reduction, water metering. These actions are completed by: Water efficiency measures and market transformation

As indicated in the figure below, the proposed WS&D measures are expected to have very marginal impacts in all river basins in the UK. The main reason which explains this very limited impact is the conservative estimates derived for input parameters of the model to represent the 2025 situation with measures being implemented. These are based on water company estimates on what they believe they could achieve by implementing all, or some of the measures described in the table above, a rather precautionary approach to the potential benefits seen by demand side programmes as compared to more optimistic views on per capita consumption and the associated water savings expected from these programmes that the Environment Agency and Defra might have. Indeed:

- Some measures are optional and not enforced by regulation of legislation and so the potential benefits from the measures are not fully realised. For example, the Code for Sustainable Homes is a set of standards which apply to new homes. As part of the Code, water efficiency is required. Adherence with the Code however is not mandatory and remains the developer's choice. Consequently the potential benefits are only realised by a proportion of all new homes even though the Code in general is a positive step towards future long term sustainability. In some cases, legislation will drive water efficiency and increase the effectiveness of measures and a higher uptake of measures.

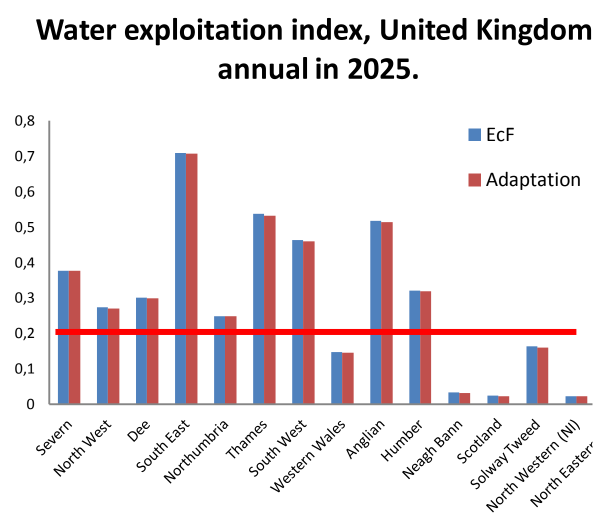


Figure 13: United Kingdom (all RBMPs): All year round water exploitation index, with and without current policy instruments in 2025-30.(Source: Modelling based on translation of measures from each RBMP into coefficients for structural change, technological change, irrigation efficiency, change in irrigated areas and new sources of water. Authors)

- Demand side measures have large behavioural elements and might be in some cases less reliable than hard engineered solutions to water scarcity, leaving some uncertainty in the outcome that might be expected by 2025;

- As not all homes in the UK are metered, the potential benefits of the measures described in the table above might not be fully appreciated.

- Water scarcity is not perceived to be problematic by the general public in many river basins, leaving high uncertainty in how the public will react to water saving measures. Indeed, it is difficult to persuade people to use less water when water scarcity is not recognised: the general opinion is that the weather is wet and cold and this does not equate with water scarcity and drought issues. This clearly could be improved with better dissemination of the problems, greater value put on water by the UK public and better education of the bigger picture of water in the environment.

France

Several baskets of instruments are proposed in France for tackling WS&D in individual river basins (see table below), their potential impact being investigated using the WaterGap model.

Table 11. Measures and support actions identified for several French River Basins

Basin	Basket of instruments
Escaut, Somme et cours d'eau côtiers de la Manche et de la mer du Nord	Water savings in the industrial sector
Adour, Garonne, Dordogne, Charente et cours d'eau côtiers charentais et aquitains	Collective irrigation management (which will lead to an adjustement of the authorisations for water abstraction to a volume compatible with the objectives of the RBMP)
Loire et cours d'eau côtiers vendéens et bretons	Implementing a collective and concerted management of water volumes; Reducing water abstraction for irrigation during summer time (including: saving water, implementing agricultural measures to limit irrigation, mobilising substitution reservoirs, diminishing the impact of water abstraction)
Seine et cours d'eau côtiers normands	Substitution of drinking water in industrial process. *(Not modeled):* This measure is mentioned in the Programme of Measures of the Seine-Normandie river basin. There is no indication by what the drinking water will be substituted. If treated wastewater is used, there is an actual saving of water. If water is abstracted directly from surface water bodies, no water saving takes place.
Cours d'eau de la Corse	N/A
Rhône et cours d'eau côtiers méditerranéens	Improving equipment for abstraction and distribution and its use

In the case of France, three scenarios and model outcomes were considered.

- The baseline scenario, highlighting the river basins that are experiencing water scarcity;
- An action scenario integrating all actions and measures identified in the RBMPs and parallel initiatives ;
- A third scenario that accounts for the future implementation of the Regulation to restore a sustainable balance in river basins with (quasi-) permanent water stress. These measures will entail abstraction caps and a reduction of quotas in the areas declared as Water Allocation Areas

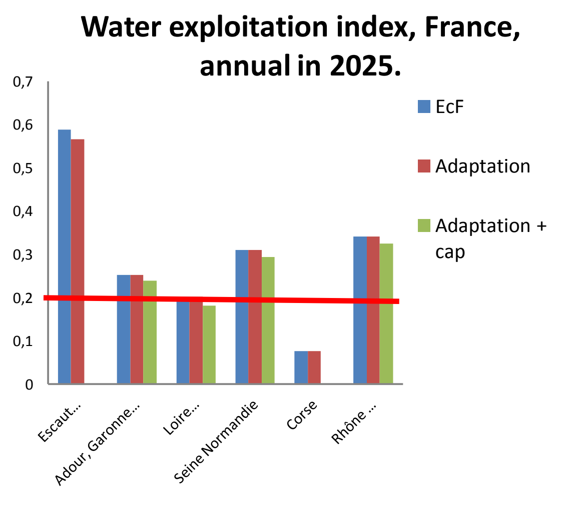


Figure 15: **France** (all RBMPs excluding overseas territories): All year round water exploitation index, with and without current policy instruments in 2025. (Source: Modelling based on translation of measures from each RB into coefficients for structural change, technological change, irrigation efficiency, change in irrigated areas and new sources of water. Authors)

(ZRE -*Zones de Répartition des Eaux*) following localized structural scarcity. These areas, at the heart of the current debate about the downward revision of quotas for abstraction, are updated regularly and their list is growing in several basins[25]. Their effect is captured by the results "Adaptation +cap" presented in the figures below that affect all river basins apart from the Escaut and Corsica. Overall, adapting water abstraction authorisations to the needs of the aquatic environment and the available volumes in groundwater bodies is expected to ensure water abstraction accounts for water availability at any given time. This measure would make water scarcity a non-issue, something that is clearly not the case for all French river basins. Modelling this scenario was made applying an overall 10% reduction in existing water abstraction quotas, a very conservative value based on the number of river basins where such abstraction reductions are currently proposed that is likely to increase as more rigorous assessments are made for additional river basins.

The results show that the effects of proposed WS&D measures will be limited in all river basins overall, with however a more significant impact on the summer water exploitation index. In the summer, the Rhône river basin will be most positively affected by the measures proposed in its RBMP. But none of the river basins (apart from Corsica where abstraction is relatively low as compared with availability) sees its water exploitation index becoming close to the 0.2 threshold value.

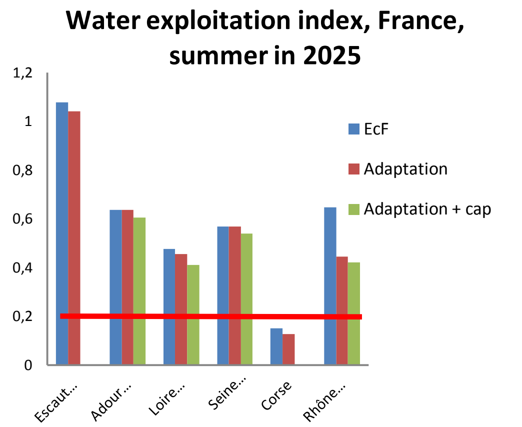


Figure 14: **France** (all RBMPs excluding overseas territories): Summer months' water exploitation index, with and without current policy instruments in 2025. (Source: Modelling based on translation of measures from each RBMP into coefficients for structural change, technological change, irrigation efficiency, change in irrigated areas and new sources of water. Authors)

[25] These new abstraction limits should have already been defined early 2011. But the process of defining new abstraction volumes has been delayed and postponed to 2012.

Cyprus

Cyprus represents a particular case with regards to the development of measures and support actions to tackle water scarcity. Having faced severe stress in recent years, a wide range of instruments addressing WS&D issues are implemented and currently proposed as indicated in the following table.

Table 12. Measures and support actions identified for Cyprus.

Basin	Basket of instruments
CYPRUS (considered as one River basin, made up of 70 major watersheds)	Awareness Campaigns, water pricing and metering, economic incentives and subsidised measures for saving potable water (i.e. drilling of private boreholes, grey water recycling systems, etc.), water rationing.
	Increase of water availability due to desalination for domestic purposes
	Leakage control in distribution networks, improvement of irrigation efficiency, quota control (allocating water to agriculture using a quota system in combination with penalty charges for over-consumption)
	Desalination
	Wastewater reuse
	Legislative and institutional measures
	New water pricing policy
	Adoption of River Basin Management Plans

The effect of additional measures to manage demand (at the margin) is not expected to yield results. Given its recent history in implementing different options, water saving technical devices in agriculture is only expected to marginally add savings. Irrigation efficiency is expected to increase due to higher water prices and limited water resources. However, the increase will be very small due to limiting conditions since irrigation efficiency is already very high.

The effect of the enlargement of desalinisation capacities is clearly at the heart of the reduction in the ratio during the summer months. As such, this measure, independently of its other economic and environmental consequences, will bring the *Government controlled* part of the island outside the probability of water stress, under any of its definitions when calculated as a yearly average. However, even with the current desalination plants, Cyprus is expected to remain within a critical zone for 2025 during the summer, less critical though than without the measures.

Malta

The range of policy instruments proposed for Malta and taken into account in the WaterGap model is presented in the following table.

Table 13. Measures and support actions identified for Malta

Basin	Basket of instruments
	Regulation of private water supply operators/Regulate the sale of water by tankers
	Development of a code of good practices for ground waters abstraction
	Maintain and implement the borehole census for water demand Management
	Enforce the regulatory framework for groundwater management
	Pilot Project on Efficiency of water use in the domestic sector
	Distribution of water saving devices in houses
	Develop an awareness campaign on national water issues
	Carry out water audits and advise industry on water saving methods
Malta	Set up a National Water Information System (The National water information system would have a dual role of providing information to the general public on several water related aspects and also act as an access portal to water quality data (data that is a result of other water-related directives such as drinking water, bathing water etc.)
	Prepare and implement a full information campaign on good agricultural practices (*This campaign focuses on good farming practices: use of fertilisers and pesticides, manure management, water management, irrigation, reuse of treated wastewater. Training and capacity building initiatives together with the development of a communication plan and programme would also be included.*)
	Carry out a pilot project to promote integrated valley management
	Increase in the capacity of rainwater runoff storage facilities Development of infrastructure to increase water availability to agriculture, Maintenance and management of valleys to store rainwater and possibly use the said water for groundwater recharge, Enforce water harvesting rules and obligations for all new houses
	Desalination (Reverse Osmosis)

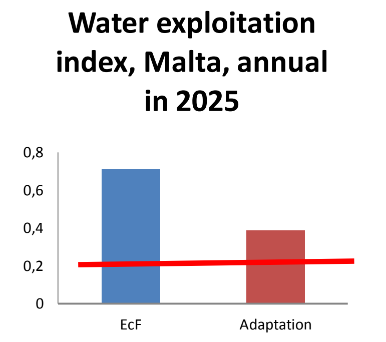


Figure 17: Malta: All year round water exploitation index. (Source: Modelling based on translation of measures from each RBMP into coefficients for structural change, technological change, irrigation efficiency, change in irrigated areas and new sources of water. Authors)

The measures to be introduced by Malta through the RBMP are expected to significantly reduce the water exploitation index in the island as indicated in the table below, but still not achieve the 0.2 target for the water exploitation index. As such, desalination by osmosis is expected to bring about a 25% reduction in groundwater use. Desalination already contributes to about 55 percent of the water supplied to the public distribution system[26]. And an additional volume of 15 million cubic meters could be produced at a cost of Lm 0,25 per cubic meter with the existing infrastructure[27]. This would allow reduced groundwater abstraction by the same volume of water. The resulting increase of energy consumption would however generate an environmental cost due to the equivalent CO2 emission. The additional operation cost could be passed on to the consumer through an increase in

[26] In terms of production costs, the cost of substituting groundwater with desalinated water would be about LM4 million/year (about US$1.333 million/year, at an exchange rate of LM1 = US$0.3332) based on current energy costs. (http://www.fao.org/docrep/009/a0994e/a0994e00.htm)

[27] Based on the Twinning Light Project (ACTeon, 2007)

water price (first and second block). In contrast, the combination of alternative sources and water saving instruments would provide only around 5% in water savings.

Italy

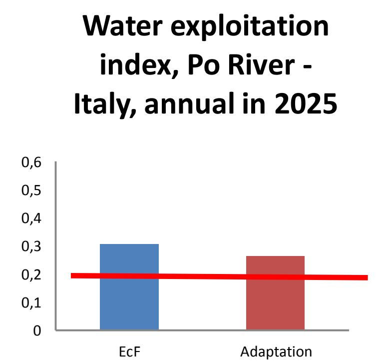
The Po river basin only was investigated for assessing the expected impact of proposed WS&D measures in Italy. The range of policy instruments proposed for the Po river basin and taken into account in the WaterGap model is summarised in the following table.

Table 14. Measures and support actions identified for the Po (Italy)

Basin	Sector	Basket of instruments
Po	Domestic	Plan for water conservation (*Piano di Conservazione della Risorsa*)
		Users' consumption's metering
		Installation of aerators for taps, discharge reductors (also for WCs)
		Experimental application of domestic water saving technologies
		Tariffs progressively based on consumption
		Awareness campaigns
		Losses' identification through research that covers at least 15-20% of the network, with a critical value below 6%
		Reduce by 2016 to no more than 10% the % of the network's sections in use for more than 50 years (critical value 3%)
		To achieve by 2016 water storage reservoirs with capacity of at least 50% of average daily distributed volumes, particularly in mountain areas, incl. Aqueducts' improved interconnection
	Industrial	Industrial withdrawal measuring
		Annual taxation on uses and efficiency in production process
		Economic, administrative, marketing incentives for environmental friendly management
		Construction of industrial aqueducts or assessment studies for increasing surface water use
	Agriculture	Reduction of surface and furrow irrigation, improvement of distribution network through waterproofing of the land
		Improvement of conveyance and delivery's efficiency rates
		Water reservoirs for areas preferably in pre-existing mines situated upstream of diverting structures, for both irrigation and flood control.
		Pumping water
		Wastewater-reuse for irrigation purposes (quantitative)

The Po river basin is currently not under high stress and the measures are projected to have some impact but not a significant one, as illustrated by the figure below.

According to the *Piano di Tutela delle Acque* (PTA- Water Management Plan for Emilia-Romagna), the basket of measures per sector are expected to deliver, already in 2016 reduced total water needs from 408 Mm3/y to 348 Mm3 for the domestic sector, from 265 Mm3/y to 214 Mm3/y for the industrial sector and 1329 Mm3/y to 1279 Mm3/y for agriculture. In total, water saving of around 8-10% is expected across the Po basin. It is important to stress that climate projection is highly uncertain for the transition area to which the Po river basin belongs. Whereas some projections pinpoint significant changes in precipitation and summer river flows (up to - 40%), others see little change. However, the effect of the measures as they currently stand leaves the river basin at risk.



Figure

Figure 18: Italy (Po RBD only): All year round water exploitation index. (Source: Modelling based on translation of measures from each RBMP into coefficients for structural change, technological change, irrigation efficiency, change in irrigated areas and new sources of water. Authors)

Germany

The case of **Germany** was also selected as a pilot.. However, while some river basins in Germany have introduced a few measures to reduce water abstraction in certain sectors (e.g. industry, fisheries, domestic supply), water use for the most part is still well below the threshold of causing water stress. River basins in Germany are mostly not experiencing water stress at the moment. Furthermore, projected water stress as as result of the "Economy first" (EcF) scenario will only lead to marginal changes.

6.3.2 Conclusions

The simulation of the WaterGap model has shed some light on the expected impact of the measures and policy instruments currently proposed by MS for addressing WS&D.

- Overall, **none of the 23 river basins** assessed as water stressed by 2025 (be it the year round or during the summer only) under the baseline scenario **will see their deficit being balanced with the measures currently proposed by MS** for addressing WS&D. Indeed, the water exploitation index remains higher (and significantly higher in most cases) than the 0.2 threshold, both with and without proposed WS&D measures.

- In general, the proposed measures have a **limited to very marginal impact** on the year round water exploitation index, with slightly more visible impacts estimated for the index assessed for the summer season for some river basins. Impacts are significant only for Malta (year round), Cyprus (year round), the Rhône river basin (summer only) and Spanish river basins (summer only).

- As it stands, the basket of measures identified for the basins reviewed is **not particularly focusing on drivers**, expected to yield more decisive results on water stress.

    - **Desalination**, a measure mainly responding to impact, is the most influential measure captured by the WaterGap model that explains the good performance of measures considered, for example, in Malta or in some of the Spanish river basins;

    - A clear quantified impact in reducing scarcity is also derived from **leakage control in networks**, pointing to the importance of continuing support for this specific type of measure;

    - Other **water demand management** options focus on pressures and impacts. But these measures are rarely decisive in answering the challenges of the future, and in reducing water stress. In the Po river basin, demand management measures alone are expected to stabilise water exploitation not far from the 20% threshold for the water exploitation index. For the remaining cases, demand management instruments have provided marginal contributions. Adapting the conservative estimates used in the WaterGap model for parameters relevant to water demand management to capture a more optimistic view did not change the picture, stressing the insufficient attention given to water demand management in most MS investigated.

- Although **water supply instruments** (i.e. desalination, water re-use) have provided a more effective response to water stress, they can have negative environmental impacts: desalination in particular results in high energy needs and related green house gas emissions. They are emerging as part of the response mix but cannot be expected to ease all stresses. Given that previous experiences have demonstrated that important changes in drivers have significantly changed water stress patterns[28], more emphasis is needed in developing responses to water scarcity that influence drivers for a sufficient and durable response.

Overall, the **most recent policy responses** in place are **not fundamentally reversing the trend in water scarcity** in the near future. Measures recently implemented or about to be so, are clearly not sufficient to answer the challenges of water scarcity that will become more acute in coming years within the time horizon studied (2025/30).

[28] Providing some credit to the trends depicted by the historical evolution of the WEI from 1990 to 2010 (EEA, 2010). Please refer to Annex 12 for details.

7. Question 4 – What are the main sources of uncertainty underlying the assessments and results presented?

The two main assessments of the report were i) generating an image on the magnitude of WS&D at present and in the near future (up to 2025-30), as well as an ii) assessment of the impact of current measures and support actions tackling WS&D today and in the near future (up to 2025-30). Both exercises were developed following the methodologies presented but were inherently influenced by a wide range of sources of uncertainty which potentially bias their outcome and limit their ability to generalise the trends identified.

Information quality and availability is a clear source of uncertainty, particularly with respect to the impacts of measures, as well as the possibility of bias in the type of measures and support actions actually collected in the database. However, although lack of data on the actual performance of measures is rife, the representativeness of the policy instruments collected is expected to be high.

The analysis is based on the WEI as traditionally defined and suffers from its weaknesses, although as mentioned the analysis is done at river basin level and can also provide a seasonal result. However, this is not discussed further here as it is the only current indicator available and is clearly identified as one of the major gaps.

When apprehending the magnitude of water scarcity, the lack of consistent data and adequate indicators generated another source of uncertainty, which is not about the direct lack of data but about the potential biases associated with the strategy to reduce or circumvent the lack of data through modelling. These biases are also to be accounted for in modelling the potential effects of a given policy instrument into the near future.

Of these, two main sources of uncertainty were further investigated in the context of the project[29]:

- The differences between water stress as estimated by the WaterGap model and water scarcity information available in different sources such as: i) the EEA water exploitation index (EEA,2012); ii) indications of water scarcity/stress presented in some of the RBMPs; and, iii) MS self-reporting (EC 2007). The comparison between the model's output and the information available from different sources stressed that the model's output is compatible with most reported sources, thus providing a robust and coherent baseline given the low coherence level among currently available data.

- The difficulties faced in modelling the potential future impact of a specific set or basket of measures. A key component of uncertainty relates to the relative balance between demand management options as compared to technological options favouring supply increase (i.e. desalination). Although demand management options are expected to be preferable (production costs, including negative externalities linked to energy use), the uncertainty of their effect in a given situation may present them in an unfavourable light compared, for example, with desalination for which estimates are more precise[30]. To control this, simple sensitivity analyses were performed on illustrative basins to test the hypothesis of an under-estimation of the effect of demand management instruments. Overall, no fundamental

[29] For detail on the degree of coherence, please refer to Annex 13.

[30] This does not mean that under-used desalination plants are not accounted for.It only shows that they tend to be more accurately represented.

difference was observed in the results of the water stress in the year 2025 as compared to the baseline scenario (EcF).

Despite limitations of key assumptions made in the socio-economic baseline scenario, the comparison between different sources of information on water scarcity, complemented by sensitivity analysis of key parameters linked to water demand, stressed the relative robustness of the general conclusions presented and given above. The general conclusions point to the need for more decisive interventions for addressing WS&D in Europe, in particular actions to tackle in priority the drivers of water scarcity.

8. Question 5 - What are the current gaps in addressing WS&D in the EU?

8.1 What are the Gaps? Lessons from the assessments

The assessments presented above stress a diversity of "insufficiencies" or "gaps" for addressing fully water scarcity and droughts in Europe. Overall, four types of gaps have been identified. These include:

- **Conceptual gaps**, i.e. an inadequate understanding of the causal relationships between drivers, pressures, states and impacts that would help identify the adequate (most cost-effective) measures for addressing WS&D. This inadequate understanding is exacerbated by the common combination of assessments and measures of water scarcity and those of droughts. In this sense, over-simplified main indicators such as the WEI also present opportunities for important improvements

- **Information and assessment gaps**, i.e. insufficient information and assessments on the magnitude and recurrence of WS&D (including the socio-economic dimensions of impacts), on the measures effectively proposed for addressing it (measures are rarely "WS&D-flagged" and part of specific policy initiatives targeting WS&D) and on their (potential, expected or actual) effectiveness in reducing water scarcity and drought problems ;

- **Policy, governance and implementation gaps**, i.e. the lack of adequate policy response and governance (including those actions aiming to ensure that WS&D issues are internalised into water policy, sector policy and land-use planning) to tackle the WS&D challenge, and the absence of pre-conditions (allocation of adequate human and financial resources, monitoring and enforcement, etc) for effective implementation of measures and support actions. In some cases, the absence of the "right" pre-conditions questions the actual implementability or suitability of proposed measures to address WS&D

These gaps are further analysed individually in the following paragraphs. However, it is important to stress their inter-relationships, each gap reinforcing the other in weakening the effectiveness of policy responses to address water scarcity and droughts in Europe.

8.2 Conceptual gaps

The literature review that has supported the assessments presented above highlights two types of conceptual gap.

- The first conceptual gap relates to the availability of theoretical frameworks with good predictive power on the drivers, pressures, states and impacts of WS&D. Fragmented approaches are mostly applied in an incoherent manner, with insufficient transparency in causal relationships (expected or proved) and basic assumptions made.

- The second conceptual gap, which affects both a) the possibility to benchmark MS assessments and responses and b) the coherence in response particularly at the EU level, is the challenge of a common understanding of what water scarcity and droughts are. Indeed, as illustrated above, there is no common definition of what water scarcity and droughts nor a coherent methodology for assessing Europe's vulnerability to drought and water scarcity[31] and to identify environmental, social and economic co-determinants of drought impacts (Ribot, 1996).

The country-level use of the WEI as the indicator for water scarcity has been questioned as an over-simplifying indicator of water scarcity. As indicated earlier in this report, it represents a severe limitation to understanding the magnitude of the challenge in the EU[32]. Although this is now being addressed at the EU level with the adoption of a WEI+ indicator, calibrating the current magnitude of water scarcity remains a clear challenge.

To assess vulnerability (and thus plan for adequate response), a clear view of the drivers, pressures, state, impacts and responses and their cause-effect relations would be required. This interplay is inherently complex and requires in-depth analysis in order to be able to define how the different variables (and encouraged changes of) affect one another. There are currently only limited robust assessments, even more so at the EU scale, where these cause-effect relations are studied or adequately monitored. Thus, insight into the interplay of the WS&D parameters remains limited, including in terms of the effect of (potential or proposed) mitigation measures and the adaptive capacity of affected populations under various socio-economic scenarios.

8.3 Information and assessment gaps

The DPSIR framework suggests a path of causality between policy instruments or responses to specific drivers, pressures and impacts related to WS&D; and an assessment of the adequacy of existing or proposed measures for tackling WS&D requires significant information on these causal relations, but also on current (initial) water scarcity and drought problems and their explanatory factors. Ironically, basic data on water use by regions and by different economic sectors, that can then be examined against water supply (hydrological) data are often the least reliable and most inconsistent of all water-resource information (Gleick, 2006). Other studies concluded that reliable and comprehensive data on water supply and demand is hard to come by (Gleick et al., 2002). As such, there is insufficient data on drivers, pressures and impacts related to the measures/support actions.

- The absence of robust information has been stressed throughout the assessments presented above, generating its main limitations and uncertainties.

- The assessment of how the WFD RBMPs addressed water scarcity and droughts in their RBMPs confirms the inadequate knowledge base on WS&D (TYPSA, 2011a).This screening exercise stressed the significant number of unclear or non-transparent datasets for water quantity aspects, with e.g. sources of data for present water consumption and availability being explicitly mentioned in only 40% of the assessed RBMPs and limited attention given to projections of future water demand and water availability. Furthermore, information on measures that target WS&D, including those regarding implementation (e.g. social acceptance, availability of funding, etc.) and their expected impact on WS&DD is scarce or difficult to trace. Finally, only one RBMP out of ten made the uncertainty of data explicit.

[31] In line with the prevailing view in literature, the vulnerability is determined by three components: (a) exposure, being the nature and degree to which a system is exposed to drought hazards; (b) sensitivity, being the degree to which a system is adversely affected by droughts and water scarcity; and (c) adaptive capacity, being the ability of a system to adjust to drought-encouraged shocks, either in short or medium terms, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

[32] However, given that it was the reference its basic logic is still used in this assessment as to provide a coherent picture of the phenomenon in the model chosen.

- The state of knowledge on WS&D is illustrated by the current status of the water quantity information available under the EEA WISE-SoE#3 reporting that supports the calculation of indicators on Water Scarcity and Droughts, in the context of monitoring the European "State of Environment" (SoE) and as part of the Shared Environmental Information System (SEIS)[33]. This reporting has only been running for 2 years (2009 and 2010 following a test exercise in 2008). Although MS engagement (which is voluntary) is encouraging, the current data do not yet provide Europe-wide coverage or long-time series results, thus rendering it difficult to identify the extent and magnitude of WS&D and associated impacts. The following table summarizes the data available and current gaps in the WISE-SoE#3 at RBD (or SU) level, per data category and for different EU countries. A closer look at available data stresses differences in reporting in terms of temporal scale (from annual to monthly) and parameters under each main category (availability, abstraction, use)[34], limit the possibilities of in depth and homogeneous analyses.

Table 15. Overview of data availability in WISE-SoE#3 at RBD **(or** SU**) level:**

Country	Data on Freshwater Availability	Data on Freshwater Abstractions	Data on Freshwater Use
Austria	+++		
Belgium	++	++	++
Bulgaria	+		
Cyprus	+++	+++	
Czech Republic	+++	+++	+++
Denmark	+	+	
Estonia	+++	+++	
France	+++	+++	
Ireland	+++	+++	+++
Latvia	+++	+++	
Lithuania	+++	+++	+++
Portugal	+++	+++	
Romania		+	
Slovakia	+++	+++	
Slovenia	+++		
Sweden	+++	+++	
Switzerland	+++		
United Kingdom	++	++	
Total: 18 countries	***Overall satisfactory***	***Overall satisfactory***	***Overall poor***

Note: The number of "+ " is used to rate the overall availability of data at RBD or SU scale as reported in the WISE-SoE#3. It does not reflect the spatial scale at which these data were reported (i.e. data can be annual or monthly), nor the number of the reported parameters under each category (i.e. core parameters vs. additional parameters).

- Data on impacts of WS&D are not widely available, nor has a common impact typology been developed. Further, concrete evidence on the effectiveness and efficiency of measures and support actions addressing WS&D is missing, or largely qualitative when available. This results partly from the relatively recent application of some measures, combined with a more structural pattern of weak (*ex-ante* and *ex-post*) evaluation as suggested by the

[33]This data reporting has been integrated into the EEA annual dataflow and comprises of data on freshwater resources availability, abstraction and use. The spatial resolution of the data is the River Basin District (RBD) or Sub-unit (SU) scale, while the requested minimum temporal resolution is the monthly scale. This disaggregation was specifically desired to capture the high variability of water resources that is leveraged if we look at the problem in larger spatiotemporal scales. Additionally, stream-flow data are requested at a daily time step. To avoid double reporting of the data, The WISE-SoE#3 reporting has been streamlined with the Eurostat reporting under the JQ IWA (joint questionnaire on inland water) which traditionally requests more aggregated data (at country level and annual scale). The collected data are published in the Waterbase, a series of water topic-specific databases and web pages publicly accessible via the EEA Data Service's web site Data on the status and quantity of collected Europe's water resources at:
http://dataservice.eea.europa.eu/dataservice/available2.asp?type=findkeywordandtheme=waterbase

[34] also vary, with some countries having reported only few basic parameters (i.e. areal precipitation, evapotranspiration, total abstraction, total use) while others have reported additional parameters (i.e. abstraction per source, return water, reused water, use per sector)

information gathered in the Policy Instrument Database[35]. Furthermore, the consistency of available data is also a recurring issue, as illustrated above for the WISE-SoE initiative or regularly highlighted by other sources (such as the Call for Evidence or the Annual reports on WS&D). Overall, more systematic information on costs, impacts and effects of measures is required from monitoring but also reporting.

8.4 Policy, governance and implementation gaps

The assessments presented above have stressed the limited attention given to WS&D issues in current water policy development in most MS. They also clearly question the level of ambition and choice of interventions made by MS for addressing, fully and sustainably, WS&D.

- Overall, most support actions and measures proposed by MS for addressing WS&D stress are targeting pressures, state and impacts, with only few measures directly targeting drivers at the origin of WS&D. This might indicate that MS responses to the problems are likely to fall short of what is required to successfully and sustainably tackle WS&D;

- The modelling exercise for selected river basins/countries highlighted the limited impact of proposed measures and initiatives, in particular those targeting water demand. All measures proposed fall short of the actual needs, with areas under stress remaining so by 2025.

The comparison between the policy areas identified as a priority in the 2007 EC Communication on WS&D, and measures currently proposed by MS, questions the adequacy of MS measures and solutions.

- While the Communication stressed the importance of *putting the right price tag on water*, implementation in this area is clearly lagging. Limited efforts are made to adapt water pricing for agriculture or for the domestic sector. However it has also emerged that less expectation should be placed on water pricing in agriculture.

- It is difficult to capture MS efforts to *allocate water (and water-related funding) more efficiently* in response to WS&D. Although actions taken at the EU level set a solid framework and the right incentive to Member States, adapting land use in coherence to the vulnerability of water resources is rarely addressed at national level. MS promote highly fragmented support actions and technical measures instead of integrated land-use planning.

- With the exception of the CAP, it is unclear that efforts undertaken at EU level for *improving conditions for EU and national funds to ensure the financing of water savings measures* are translated into action at Member State level. This is highlighted by the lack of response for using regional, cohesion and EIB funds for MS WS&D programmes and actions.

- It is difficult to assess the economic and environmental impacts of the supporting actions promoted by the 2007 Communication (i.e. DMP, EDO and EUSF) for *improving drought risk management*. All three actions contribute to reducing the economic losses and environmental impacts caused by droughts, but each in a different way. The development of DMP and EDO has progressed but the implementation of DMP remains critical. Limited progress has been made with EUSF in the area of droughts.

[35] Information on the impact and effectiveness of measures collated in this database is often limited to general statements; and it includes specific quantitative outcomes for a few measures only.

- In some countries, *additional water supply infrastructure* has been justified on WS&D grounds before grasping the full potential of water saving measures, thus in contradiction with the message of the 2007 Communication. In addition, it is unclear whether full consideration of all adverse effects of infrastructure development have been considered adequately by MS, including impacts on air quality and climate change when desalination is involved.

- *Fostering water efficient technologies and practices* is an area where MS appear to follow the recommendations of the 2007 Communication. Substantial gains by reviewing application schedules have been reported in irrigated agriculture. Uncertainty remains however on how water saving at the field level is effectively translated into overall water saving at the farm and regional (river basin) levels.

- There is limited or no evidence of possible MS efforts in *fostering the emergence of a water-saving culture in Europe*, through the promotion inter alia of new water labelling, certification and environmental footprinting.

- Despite efforts to *improve knowledge and data collection*, reliable information on WS&D has not been reached as already stressed above. In addition, water scarcity and drought have not been the focus of large scale and articulated research effort. Instead, WS&D issues are mixed with other water management issues in research projects funded under the 6th and 7th Framework Programme or MS research funding initiatives. Moreover, it is unclear whether research results have provided input to policy development and needs.

It is difficult to assess the overall implementation and performance of current specific MS responses to WS&D, because of the absence of sufficient information as highlighted above. The development and implementation of the River Basin Management Plans (RBMPs) and PoM, however, give an indication of problems MS might face with implementation. The assessment of the RBMPs (TYPSA, 2011a) highlighted in particular:

- The limited coherence (and likely effectiveness) of measures proposed in the PoM. While many RBMP proposed measures to reduce and manage groundwater abstraction, few RBMP proposed support actions such as metering, pricing/subsidies and water consumption restrictions that would reduce groundwater abstraction;

- The limited information on the link between proposed measures and targeted water bodies, and on the geographic focus of proposed measures. Even when measures are proposed, no information explains where and when proposed measures are expected to be implemented, making any assessment of their expected impact and effectiveness difficult;

- The absence of information on the role and responsibility of authorities and stakeholders in implementation, combined with limited information on financing and the availability of financial resources for implementing the proposed measures.

- The priority given to water supply measures (proposed in 30-40% of the RBMPs) over measures that impose new restrictions of pressures or that ensure the achievement of the environmental WFD objectives under WS&D conditions.

- The absence of links between water scarcity and minimum environmental stream flows that would be required for the adequate ecological functioning of river systems in coherence with the WFD ecological objectives. Overall, the absence of clear, quantitative, and coherent targets to reach the WFD environmental objectives remains the norm rather than the exception.

8.5 From the gap analysis to policy recommendations

Following the review of the state of knowledge about the magnitude of water scarcity and droughts, the magnitude of the challenge itself for the EU and the responses from MS and in the framework of the response to the 2007 Communication through measures and support actions, several courses of action have been identified. Components of policy recommendations that follow from the main gaps identified above are summarised in the following table. The recommendations are then further grouped in the following summary template so policy options for which impact that will be assessed are clearly identified. The recommendations in the following table deal with:

- Enhanced knowledge and awareness raising, including on new indicators for WS&D;
- Internalising WS&D issues into existing policy initiatives and instruments, in particular:
    - Strengthening the "quantitative dimension" of WFD implementation (be it in monitoring, assessments, definition of targets or selection of measures);
    - Accounting for water balance and quantitative targets in the allocation and use of EU funds (structural funds, cohesion funds, etc.)
- New EU policy initiatives in particular dealing with drought management and water use permits and trading.

Table 16. From gaps and issues to components of policy responses

Gap type	Issues	Potential policy recommendations	From recommendations to policy areas and options
Conceptual gaps	1. Availability of theoretical frameworks with good predictive power on the drivers, pressures, states and impacts of WS&D 2. Common understanding of water scarcity and droughts, with adequate indicators	Strengthening the knowledge base for establishing the magnitude of the problem of water scarcity) Strengthening the knowledge base (New proposal for WEI+ , clarification of the concept of vulnerability)	Addressing conceptual gaps is a pre-condition for any effective policy on WS&D. They will not form a specific policy area or option for further assessment.
Information and assessment gaps	1. Inadequate knowledge base on abstraction, uses, balances 2. Inadequate knowledge base on effectiveness and impact of measures	Building a robust monitoring and evaluation systems for WS&D, strengthening the quantitative dimension of the WFD Strengthening the knowledge base, strengthening the quantitative dimension of the WFD	Reinforcing the current knowledge on abstraction, uses and balances is a pre-condition for more effective WS&D policy. Depending on the policy area, additional knowledge will be required in particular on causal relationships between drivers, pressures and state. These will be further specified when policy areas are described.
Policy, governance and implementation gaps	1. Limited ambition of current WS&D measures 2. Focus in priority on Pressures, Impacts and States instead of	Awareness raising, strengthening the quantitative dimension of the WFD, establish specific (regulatory) targets Strengthen the implementation of measures	**Follow-up to the 2007 Communication** For each policy areas, different policy options will be systematically proposed, from awareness-raising to new regulation. Internalising water scarcity in

Gap type	Issues	Potential policy recommendations	From recommendations to policy areas and options
	Drivers	and actions focusing on drivers	existing EU policies (CAP and financing instruments) that influence economic sectors will be considered whenever possible and relevant.
	3. Limited attention given to adequate water pricing, and when given, potentially over-optimistically so	Strengthen the quantitative dimension of the WFD (ensure application of Article 9.2 of the WFD), Strengthen the implementation of the 2007 WS&D communication	Strengthening the role of economic instruments for quantitative management of water resources will be revisited as a separate policy area.
	4. Inadequate efforts to adapt land-use to water scarcity levels	Promote new water rights regimes (flexibility), Structural Funds (SF) funds to target investments based on water scarcity, agriculture funds to account for water issues in impact assessment,	Two alternative policy area will address the adequacy between land use and water scarcity: • Guiding land use to respond to water scarcity • Re-allocating water resources between water users
	5. Insufficient development (and implementation) of DMP	Developing a specific DM EU initiative, strengthen the quantitative dimension of the WFD (ensure systematic consideration of drought management in RBMP), promote new water right regimes (uncertainty)	The development of Drought Management Plans will be proposed as a specific policy area, with different policy options considered and compared.
	6. No systematic consideration of demand-based measures prior to consideration of supply-based measures	Strengthening the quantitative dimension of the WFD (cost-effectiveness), target SF only when cost-effectiveness analysis performed	Better use of cost-effectiveness analysis is considered as a pre-condition for sound policy making that is not specifically assessed.
	7. No certainty that individual water saving measures deliver aggregated water savings	Strengthen ex-ante assessments (guidance, requirements for SF), building a robust monitoring and evaluation systems for WS&D (ex-post)	Better use of ex-ante assessments and monitoring and evaluation is considered as a pre-condition for sound policy making that is not specifically assessed.
	8. Absence of coordinated efforts to promote a water saving culture	Raising awareness overall, strengthening the quantitative dimension of the WFD	Awareness raising will be considered in different policy areas.
			Pre-conditions for implementation
	1. Insufficient financing for support actions for implementation of water saving measures	SF as dedicated funding instrument for water saving measures, establishing targets for water use efficiency	The internalisation of water scarcity issues in SF allocation is considered as policy option whenever relevant.
	2. Unclear whether proposed water saving measures target areas (water bodies) with highest deficit	Building a sound monitoring and evaluation systems for WS&D, systematic water balance for SF, SF funding allocated to projects with water use efficiency targets, strengthening the quantity dimension of the WFD, establishing water use efficiency targets for water scarce areas	Better monitoring and evaluation is considered in all policy areas and policy options. It is assumed that policy areas and options proposed target in priority areas with highest water scarcity.
	3. Insufficient clarification on roles and responsibilities	Clarifying the roles and responsibilities in the quantitative management of water resources	With roles and responsibilities being adapted to the instrument selected for addressing WS&D, governance is described for each policy area and policy option
	4. Insufficient funding allocated	SF targeted to water saving, strengthening the quantitative dimension of the WFD	The internalisation of water scarcity issues in SF allocation is considered as policy option whenever relevant.
	5. Absence of operational link between water scarcity and minimum environmental stream flows	Strengthening the quantitative dimension of the WFD	The development of minimum environmental stream flows is proposed as a separate policy area that will be further investigated.

9. Question 6 – What are new policy areas and options for addressing WS&D in Europe?

9.1 Policy options for addressing water scarcity and droughts

Building on the main policy gaps identified and discussed in the previous chapter, a limited set of **policy areas** that target different drivers expected to influence water scarcity and drought have been proposed for further assessment. To strengthen the clarity of the impact assessment and to facilitate the grouping of options that will take place as part of the development of the EU Water Blue Print (and Lot 2 activities):

- **Water scarcity** and **droughts** are **addressed independently as two different policy streams**, accounting for the synergies and inter-relationships between both policies as well as with other existing water-related policies. Thus, the policy areas proposed for water scarcity and for droughts have been kept separate.

- The **inter-relationships between policy areas**, and the logical order that could be proposed for achieving different levels of ambition in terms of an efficient EU water policy, are not investigated and analysed here. Some reflections on synergies and inter-relationships between policy areas are however provided in the concluding section of this report.

The policy areas proposed for further assessment are presented in the following Table.

Table 17. Key policy areas that will be further investigated in the EU Water Gap project

Policy objective	Policy area	The policy area in a nutshell
Restoring the water balance in all European river basins[36]	**WS1 - E-flows**	The main purpose of this policy area is the establishment and enforcement of clear ecological river stream flows for all rivers in Europe. It requires the adaptation of current water use/abstraction rights and the enforcement of new abstraction rights that are coherent with ecological river stream flows.
	WS2 - Efficiency targets	The main purpose of this policy area is the application of well-defined efficiency targets for different water use sectors and components of the hydrological cycle (e.g. targets for conveyance efficiency in irrigation systems, for water use efficiency in buildings, etc.).
	WS3 - Economic incentives for efficient water use	The main purpose of this policy area is to widen the scope of economic instruments to ensure they provide incentives for "sustainable "water abstraction and use.
	WS4 - Guiding land use to respond to water scarcity	The main purpose of this policy area is to support the relocation of economic activities and water abstractors away from water deficit areas to areas with sufficient water and no water deficit. – or to ensure that new economic development takes place in water rich river basins and territories.
	WS5 - Trading water use rights for the environment[37]	The main purpose of this policy area is the consolidation of the existing water use right system and the establishment of water market/trading mechanisms with a defined cap for the environment. It provides the opportunity to purchase water use rights for environmental purpose to achieve the balance for river basins with deficit. Incidental benefits include the reallocation of water use rights among economic users

[36] The term « water balance » used here accounts for the "ecological demand" of rivers and aquatic ecosystem. The term "green water balance" could be used otherwise to make this clearer.

[37] This policy area is proposed here for achieving primarily an environmental objective (sustainable water balance and ecological river flows). This explains why the focus is on purchasing water rights for the environment and not on trading water rights for optimum allocation.

Policy objective	Policy area	The policy area in a nutshell
		that can deliver economic benefits.
Enhancing drought management in Europe	D1 - Strengthening the **European Drought Emergency Response** Capacity	This policy area builds on a twin approach combining: • The development of an European Drought Observatory and European Drought early-warning system for helping MS and economic operators to react and act as early as possible to forthcoming droughts; • The adaptation of the EU Solidarity Fund to ensure an effective use of this fund in case of drought emergency (for supporting economic actors and citizens to cope with damages that could not be avoided).
	D2 - Assessing and managing drought risk	This policy option builds mainly on the development and implementation of coherent set of actions for addressing drought at the river basin scale, in coherence with the planning process of the WFD.

The seven policy areas pursue to some extent different yet complementary objectives, in many cases lending themselves to joint implementation. Three different macro-objectives central to today's European policies, and to which individual policy areas and policy options will contribute, have been identified.

1) The first macro-objective relates to **resource-use efficiency**, in line with the flagship initiative for **a resource-efficient Europe** under the **Europe 2020 strategy** that supports the shift towards a resource-efficient, low-carbon economy to achieve sustainable growth. With regards to water, resource use, efficiency describes the relationship between the amount of water required for a particular purpose (or the added value produced with that amount of water) and the amount of water used or delivered. The term 'efficiency' is widely used both for water conservation, that is socially beneficial reduction of water withdrawals or losses, and the value produced with a given volume of water. In the latter sense, the increased efficiency does not necessarily imply water conservation. In fact, increased efficiency with which water resource is used may turn out to increase (rather than decrease) the rate of water consumption - an effect known as 'Jevons Paradox' (Polimeni et al. 2007). For example, Ward and Pulido-Velazquez (2008) found that more efficient irrigation techniques in the Upper Rio Grande Basin actually increased water depletion as farmers extended the areas of land to be irrigated, and thus, reduced the return flow and available water for downstream users. Also in Spain, efficiency programmes have led to increases in irrigated areas and to an intensification of land and water use (Bogart et al, 2012).

2) **Coping with risk** is the second macro-objective that has gained importance in many European policy areas in particular in the context of climate change. It refers to recurring but temporarily constrained water shortage as a result of deficient rainfall. As part of natural variability, the precipitation and thus the availability of water resources throughout time and space vary within bounds determined by given climate conditions. Droughts are extreme events at the lower bound of climate variability. They are natural and recurring phenomena of prolonged absence or marked deficiency of precipitation. The impacts of droughts are particularly austere when the 'below usual' precipitation exacerbates already existing water scarcity that may be a result of arid- or semi-arid climate conditions or demand encouraged overexploitation of the resources. Proper drought risk management can help reduce the harm caused by droughts and increase the ability of societies to respond and recover. It can also contribute to the identification of preventive measures to adapt to the changing climate(s). The policy areas 1-5 refer to Water Demand Management (WDM) which is not the same as drought risk management (policy areas 6 and 7), although the boundary between both is blurred.

3) The third macro-objective, **preserving good environmental health** of water courses and riverine ecosystems, is embedded into the European Union Water Framework Directive. Preserving good environmental health of aquatic ecosystems is met only if the conserved water left for environmental purposes is not allocated to other consumptive or non consumptive water uses. There are many services provided by natural ecosystems and supported by the introduction of the environmental

flow. Korsgaard (2006) offers a detailed list of the main services splitting them into four categories: production (water provision - subsistence/rural and piped/urban; fish/shrimp/crab farming; fertile land for flood-recession agriculture and grazing; vegetables and fruits; fibre/organic raw material for building/firewood/handicraft; medicine plants; inorganic raw material for construction and industry); regulation (chemical water quality control/purification capacity; physical water quality control; flood mitigation; groundwater replenishment; health control; pest control; erosion control; prevention of salt water intrusion; prevention of acid sulphate soils development; carbon sequestration; microclimate stabilisation); information (recreation and tourism; biodiversity conservation; cultural/religious/historical/symbolic activities); and life support (prior existence of healthy ecosystems) (Korsgaard, 2006).

Box 4. The likely contribution of proposed policy areas for effective management of water resources

Figure 1 A ladder (after Arnstein 1969) of four objectives towards an effective (demand) management of water resources.

	E-flows	**Efficiency targets**	**Economic instruments**	Guiding **land use** to respond to water scarcity	**Trading water use rights** for the environment	Strengthen **Drought Emergency** responses	**Assess and manage Drought Risk**
Shifting towards higher value use of water			✔		✔		
Increasing efficiency of water use/application		✔	✔	✔	✔		(✔)
Protecting healthy river ecosystem/ecosystem services	✔		✔	✔	✔	(✔)	(✔)
Enabling environment	✔			✔		✔	✔

Figure 2: Policy areas introduced in the section 1 and their contribution to specific targets/actions which enhance water scarcity and drought mitigation (✔ indicate direct contribution, (✔) indicates indirect contribution)

Enabling environment, the first step up the ladder, comprises activities related to knowledge management, legislation and organisation of water resource management. Knowledge management includes an in-depth understanding of a river basin from a multidisciplinary perspective including climate, hydrology, ecology, economics, engineering and sociology. Second step up the ladder is the preservation of **healthy river ecosystem** and ecosystem services. Communities draw many benefits from ecosystems, including resources (e.g. water, food, medicines, etc.), a healthy environment (e.g. air purification by forests, purification of water by wetlands, pollination of crops by wildlife, etc.) and the so-called "cultural services" (i.e. the non-material benefits such as aesthetic enjoyment, opportunities for recreation and inspiration for culture and art). Ecosystems act as both a buffer and physical barrier for reducing the magnitude of hazardous events (i.e. floods and shallow landslides), while providing essential livelihoods' supporting goods, in addition to human well-being through cultural, recreational and aesthetic services. Next step up the ladder is a (more) **efficient use and application of water**. The final step includes actions meant to **shift water from low to higher value uses**, contributing so to higher community welfare and wellbeing. Using the simple concept of the ladder, the figure 1 shows the main focus and complementary nature of the seven policy areas. From the figure 1 it is evident for example that several policy areas contribute jointly to increased efficiency of water use and application. Comparable results may be achieved by application of *economic instruments* (such as water pricing systems) and *regulatory instruments* (such as *efficiency targets*).

The identified policy areas do not specify, intentionally, envisaged intensity and implementation rigour; nor do they stipulate that policies will apply to all water use sectors uniformly or in a differentiated manner. Thus the assessment discusses different ways of putting the rather wide-ranging policy principles into place and pinpoints selectively the empirical evidence substantiating the rather qualitative judgements of the potential benefits and costs of policy courses to tackle water scarcity and drought.

The drought policy areas, in particular actions related to the European early warning system and drought management plans, are prerequisites of concerted risk management approaches. Early warning systems (EWS) help to recognise the onset (and break) of drought conditions and thus optimise the use of remaining water resources. Drought management plans (DMP) on the other hand entail the concrete action, specify the responsibilities for their best possible implementation and coordinate effort at different drought governance levels. The success of mastering drought emergency depends, in addition, on a host of factors such as retention capacity of a river basin, ability to enforce compliance with drought emergency measures, etc.

9.2 Policy areas and options for addressing water scarcity

The following tables provide an overview on policy areas and options for addressing water scarcity:

Objective	Policy area
Restoring water balance in all European river basins	**E-flows**
General description of the policy area	The main purpose of this policy option is to promote the establishment and enforcement of ecological river stream flows (E-flows) for all rivers in Europe. This requires: • The establishment of an agreed methodology for defining E-flows, the application of this methodology and its enforcement. • The definition of thresholds based on a) water availability, and accounting for variability in water supply, and b) the environmental needs. These thresholds specify how to “share the burden” between water use sectors when water scarcity exists in a given river basin in terms of necessary water abstraction reduction as compared to actual abstraction levels (including potential illegal water abstractions that will need to be accounted for and formalised) and upstream/downstream river flows. • Monitoring these new water abstractions for all water users, to assess whether new water abstractions are complied with, and also E-flows – and to take necessary actions for enforcing new water abstraction that account for E-flows. To comply with these established objectives for the quantitative management of water resources, economic actors and water users will be required to invest in water saving measures (or water supply enhancement measures) so defined new abstraction limits and E-Flows are complied with. Specific financing might be provided for facilitating economic sectors’ transition to practices and processes leading to reduced water abstraction. It is important to note that the “new water abstraction regimes” that comply with E-flows will need to account for b) the temporal variability of E-Flows within a year and b) the temporal variability of water resource availability in the medium term.

EU policy options	Different policy options have been identified: Option 1 – Voluntary implementation through common guidance and best practice sharing. This implies raising awareness on the concepts and challenges of Eflows, sharing good practices on the definition of E-Flows and the establishment of water abstraction permits coherent with E-Flow and enhance knowledge through the organisation of events, communication, etc. Voluntary environmental re-allocation by individual users will be supported and promoted. Option 2 – Mandatory application of E-flows through the WFD. To strengthen the quantitative dimension of the WFD by a) making compulsory the establishment of E-Flows as key component of good ecological status and b) ensure the application of exemptions under Article 4 account systematically for quantitative issues and E-flows. Establish a CIS working group on E-flows to develop guidance (building on specific tests in pilot river basins) and update and adapt reporting to the EC so E-Flows and river flows are systematically reported and compliance with E-flows checked. Option 2b. Mandatory application of E-Flows. Adopt a specific WFD daughter directive on E-Flows that will specify the protocol for establishing E-flows, make E-Flows definitions compulsory in all (deficit) river basins and ensure compliance with defined E-flows. This option is similar to option 2 but with a more formal process and reporting. Option 3 – Establishing an EU-wide register on water abstraction and E-flows. This option will lead to the establishment of an EU-wide central register of (spatially-referenced) water abstraction and E-flows that is linked to EU physical water accounts (developed by the EEA). This will help monitoring changes in water abstraction and water balances (including allowances for the environment) and be the basis for assessing MS efforts in addressing quantitative water management and water scarcity issues. This will feed into the regular EEA "state of the environment" reports. This option can be implemented separately or be part of Option 2 and Option 2b Option 4. Cross-compliance for EU financing instruments. Ensure the compliance of all EU-funded projects (with structural and cohesion funds/rural development) with the achievement of E-flows. This requires that water accounts/water balances and E-flows are established for river basins where projects are located, that water abstraction of new projects are well assessed and that financing decisions are taken according to this information. Metering of water abstraction for new projects is also made compulsory.
Knowledge	There is a need to develop protocols and methods for defining E-flows in relation to Good Ecological Status (GES) and to Good Ecological Potential (GEP), in particular a) under conditions with high variability in water supply (e.g. Mediterranean river basins) and b) changing climate scenarios. Specific research projects could be launched to develop and test such protocols under different hydro-eco-regions. In addition, research on the link between E-Flows and ecosystem goods and services could be launched to support the identification of benefits that would arise from achieving E-Flows and thus strengthen their justification and communication around the issues. Also, different methods for estimating individual water abstractions for large number of small (diffuse) water abstractors will be developed and tested.
Monitoring and reporting	Option 1 does not require specific monitoring at the EU scale. Reporting might take place informally through the organisation of events and practice sharing conferences. Options 2 and 2b requires the systematic monitoring of (daily) river discharges at selected points, combined with hydrological modelling for estimating river flows for remaining surface water bodies. It also requires monitoring water abstraction to ensure new water abstractions coherent to E-Flows have been complied with. Additional monitoring equipment can be required for countries with limited experience in flow monitoring, along with the allocation of additional human resources for performing river flow monitoring. Specific attention will be given to E-Flows definition and monitoring at transboundary locations. Investment in metering will also be required. Reporting to the EC will be systematic and compulsory. Option 3 requires the establishment of a centralised system for reporting water abstraction permits and use for individual users. This information will input into the water accounts developed by the EEA so water balances can be assessed regularly and changes in water balances assessed. Option 4 requires water balances and E-flows to be assessed and checked on an ad-hoc basis at the project level.

Governance	The establishment and enforcement of E-Flows, along with the systematic monitoring of water abstraction in water scarce basins, can take place in the context of the WFD implementation for all options, thus not requiring specific organisational changes additional to what is currently made under the WFD. Additional human resources might however be required for: 1) establishing robust monitoring and hydrological modelling; and 2) defining new water abstractions that comply with E-Flows for individual users. In addition, specific efforts will be required for the transition from the actual to new water abstraction regimes (informing and communicating to all concerned parties (water users), involving water users in the new water abstraction definition process, etc.). A system of penalties will be put in place when not already existing for enforcing E-Flows and water abstractions.
Technical requirements	Technical requirements include the installation of river flow monitoring equipment (including automatic recorders for key locations) and metering for individual water users – or groups of water users (e.g. for members of collective gravity irrigation systems that abstract in a river from a single location). In river basins where priority water abstractions are already high and where economic development does not allow for reducing existing water abstractions to required levels (following economic tests equivalent to those proposed under the WFD under its exemption articles) for reaching E-Flows, new (limited) water storage for supporting river flows might be developed.
Other pre-conditions	As indicated above, an important step in the wide acceptance of E-flows is the understanding of the relationship between Good Ecological Status/Good Ecological Potential and E-flows (as adequate hydrological regimes for ecosystem needs). A strong mobilisation of water users at local to national levels are pre-conditions for ensuring acceptance of new water abstraction regimes and E-Flows.
Possible adaptations in existing EU instruments	Adjustments in the EIA and SEA directives will be proposed to include E-flows as mandatory issue in the impact assessments.

<table>
<tr><th>Objective</th><th>Policy area</th></tr>
<tr><td>Restoring water balance in all European river basins</td><td>Efficiency targets</td></tr>
<tr><td>General description of the policy area</td><td>
The main purpose of this policy area is to promote high water use efficiency to reduce water abstraction and re-establish water balance. It requires:

The establishment of systematic water balance assessment/water accounts at different levels (basins and catchments) so water deficit areas, water use sectors contributing to deficits and current efficiencies are well captured. These balances will provide information on where and how water efficiency can be improved.
The application of measures for enhancing water use efficiency using specific targets/standards and Best Available Technologies (for conveyance, production processes, etc.), combined with the “reallocation” of water saved from efficiency improvements to aquatic ecosystems. Note that the application of efficiency targets/standards and “BAT water use efficiency” efforts might not be sufficient for restoring adequate water balance and achieving E-flows for all river basins, in particular in river basins with very high structural water deficit. In other river basins, BAT might sometimes lead to improvements

This policy area encompasses all sectors and issues where water efficiency is at stake. It deals with the promotion and application of domestic appliances (promoted through building codes), BAT for high efficiency in industrial processes and applications, high conveyance and water use efficiency in irrigation, high conveyance efficiency in water services, etc.
A progressive approach to achieving these targets or “BAT water use efficiency” might be proposed in different sectors to account for the renewal rate of buildings/equipment/pipe, etc. (i.e. ensuring all new projects, equipments and buildings that are allowed comply with BAT, and progressive achievement of targets for existing ones depending on a given renewal rate or modernisation). More strict rules could be proposed to ensure new projects and developments are allowed only when sufficient water (equivalent to the project’s demand) is saved from existing projects and developments elsewhere. To avoid that water saved from improving efficiency is fully used by economic sectors, a given fixed share of the water saved (or the full share – likely to be less acceptable by current water users) will systematically be allocated to the environment.
A preliminary step to this policy area will be to improve water efficiency in all EC buildings so they can be seen as exemplary.
</td></tr>
<tr><td>EU policy options</td><td>
Different policy options have been identified:
Option 1 – Voluntary implementation through common guidance and best practice sharing. This implies raising awareness and promoting voluntary agreements with local operators and water abstractors to finance their water use efficiency improvements/BAT with water saved returning to the ecosystem. A CIS working group on water use efficiency will be established for preparing “BREF-like” notes on water use/conveyance efficiency and for identifying good practice in terms of governance and voluntary agreements. The establishment of an “EU Water Efficiency Blue Award” (for specific sectors like buildings, industrial plants, water supply companies) will help raising awareness and gaining acceptance by offering additional benefits to individual operators (market value, raising their profile in communicating on their efforts to increase water use efficiency, etc.).
Option 2 - Cross-compliance for EU financing instruments. Establishing new rules for granting structural and cohesion funds to projects (new or modernisation of water infrastructure) that 1) comply with given efficiency target and best practice in terms of water efficiency and, for existing projects and water abstractors that already abstract water, 2) return saved water to the environment. The application of these rules could be made everywhere or limited to projects that are proposed in river basins with deficit (thus requiring water accounts/water balance to be established prior to taking the decision on financing a given project). For projects targeting existing water uses, the revision of water use rights would be required after investments to ensure saved water is subtracted from initial water use rights.
Option 3 – Mandatory application of efficiency targets through new regulation. Adopting specific WFD daughter directives on water use efficiency for individual sectors (agriculture, key industrial branches, buildings, water services...). Fines and penalties will be applied when water use efficiency targets have not been met. Depending on sectors and on the balance between economic development and the protection of aquatic environment, this option could promote BAT throughout Europe or limit its application to water scarce basin (requiring then water accounts/water balance to be established for each river basin prior to deciding whether targets apply).
</td></tr>
</table>

Knowledge	Specific research and benchmarking (within sectors) is required on BAT water efficiency for all 3 options. Research on maximum and optimal water efficiency will be performed at different scales (Europe, MS, river basins, sectors or sub-sectors) for different types of context. This will help supporting the definition of target(s) and possible BAT water efficiency standards. For options that limit the application of efficiency targets to water stress basins, then new WEI+ indicators need to be developed and tested to ensure they fully grasp the temporal dimension of water scarcity.
Monitoring and reporting	Water efficiency for different sectors will need to be monitored. In some cases, it will be sufficient to specify the type of technology that is applied as the technology with reflect a given water use efficiency level. When the application of targets is limited to river basins under stress/deficit, then water accounts/water balances building on WEI+ will need to be established to justify that water efficiency targets do not need to be complied with. To facilitate implementation, an EU wide river basin water account/water balance system can be proposed using enhanced WEI indicators. The continuous monitoring of these water balances over time will help showing whether overall water abstraction is reduced and water balances re-established or not. In some cases, dedicated studies or monitoring of water abstraction/discharge and water demand will be required (randomly to limit costs of studies) to assess whether efficiency targets have been met by individual key sectors or operators. In parallel, specific efforts will be required to assess and then monitor water use efficiency in new projects and developments. Systematic reporting on projects' achievements and water use efficiency, but also regular reporting on efficiency under the EU WFD, will be proposed for all options. In addition to help monitoring progress in policy implementation, this will help raising awareness within the water community on the importance of water use efficiency,
Technical requirements	No specific technical requirements have been identified, apart requirements linked to individual projects that will adapt their practices and technologies to achieve water use efficiency targets. In addition, metering is likely to be required for monitoring water abstraction and establishing water saved that will return to the environment.
Governance	All options require the establishment of dedicated communication to specific sectors/sub-sectors, and the organisation of benchmarking activities within sectors. A specific committee composed of state representatives and representatives from individual water use sectors could be formed for managing the "EU Water Efficiency Blue Award". Option 1 will require the establishment of contractual arrangements between water users and "financing bodies" (local authorities, environmental NGOs, etc.), followed by adaptations in the initial water use right to subtract water saved. At the EU level, it will not require particular governance For option 3, sector-based working groups at the EU level will be launched for establishing BAT water use efficiency and monitor progress in implementation of targets/water use efficiency. This will entail specific transaction costs.
Pre-conditions for "making it work"	This requires the development of sector-based processes involving users and producers of new technologies so new BAT are developed and made available at adequate costs. Specific discussions with sector representatives and their customers will be required prior any launching of the "water efficiency Blue Award". The scale at which this award will be allocated will need to be discussed
Possible adaptations in EU instruments	Option 2 establishing new rules for granting structural and cohesion funds to projects that comply with water efficiency standards will require amendments in the corresponding directives.

<table>
<tr><th>Objective</th><th>Policy area</th></tr>
<tr><td>Restoring water balance in all European river basins</td><td>Economic incentives for efficient water use</td></tr>
<tr><td>General description of the policy area</td><td>The main purpose of this policy is to promote the application of economic incentives (tariffs for water services, abstraction taxes and charges) that promote more efficient water use in individual sectors to reduce water abstraction. The proposed actions require:

• The establishment of volumetric water tariffs and water charges/taxes with unitary rates that are sufficiently high. The application of volumetric tariffs will take place at the scale of water supply service areas, be it for irrigation or for drinking water supply. For water charges/taxes, it will take place at the national level or at river basin level (like for example in France);

• The application of abstraction taxes with set "spatial differentiation" to account for different levels of water scarcity among river basins. Abstraction taxes and charges will be set at higher rates in river basins with over-exploitation.

• The earmarking of financial revenues from abstraction taxes and charges to support projects and actions that aim at reducing water demand and water abstraction for given sectors. Financial support will be provided only if the water saved through improved water use efficiency and water saving is returned back to the aquatic environment.

The applications of these instruments in individual MS will vary in terms of the spatial scale at which instruments will be defined and applied (country-level, water service operator level, river basin level....), depending on the current institutional framework of the water sector.

Specific databases of water tariffs experiences will be developed to complement the database of the OECD/EEA on environmental taxes and charges. Publicity on these databases will be carried out so they are more widely used and consulted including by a wide diversity of operators and water managers.</td></tr>
<tr><td>EU policy options</td><td>The different options that can be envisaged include:

Option 1 – Voluntary implementation through common guidance and best practice sharing. Raising awareness and promoting the use of incentive water tariffs and abstraction taxes/charges. A CIS working group on economic instruments for water management could be formed, identifying good practice that would be shared and promoted as part of policy conferences and debates. This working group would need to mobilise representatives from both the water ministry and the financing/economic ministry, along with key representatives of water service sectors (both drinking water and irrigation water supply).

Option 2 – Mandatory application of volumetric and scarcity pricing within an expanded scope of the WFD. Strengthening the implementation of the WFD Article 9, by providing specific advice on reporting from the Article 21 committee of the WFD (so reporting is streamlined and can effectively support policy assessment) and making more systematic use of infringement procedures on the obligations of Article 9 of the WFD (in particular linked to incentive pricing/taxes/charges)

Option 3 – Cross-compliance for EU financing instruments. Establishing new rules for the use of structural and cohesion funds for making the establishment of incentive pricing compulsory for (relevant) projects in areas with high water deficit. These rules will complement cost-recovery rules that are currently applied to projects financed by these EU financing instruments.</td></tr>
<tr><td>Knowledge</td><td>New knowledge on the price elasticity of water demand, and on the (social, economic and environmental) impacts of different water tariffs/water abstraction taxes, under different conditions (including variable water supply) and for different water services/water uses, will be required. Specific research or innovation projects could be launched to develop, test and evaluate new water tariffs or water abstraction tax regimes. Specific research could support the testing of methods for estimating individual water abstractions/demand for large number of small water abstractors in particular. New methods for water metering will also be developed and tested.

Further research and studies on water demand forecast will help estimating future water demand and the required changes in water demand that would be expected from price/tax/charge increase so water balance is re-established.</td></tr>
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Monitoring and reporting	Regular monitoring and reporting of current economic instruments (water tariffs, abstraction taxes and charges) and of their performance will be required. While it might be straightforward to monitor the levels of abstraction charges and taxes that are usually defined and managed at global scale (national, river basin district) and that will build on the existing OECD/EEA environmental taxes database (complementing current information with data on volumes abstracted for example), monitoring whether tariffs of water service provide an incentive to more efficient water use might be more difficult in countries with a significant high number of water service operators. Dedicated efforts will be required to link economic instruments and water balance databases so the performance of economic instruments at different scales can be assessed. Whether option 1 or option 2 is chosen, reporting can be made as part of the regular WFD reporting. With regards to option 2, specific guidance on reporting "incentiveness" of existing and new economic instruments will be required.
Governance	Benchmarking among water service suppliers (water tariffs) and among countries (abstraction taxes/charges) can be promoted to contribute to the sharing of experience, the establishment of good practice and strengthen communication on the potential for economic instruments in water management. It is important that representatives from finance and economy ministries are involved in the governance of different options – as finance ministries are traditionally the ministries in charge of economic instruments. National price commissions could play the role of intermediaries and relays for sharing knowledge and results to water service operators.
Technical requirements	Systematic metering (be it for individual users or groups of users) will be required for assessing water demand, monitoring progress in water demand and monitoring the impact of changes in abstraction taxes/charges or water tariffs on water demand. New techniques might be developed and promoted for monitoring small (diffuse) water users.
Other pre-conditions	A strong mobilisation of politicians will be required to support the use of new water taxes/charges (of sufficient level) to support more sustainable water abstraction/water consumption. Thus, dedicated awareness raising actions will be required whatever the option chosen. The promotion of "revived" abstraction charges and taxes could take place within the frame of the Green Growth policy initiative that would provide clear political impetus and deadlines.
Possible adaptations in EU instruments	

Objective	Policy area
Restoring water balance in all European river basins	**Guiding land use to respond to water scarcity**
General description of the option	The main purpose of this policy area is to promote 1) land use changes in line with water scarcity, and 2) the relocation of economic activities from river basins in deficit to water rich river basins. This policy requires that a coherent land and water use planning system is progressively put in place and enforced in Europe. Incentives for ensuring economic sectors move their economic activities to water rich areas will be proposed (e.g. specific "relocation subsidies"). Also, all new economic development will be assessed from a water balance point of view, limiting (or banning) developments in areas that are under deficit or at risk of becoming deficit areas.
EU policy options	Different EU policy options have been identified: Option 1 – Voluntary implementation through common guidance and best practice sharing. Raising awareness on water-*cum*-land planning and the promotion of land and water planning tools via dissemination campaigns, conferences, sharing of experiences, etc. Option 2 – Mandatory approach to land use to account for water stress. Strengthening of the land use dimension of the WFD. This would require that data on land use at the right spatial scale (maps) is reported along with efforts made by MS for shifting land use activities to strengthen the coherence between land use and water resources, and thus reduce the pressures on water resources. Option 3 – Cross-compliance between water scarcity and the CAP. Promoting crops with low water demand as part of the CAP (e.g. sorghum instead of maize) and making selected CAP payments for high water demand crops compliant to sustainable water balance. A specific assessment of the impact of CAP reforms on water demand/water abstraction from agriculture and on the overall water balances/water accounts will be made prior to any CAP reform as input to adapting agriculture product price regimes and mechanisms for supporting agriculture. Option 4 –Cross-compliance for EU financing instruments. Guiding new investments supported by structural and cohesion funds to basins that are water rich. For economic developments required in basins with existing water deficits, to ensure new projects are "water neutral" with no impact on the water balance, or reduce water abstraction and return water to the environment by promoting new technologies with high efficiency. This would require that a systematic water balance/water account is made prior to any structural and cohesion fund financing. The notion of "cohesion" could also be expanded to environmental issues, with cohesion funds supporting projects and economic activities that lead to a balanced access to water for all including for the environment. Option 5. Adaptation in economic instruments for land. Promotes the use of differentiated land taxes to account for current water deficit levels in river basins, land taxes being higher for basins with high water deficit. Exemptions to taxes could take place when land owners, economic operators and planers promote projects and activities that contribute to reducing water imbalance (e.g. by increasing water infiltration, reducing water abstraction, etc.) Earmarking of part of the tax revenue would help promoting such projects. Option 6 – Constraint land use development in river basins with water deficit (imposing a maximum use of land under different uses accounting for their respective (expected) water demand). This system however is likely to impose rigidity on economic development, and will not be considered thereafter.
Monitoring and reporting	Monitoring will combine land use and water balances (using the adapted WEI+) to assess the changes in land use and the development of economic activities in river basins with different levels of water scarcity (analysing economic development data, combined with interviews with selected decision makers). This will complement water balance developed at the river basin scale (using adapted WEI+). .
Knowledge	A review of the existing practice in land and water use planning, and how these are connected/disconnected and why, would help identifying best practices and how these have worked. Additionally, research is required on the incentives and mechanisms for allocating or relocating land use and economic activities to areas that are water rich. Specific attention will be given to drivers to agriculture land use as agriculture remains the key water abstractor in many river basins.
Technical requirements	No specific technical requirement has been identified.
Governance	Governance will depend on the options proposed: • Option 1 does not require specific governance. • Option 2 will build on the WFD governance, promoting the involvement of land use planers into the WFD implementation process • Option 3 and 4 do not require any change in existing governance. Option 3 might be difficult to achieve • Options 5 and 6 will involve ministries and local authorities in charge of local planning Whatever the option, specific land and water committees could be established at different spatial scale for discussing and guiding decisions on spatial planning and the location of economic activities.
Other pre-conditions	There is a need to involve new stakeholders into water issues and planning. These include: land owners, related land owners' associations, local authorities in charge of land use planning, infrastructure ministries.
Possible adaptations in EU instruments	Possible adaptations in EU instruments could include the adaptation of the EIA and SEA directives to better account for water stress and scarcity.

Objective	Policy area
Restoring water balance in all European river basins	**Trading water use right for the environment**
General description of the policy area	The main purpose of this policy option is the establishment of a water use right market in river basins in Europe. Following an initial formal recognition of existing water abstraction rights (including informal abstraction), and their possible adaptation to account for variability in water supply, specific mechanisms will be put in place to promote trading of water rights (be it permanently or for periods with low water supply – via option market like mechanisms). And financial resources (from public sources or from compensation mechanisms) will be used to purchase water rights for environmental purposes. In parallel to these transactions that will have an environmental character, trading water use rights might take place between economic operators and water users as means to bring short-term and medium term adaptation to initial water use right allocation, and to deliver economic benefits. With the policy objective being "restoring water balance", this is however not the primary objective of this policy area. The policy area will require the establishment of E-Flows as pre-requisite, so a target (CAP) for water use right to be purchased is proposed. Thus, this policy area can be seen as a "second step" once the E-Flow policy area has been implemented. Locally, however, purchasing water use rights from water users to allocate it to the aquatic ecosystem might take place. it will be important to establish clear protocols for translating water use right into water use right for the environment, taking into account in particular of all third party effects/positive and negative environmental impacts.
EU policy options	Different EU policy options are proposed: Option 1 - Voluntary implementation through common guidance and best practice sharing. The establishment of a specific CIS group and guidance on "trading water use right for the environment", along with systematic awareness raising campaigns on trading water use right and its functioning Option 2 - Mandatory consideration within an expanded scope of the WFD. The promotion of the mechanisms in the WFD process, and the systematic reporting on elements linked to trading in the different reports and RBMPs, will be proposed. However, in line with the principle of cost-effectiveness, purchasing water back for the environment will only take place when it is considered as the most cost-effective option. Option 3 – Towards a mandatory approach to EU wide tradable water use right. This implies the launching of an EU initiative, starting from an EC Communication followed by a WFD Daughter directive on tradable water rights for the environment. This will imply the establishment of an European water use right register, that would propose a common definition of water use rights and monitor all actual water use rights, including those for environmental purposes, and all proposed transactions. As compared to option 2, option 3 will contribute to trading water for the environment within transboundary river basins.
Knowledge	The knowledge required for all options is rather similar. As water use rights have long-standing historical roots, it will be important to review and analyse existing legislation and informal rules (norms) underlying water use rights and entitlements. A review of the existing practice in tradable water use right, in particular on a) the definition of water rights and b) the transfer mechanism put in place, will help identifying "how it can work" and pre-conditions for its success. Research will also be carried out to estimate the total water use rights (building on the definition of E-Flows, see policy area above) and financial resources that would be required to purchase water use rights back for the environment. Finally, research will be required to assess the social, environmental and economic impacts of different types of trading mechanisms.
Monitoring and reporting	Monitoring will focus on water use rights and on transactions with focus on water use rights that have been purchased back to the environment. Whenever trading is implemented, a specific water use right register will be developed and systematically filled to record water transactions. The scale at which this register is developed and maintained will depend on the options: for individual river basins in which trading take place for options 1, and for all river basins for options 2 and 3.
Technical requirements	In some cases, additional infrastructure for water transfer – or water storage - among river basins and water users might help trading water use right (in particular under highly uncertain supply conditions), in particular in river basins and between river basins where the achievement of E-Flows is at stake. Similarly to the policy area "E-flows", metering of individual water use right, along with monitoring of river discharges, will also be required. For option 2 and 3, compulsory metering will be required for individual water users and for E-Flows.

Governance	Specific attention is required for establishing a participatory and transparent process for reviewing existing water use right and proposing if required an adapted system of these rights. Specific governance mechanisms are required for a) putting potential sellers of water use right and potential buyers into contacts, b) establishing regulation mechanisms for ensuring third party effects (including on the environment) are systematically accounted for in transactions and c) limiting speculation and inequity. The emergence of brookers that will help a) keeping track of expression of sale/purchase and b) manage the trading.... could be promoted – if economic trading is well developed and not only limited to environmental purposes. Also, additional changes in government administration will be proposed so any request for transaction/change in water use right is “checked” (in particular *vis-àvis* possible negative third parties). Specific information system to ensure transparency in water use rights and transactions will be required. At the EU scale, there is no specific governance requirement apart than those specified above with the establishment of specific CIS group or the process for developing a new regulation (option 3)
Other pre-conditions	There is a need to review and adapt the water use right system (definition of water use rights, initial allocation building on historical water use and future variability in water supply, etc.). Pilot testing in selected locations might be used as “demonstration” whatever the option chosen. Specific awareness raising activities towards politicians and stakeholders will be required, presenting in particular different options foreseen for trading water use right and their advantages and disadvantages. This is in particular required as there is increasing scepticism on liberalism and markets in general. Visits to sites where systems are implemented (e.g. Australia), complemented by pilot testing in selected locations, might help removing negative views on the mechanisms and stress the contribution of trading to the adaptive character of river basins to react to “global changes”. Purchasing water use rights to water users of a given country so E-Flows and water balance is re-established in a different country, might not take place. Option 4 would require the establishment of a coherent system of water use/abstraction permits/rights within Europe (or within given river basins). This is clearly unrealistic because of the large heterogeneity of systems among Member States. And it is proposed that this policy option is not considered in further assessment.
Possible adaptations in EU instruments	

9.3 Policy areas and options for addressing drought

<table>
<tr><th>Objective</th><th>Policy area</th></tr>
<tr><td>Enhancing drought management in Europe</td><td>Strengthening the European Drought Emergency Response Capacity</td></tr>
<tr><td>General description of the policy area</td><td>This policy option builds on a twin approach developed at the European scale and combining:
The development of an European Drought early-warning system and European Drought Observatory by 2012. This observatory will help MS and economic operators to monitor drought issues and to react and act as early as possible to forthcoming droughts. This geo-referenced system linked to an internet platform will mobilise a wide range of data and information (daily time scale) so drought indicators are automatically processes and warning sent. This will be complemented by specific information and communication activities, including in the general press, and the relay of information to specific agencies in MS that will disseminate warnings and messages to local authorities, economic operators and to the general public.
The adaptation of the EU Solidarity Fund for strengthening the attention given to droughts. Financial resources of the fund will then be used for supporting economic actors and citizens when coping with the damage of droughts that could not be avoided. This is clearly an emergency fund that provides a clear European response to climate events that are impacting different MS.
The Community Drought Emergency Response Capacity can be improved by:
Coordinated positioning of drought monitoring stations (particularly in border areas between two or more MS) , and data sharing/exchange.
Provision of drought monitoring and early warning services through the EDO to all Member States but particularly those who do not yet dispose with systems of
Coordinated capacity building exercises/activities of the Civil Protection Agencies throughout Europe;
Bilateral agreements for temporary water transfer or re-allocation (in international basins) between up- and downstream countries under the condition of drought. Included may be provisions governing the water transfer such as the recent experiences for Barcelona (shipping water from France) and Cyprus (shipping water from Turkey and Greece).
Adaptation of the rule for application for support from the EU Solidarity Fund to ensure an effective use of the available resources in case of drought emergency.</td></tr>
<tr><td>EU policy options</td><td>Two policy options have been identified for the establishment of the EU Drought Early-warning system:

Option 1. A truly European wide system that will follow a well-established approach applied to all parts of the EU territory.

Option 2. A system based on MS initiatives following common protocols and guidance and that will be inter-connected under a given internet resource site. This option might lead to problems of coherence and integration although it is likely it will facilitate MS acceptance.

There is only one option for the adaptation of the EU Solidarity Fund to ensure an effective use of this fund in case of drought emergency.</td></tr>
<tr><td>Knowledge</td><td>Continued efforts (by the CIS Expert Group on Water Scarcity and Drought) are required to establish a common set of drought indicators to be applied to individual river basins. Additional research might also be undertaken on the effectiveness of different emergency responses taken by MS and on possible improvements in emergency responses.

A review of existing financial mechanisms and funds, including those related to insurance systems, for supporting economic sectors that are particularly affected by droughts will be made, so pre-conditions for effective application of such mechanisms can feed into the adaptation of the EU Solidarity Fund.</td></tr>
<tr><td>Monitoring and reporting</td><td>Monitoring is the focus of the European Drought early-warning system and establishment of the European Drought Observatory.

For the adaptation of the EU Solidarity Fund, the use of funds for Drought Emergency will follow specific monitoring rules for ensuring transparency on the use of these funds and on their impact.</td></tr>
</table>

Technical requirements	For the establishment of the EU Drought Early-warning system and the European Drought Observatory • The technical requirements for option 1 include an internet based platform and database combined with sophisticated modelling and GIS capacities. • Technical requirements for option 2 are limited to internet web pages that can be hosted under WISE. The need to strengthen the capacity to transfer water might lead in some places to new infrastructure. However, it is unlikely that such infrastructure would be built purely for "drought emergency" purposes, but more for "water re-allocation' for tackling water scarcity. There are no technical requirements for the adaptation of the EU Solidarity fund.
Governance	For the establishment of the EU Drought Early-warning system • Option 1 for establishing an European Early Warning system requires a combined effort from the JRC and the EEA for building a specific geo-referenced information system linked to modelling (building on projects and initiatives already in place in these organisations). It will be monitored by a dedicated group of MS experts that will act as "emergency warning platform" to decide whether actions are required or not, and whether warning messages should be sent to MS, regional and local authorities. Organisations that will play the role of relays in individual MS will be identified • Option 2 does not require specific governance – only reporting to the EC/DG Environment for ensuring MS information is put in a dedicated page of WISE or web site. The governance of the adaptation of the EU Solidarity Fund might be limited to the involvement of "environmental bodies" in the steering of this fund.
Other pre-conditions	It will be important to raise awareness among MS and to convince them on the cost-effectiveness of an EU wide initiative in this field. The options should be specifically analysed in terms of subsidiarity.
Possible adaptations in EU instruments	The policy option itself is the development of new EU policy instruments and initiatives. Coherence might be searched for with other instruments – however, it is unclear at this stage what this might imply in terms of sector policies (e.g. CAP) and structural and cohesion funds. It is unlikely these might be affected.

Objective	Policy area
Enhancing drought management in Europe	**Assess and manage Drought Risk**
General description of the policy area	This policy option builds on the development and implementation of specific actions aimed at addressing drought issues and risk at the river basin scale. In addition to tackling drought issues, this will increase the policy profile of drought management – and contribute to raising awareness on drought issues in MS. This policy area entails actions meant to improve the understanding and appreciation of drought risk at the river basin scale. It is closely linked to the European normative framework established by the Directive 2000/60/EC (Water Framework Directive) and the Directive 2007/60/EC (Floods Directive). The policy options described below are complementary and refer to different stages of drought management, starting from an analysis of drought hazard and impacts; development and assessment of risk reduction measures and strategies; and monitoring and review of the performance. A thoughtful understanding of drought risk requires knowledge of 1) past drought events and their impacts; 2) medium to long term average water yield; and 3) water entitlements and demand by the key water uses. Management of drought risk necessitates a coordinated set of actions including 1) monitoring and forecast of meteorological, soil, and eco-physiological conditions, river and groundwater levels, 2) adoption of appropriate preventive, preparatory, response and recovery actions; identified and studied in advance of drought; 3) systematic research and experimentation of innovative technologies, policy instruments, and public awareness meant to increase the yield of or conserve water resources, and make its use more efficient. The following policy actions are considered as complementary and mutually reinforcing, although they could be implemented also separately from each other to some extent. • Introduce Drought Management Plans (DMP) in the portfolio of river basin planning instruments that include River Basin District Management Plans and the Flood Management Plans. • Systematically review the significant past drought events; their economic, social and environmental impacts; as well as the effectiveness of the measures put in place to reduce them. • Establish drought monitoring and early warning systems based on seasonal climate and short-term weather forecasts, water level measurements, and short to medium term forecast of water demand; • Establish a Drought Impact Database, based on the reported impacts of past and ongoing significant drought events by the EU Member States. • Promote review and assessment of drought risk management measures.
EU policy options	Different policy options have been identified for this policy area: Option 1 – Voluntary implementation through common guidance and best practice sharing. Strengthening knowledge and raising awareness on cost-effective measures for addressing drought in water management planning process, combining research targeted on drought management, the establishment of a specific CIS working group on DM, the development of a good practice guidance on DM, and voluntary agreements between the EC and MS for a partnership towards effective DM (including specific reporting); Option 2 – Mandatory development of Drought Management measures within an expanded scope of the EU WFD. A systematic consideration of DM in the WFD and in the RBMP, leading to guidance on how to take DM into account, specific sections of the RBMP dedicated to DM and clear reporting on how DM has been considered in the RBMP process including measures dedicated to DM or DM concerns integrated into the selection of measures (requiring a systematic DM-proofing of the RBMP in parallel/combined with climate-proofing). Research targeted on drought management, the establishment of a specific CIS working group on DM and the development of a good practice guidance on DM will remain the same as in the previous option. Option 3 – Mandatory Development and implementation of Drought Management Plans. A regulatory approach to DM with the adoption of an European Directive on Drought that would make compulsory the establishment and implementation of DMP at the river basin scale (ensuring coherence with the WFD planning process).
Knowledge	The specific content of a DMP should be clearly established, along with methods and tools that could be used to fill the different parts of the DMP and support decisions on DM. Past drought events, along with the measures taken by MS to react (act) before and after a Drought event, should be studied in more details. The existing Guidance Document should be further developed and complemented by 1) a catalogue of

	drought management measures and their likely effectiveness, 2) guidance document on how to assess indirect economic, wider social and environmental impacts of drought.
Monitoring and reporting	Reporting sheet for the review of the past events should be developed. Drought affecting more river basins and/or Member States should be identified and reported as a single event with unique ID. Reporting is voluntary in option 1 following a common template agreed among MS and the EC. It is fully integrated into the WFD reporting for Option 2. Option 3 requires specific reporting (leading to higher efforts by MS), harmonised with the existing reporting obligations under the WFD and Floods Directive. Whatever the option, reporting on drought management will be required every 6 years in line with the WFD reporting frequency. Whenever required, reporting will distinguish between river basin districts and lower spatial scale considered as relevant. In some cases, a single national reporting or for a sub-part of a country might be sufficient if drought has been rather similar in terms of event and impacts.
Technical requirements	No additional technical requirement has been identified at this stage, apart for the establishment of the new Drought Impact Database.
Governance	All options would require the establishment of a specific CIS working group on DM, this working group being set up temporarily up to the adoption of the new DM directive for option 3. For Option 3, the establishment of DMP will build on similar participatory processes as promoted by WFD Article 14 – it will be possible to combine both processes thus making both option 2 and option 3 comparable from the governance point of view. Option 3 will however require the establishment of a specific DM directive committee.
Other pre-conditions	There has been limited follow-up to the 2007 Communication on WS&D. And MS have given limited considerations to drought issues in the RBMPs. Thus, MS should be convinced of the need for a more vigorous response to drought, potentially under the umbrella of responses to climate change.
Possible adaptations in EU instruments	The drought management measures can be financed through European Regional Development Fund (ERDF), European Agricultural Fund for Rural Development (EAFRD), and the Cohesion Fund (CF). Best practice sharing could also be supported through the Financial Instrument for Civil Protection.

9.4 In summary: crossing policy areas and policy options

The following table summarises the policy options identified for the different policy areas.

Table 18. The different policy options proposed for individual policy areas : a summary

Policy objective	Policy area	Voluntary - Strengthening knowledge and raising awareness	Mandatory and regulatory - Strengthening the quantitative dimension of the WFD	Cross-compliance - for EU sector policies (e.g. agriculture)	Cross-compliance - for EU financing instruments[38]	Mandatory and regulatory - A new EU directive
Restoring the water balance in all European river basins	**E-flows**	✔	✔	✔	✔	✔
	Efficiency targets	✔		✔	✔	✔
	Economic incentives for efficient water use	✔	✔		✔	
	Guiding **land use** to respond to water scarcity	✔	✔	✔	✔	
	Trading water use rights for the environment	✔	✔			✔
Enhancing drought management in Europe	Strengthening the **European Drought Emergency Response** Capacity	✔			✔ (adaptation of the EU Solidarity Fund)	
	Assess and manage Drought Risk	✔	✔			✔

For the purpose of the follow-up assessment, it was assumed that 1) the mandatory and regulatory strengthening of the WFD would be similar (in terms of environmental, social and economic impact) to developing a new directive. In practice, differences between both options might occur in terms of acceptability (higher political resistance might exist for the development of a new EU directive as compared to the adaptation of the WFD) and related transaction costs (higher transaction costs being expected from the development of a new directive).

[38] Sructural Funds, Cohesion Funds, EU Solidarity Fund

10. Question 7 – What are the potential social, economic and environmental impacts of proposed policy areas and options?

A qualitative impact assessment has been carried out for the policy options proposed under different policy areas. As indicated above, the policy areas have been investigated first by assessing their economic, social and environmental impacts separately, prior to comparing the different policy options/delivery mechanisms proposed for a given policy area presented in Section 9. The assessment of policy options is summarised in a table format that stresses their main implications and provides the basis for a comparative assessment of policy options.

It is important to highlight that:

- The assessment of policy areas and policy options remains very qualitative, based on the knowledge of the team of experts of the consortium combined with information available in the literature. Thus, it is aimed at: a) listing the range of issues that one might be confronted with when implementing a given policy area or option; and b) contributing to a first screening by DG Environment.

- The comparison between the impacts of the proposed policy areas and options remains difficult without going into more details in the description and design of the policy areas and policy options. This would however only be possible if a small number of (2-3) options are selected.

- Each policy assessment is summarised in a table gathering the main results of the qualitative assessments, accounting for the relative importance of the EU (in terms of area and population) that would be affected (positively or negatively) by the environmental, economic and social impacts identified above. The potential geographic impact and associated population of each of the considered option was estimated following certain assumptions about:
    i. the relevance of policy option with regards to the needs of a basin according to whether it is expected to be experiencing water scarcity. This is established using the results from the WaterGap Model presented in section 4.*Question 1 - What is the magnitude of today's WS&D problem in Europe?*
    ii. the relative weight of each key sectors in terms of water use
    iii. the EU status of certain region as priority areas of intervention through EU funds
    iv. precedents in terms of a given option being implemented but limited to certain MS

- The assumptions used in estimating the potential geographic impact and associated population of each of the considered option are detailed at the end of ANNEX 1. *Key components of the methodology applied in the context of the Gap Analysis study.*

- In turn, all details about the elements that inform the assessment are presented in ANNEX 4. *Environmental, Social and Economic impact assessment template for individual policy areas and options.*

10.1 Water Scarcity Policy Options

10.1.1 Environmental flows (E-flows)

The flows of the majority of rivers have been significantly modified through impoundments (dams and weirs) and compromised by abstractions for agriculture and urban water supply, drainage return flows, maintenance of flows for navigation, and structures for flood control (Dyson et al., 2003; Postel and Richter, 2003). It has been estimated that a large part of rivers are fragmented by human driven alterations with the consequent degradation of aquatic ecosystems (Korsgaard, 2006). The establishment of environmental flows (E-flows) serves in the first place to maintain essential processes of healthy river ecosystems and good ecological status of water bodies. Over the past decades, e-flows and ecosystem services have gained in importance, even more so since the economic value of the ecosystem services has been documented empirically. Where water resources are over-allocated or overexploited, E-flow requirements impose a reduction (a cap) for water withdrawal which the water-intensive economic sectors have to bear. Where water resources are still abundant but may decline due to future environmental (including climate) change and development, E-flows specify the limits on future water exploitation to be taken into account in the medium to long term development of policies. Allocating water to environmental flows and consumptive and non-consumptive uses is a social, rather than a technical choice (World Bank, 2009), although it might lead to economic benefits when downstream water users and ecosystem service users benefit from restoring E-flows.

Economic Impact

- *Water use sectors and households*: The establishment of E-Flows will have significant direct or indirect benefits from well-functioning ecosystem services. On the other hand, it reduces the volume of water that can be abstracted (or the timing and rate of abstraction) for any consumptive or non-consumptive use of water, being an incentive to innovation in water efficiency whenever financially feasible. A healthy environment produces an arguably higher 'return' than any other water use excluding direct human water consumption. The benefits and costs of imposing E-flow requirements differ in response to a host of river basin specific factors. Existing studies have shown that both the marginal costs and marginal benefits can be significant (see for example Korsgaard, 2006) and unequally distributed across the basin area. A recent study conducted in the Murray Darling River basin in Australia showed that the overall benefits from allocating additional water to the ecosystem were higher than the economic costs of reduced water availability in the agricultural sector[39].

- *Specific regions or sectors*: The regions impacted by the E-flows are those with water scarcity. Overall, agriculture as the largest water abstractor is expected to be the most affected. The expected change in farm revenue and income will depend on farm types and the alternatives available for saving water within existing farm constraints. If investments in enhanced irrigation technology or on-farm storage are considered as possible options to respond to reduced water abstraction rights, it is likely that large-scale farmers only will be able to

[39] The study assessed the environmental benefits, where possibly in economic terms, that arise from recovering 2800 GL/year of water for the environment in the Murray–Darling Basin (CSIRO, 2012). The value of improved habitat ecosystem services alone was found worth 3-8 billion AUD. Other ecosystem services (carbon sequestration, aesthetic appreciation, avoided damage and treatment costs) were estimated at between 500 to 1.360 million AUD. Tourism benefits have been found worth of up to 160 million AUD annually. For comparison, the economic costs of reduced water availability for agriculture was estimated to 542 millions AUD annually.

An eaerlier study by Eingenraam et al. (2003) assessed the economic cost of increasing the environmental flow of respectively 750, 1,500 and 2,800 Giga Litres (GL) per year with respect to the current situation (baseline scenario). They found a reduction of annual agricultural returns under the 750 and 1,500 GL scenario by 82.3 million AUD (5.8%) and 155.1 million AUD (11.0%), respectively. The reduction in agricultural returns in NPV terms, reflecting the permanent nature of the change, incurs costs of 1,160 million AUD and 2,186 million AUD respectively.

invest. Overall, the relative reduction in farm income is expected to be significantly lower than the relative reduction in water abstraction[40]. Energy production might also be negatively affected, in particular in dry summers.

- *Administrative burden*: The establishment of E-flows requires specific methods to be applied in individual river basins. Furthermore, it requires monitoring and enforcement for environmental impacts and benefits to be obtained. While initial efforts for defining E-flows and abstraction rights is expected to require new resources for administrations in charge of water management, monitoring and enforcement is likely to be carried out with similar resources to current monitoring and enforcement. Overall, the definition of new water abstraction rights is expected to require time and lead to “significant” transaction costs as specific processes and assessment are required for individual river basins[41].

- *Macroeconomic effects*: Significant reduction in water abstraction can lead in the short-term to direct socio-economic impacts (for the main water abstractors) that are then translated into indirect socio-economic and employment effects for some territories. The long-term impact is however unclear as the initial drop in economic output might translate to the development of new economic opportunities. The magnitude of the initial changes will depend on the political process and the rules established in individual Member States on “how to share the extra burden”. Overall, macro-economic effects are expected to range from marginal to very moderate at the EU scale.

Social impacts

- *Impacts on low income groups*: In some river basins, significant reduction in water abstraction might yield difficulties for small farmers with more limited financial resources for adapting to new water abstraction rules (e.g. for investing in water saving technologies or in on-farm storage capacity). At the same time, enhanced quality of river ecosystems might be of benefit to all inhabitants equally, independently of their income levels.

- *Governance*: The establishment of e-flows requires understanding flow regime and/or the pattern necessary to maintain and/or achieve a given state in the river ecosystem, a clear definition of the water balance, monitoring and forecast of river flow, and enforceable legislation guaranteeing an appropriate level of river flow under ordinary and extreme weather/climate conditions. This will imply additional costs for research/knowledge creation. In some MS (e.g. France), target flows for environmental purposes are already (or going to be) implemented thus this policy option will not entail additional costs, or there are plans to do so. Defining E-flows, the negotiation of socially acceptable reduction of water withdrawal across sectors, and constant monitoring and enforcement of the E-flow regimes represent

[40] A study for DG Environment (Dworak et al. 2009) showed that achieving minimum river flows or ecological flows could imply reduction in farm water abstraction by as high as 80%. Corresponding reduction in farm income estimated through farm modelling for 5 different study sites ranged from -5% to -36%, comparatively less than reduction in corresponding water abstraction as a result . This results from possible changes in cropping pattern, adoption of new crops capable of adapting to deficit irrigation, etc. Additional studies from Australia (Randall et al. 2007) confirmed the lower relative income reduction as compared to the relative water abstraction reduction translating the possible adaptation of economic sectors within their existing constraints: the results of their analysis indicate that the proposed level of environmental flows reduces water extractions by around 6 per cent, imposing an opportunity cost of less than 1 per cent in terms of reduced net income over a 20-year period.

[41] In France, studies of around 100 000 € are financed for defining E-flows and new water abstraction rights in each individual water scarce catchments (defined as zone de répartition des eaux ou ZRE). Processes that accompany these studies can be rather long, as reduction in water abstraction meets opposition from main water users. In some catchments, the reduction in existing water use rights is accepted under the condition that new storage capacity will be built (with public support) to compensate for the water abstraction reduction.

major challenges for public administration, and might entail transaction costs. In most cases, however, no change in the current organisational setup is expected as a result of this policy area.

- *Public health and safety*: Restoring the E-flows regime will likely add value to a region in terms of qualitatively better ecosystems and services provided by them. This in turn might yield living environments (including close to cities) of higher quality. Reduced health risks might take place when bathing is taking place in an unofficial bathing site of currently poor quality. However, impacts are expected to remain marginal and localised.

Environmental impacts

The changing quantity of water flowing in a river significantly influences water quality, temperature, nutrient cycling, oxygen availability, and the geomorphic processes that shape river channels and floodplains (as indicated by several studies in this regard). Thus the implementation of e-flows will surely have a relevant impact in the river ecosystem (hence the environmental and services provided by them). Expected benefits include re-establishing:

- A "drying cycle" for some rivers that is important for some ecological processes, having in addition the benefit of reducing numbers of exotic pest species.

- Low flows that generally provide a continuous flow through the channel. This may either maintain the flow above a 'cease to flow', or provide habitat as a change from 'high flows'. It ensures connections with in-stream habitats and can have benefits for other system users, such as providing water for livestock.

- Small or short duration peak flow events. These are flows that exceed the base flow and last for at least several days, and that are a key contributor to the variability of flow regimes, providing short pulses in flow. They help to maintain or improve water quality and prevent algal blooms from occurring.

- High flow periods that allow for fish migration and enhance recreational fishing opportunities.

- Bankfull flows that are an important trigger for fish breeding, and that help with sediment movement and bank maintenance. They can also enhance recreational opportunities.

- Overbank flows (greater than 'bankfull' flows), resulting in flooding of the adjacent floodplain habitats. Overbank flows are critical for a range of ecological factors, including floodplain productivity. It maintains floodplain and wetland connectivity, stimulates fish and bird breeding and enhances recreational opportunities.

This impact will vary depending on the expected impact on ecosystems of e-flows and on the initial state of the ecosystems (that is clearly river basin dependent). Nevertheless, in those RBDs where recurrent water scarcity occurs, there will be a positive impact on river ecosystems given that environmental needs will be taken into consideration and given priority in water allocation.

Negative environmental impacts might take place locally: a) along the coasts if reductions in water abstractions (in particular for the industry and urban sectors) required for achieving E-flows are compensated for with desalination plants; b) in some river basins if new storage is built (even if disconnected from river streams) to compensate for reductions in water abstraction for individual users[42]. Also, additional environmental impacts might include:

- Positive environmental impacts (when new water saving techniques put in place for achieving new abstraction limits are accompanied by more extensive farming practices or when reduced water abstraction is accompanied by reduced energy use by household)

- Negative environmental impacts, when new water-saving technology (e.g. the installation of drip irrigation and plastic pipes) leads to waste increase.

At the EU scale, however, these environmental impacts are likely to remain of limited importance.

Comparison of the delivery mechanisms

Under the voluntary option, e-Flows regimes can be promoted in so-called 'river contracts', a concept of multi-level water governance which permits the "implementation of a system of rules in which the criteria of public utilities, economic profitability, social value and environmental awareness are equally involved in the research for effective solutions". Current experiences show that such voluntary approaches might take time (e.g. 3 - 4 years) and require social engineering for mobilising local parties to ensure acceptance and implementability. This could cover the basins with "severe"[43] water deficit today and by 2030 setting aside basins only facing scarcity during summer months. The identified area (28.6% of the EU) also excludes countries which have already translated E-flows in the regulatory framework, such as the case of France[44] and are therefore included in the baseline.

The mandatory options envisage that e-flows are either mandated by the WFD as a key component of good ecological status (GES) for the different water bodies and good ecological potential (GEP) in the case of heavily modified water bodies; or an additional piece of legislation is adopted and linked with the WFD. Both options differ in terms of the time needed for implementation: the Water Framework Directive is scheduled to be revised in 2018 whereas a new directive can be proposed earlier but the negotiation can take significant time (5 to 10 years[45]) and effort. The mandatory option would provide for coherent implementation and set the stage for a socially negotiated reduction of current withdrawal shared by the most important water use sectors. Embedded in the holistic planning framework of the WFD the e-flow definition would take into account medium and long term climate variability and change. This option is expected to influence all the basins that will be facing water scarcity (all year round and during the summer) by 2030 and covering a bit more than 45% of the EU surface.

The implementation of e-flow regimes could in principle be promoted selectively by the various EU Financial Instruments of the Common Agriculture Policy (CAP) and/or the Cohesion Policy. Theoretically, as an intermediary step between voluntary and mandatory implementation of e-flow regulation, the beneficiaries of the EU aid and payments under this policy option are required to contribute to the maintenance of good environmental health of rivers and dependent ecosystems. In practical terms, cross-compliance under the Common CAP bears little suitability for the coherent implementation of e-flow regulation as there is a mismatch between the farm level, to which the

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[42] In France, where the definition of E-flows and related changes in water abstraction is under way, additional storage facilities are considered in several river basins to for limit potential negative impacts on agriculture and farm income.

[43] The threshold for defining "severe" water scarcity is similar for all policy areas. "Severe" water scarcity is defined as water scarcity the year round as opposed to water scarcity that affects river basins during the summer period only.

[44] E-flows is now part of the regulatory framework (*Loi sur l'Eau et les Milieux Aquatiques*), thus France will not be affected by this option. Other countries such as Spain and Italy are also defining minimum river flows, but these are cnot considered to be E-flows that would provide the right basis for the ecological functioning of rivers.

[45] The adoption of the EU WFD took around 5 years of intensive efforts. It is expected that a EU regulation dealing with quantity issues would take longer time, because of its high political sensitivity.

cross-compliance applies, and the river basin level, at which the e-flow requirements are defined. Although potentially influencing all water scarce basins, this option is limited to where agriculture water abstraction is above 5% of total water abstraction given the sectoral orientation of the option. This brings the potential area covered to 33.7% of the EU surface. Financial instruments of Cohesion policy face similar practical issues and raise concerns with respect to policy coherence and proportionality. The EU Financial Instruments and cross-compliance are more suitable as auxiliary instruments for reducing the initial economic and/or social hardship caused by the transition of the regional economy set off by the E-flow regulation. The option would involve all river basins from MS that are beneficiaries of the cohesion funds. For structural funds, it is assumed that they will contribute to improvements in all river basins as compared to the baseline, but not sufficiently to achieve E-flows in all basins

Finally, stricter consideration of e-flows in WFD implementation would require limited changes in implementing the WFD. *Policy area/ policy option*	Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
Geographic coverage				
as % of EU-27 area	28.6%	33.7%	31.3%	46.1%
as % of EU-27 population	40.0 +/-5%	27.2 +/-5%	25.0%	57.3 +/-5%
Magnitude				
Economic impacts	+/-	+/-	marginal	++/--
Social impacts	+/-			++/-
Environmental impacts	++	+	+	+++
Expected performance (EU level)	low-medium	Low	low	High
Time frame for implementation	short	short to medium	short to medium	Medium to long
Feasibility and suitability	High	Low to moderate	Moderate	Moderate
Political acceptability	High	Low	Moderate	Moderate
Overall rating	■■□	■□□	■□□	■■□

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes

10.1.2 Support to Water Efficiency Targets

A resource-efficient Europe is one of the seven flagship initiatives as part of the Europe 2020 strategy to deliver a smart, sustainable and inclusive growth[46]. This flagship initiative sets out a long term framework to guarantee that several areas such as energy, climate change, research and innovation, industry and environmental policy will lead to a resource efficient Europe. A recent EEA report (EEA, 2012) explores the role and potential of water (efficiency) towards this ambitious goal. The report highlights the contributions of all sectors and acknowledges the vital role of preserving healthy river ecosystems.

There is abundant evidence about the potential to improve water efficiency in Europe, ideally promoted through a mix of policies, including both mandatory and voluntary instruments and targets. The way energy efficiency (EE) has been advanced in Europe offers valuable lessons for the implementation of policies on water efficiency. The EE-related policies have been introduced in a piecemeal way,. It started in 2002 with the energy performance of buildings. Then, EE-related policies developed in 2004 with policy on combined generation of heat and electricity, in 2005 with the Directive on Eco-design to increase energy savings from domestic appliances, and finally with the 2006 directive on energy end-use efficiency and energy services[47]. The 2011 proposal for a new EE Directive preserves indicative national energy saving targets, which however can become mandatory after the 2014 review. However it introduces a legal obligation to establish energy saving schemes and places high emphasis on the role of the public sector in driving energy efficiency. In many respects, promoting water efficiency can be pursued in a similar way to energy efficiency; in fact water and energy are closely interlinked (energy-water nexus[48]). However, there are important differences that need to be accounted for. Whereas energy efficiency is a worthwhile goal to pursue throughout Europe, the urgency of promoting efficiency is highest in places where water is scarce or likely to become so in the future. It is equally a worthwhile goal however as it can contribute to reduced energy consumption and to Community climate change mitigation and adaptation goals.

The impacts of this policy area depend to a large extent on where and how water efficiency goals will be pursued. In fact, water efficiency targets will inflict different costs and produce different (magnitude of) benefits if pursued in residential, industrial, energy or agriculture (the largest water consuming) sectors. And the balance between costs and benefits will be influenced by the scale at which water efficiency targets are fixed: a) common water efficiency targets at the European scale might lead to lower water saving technology costs (as e.g. all appliances will apply the same standards than if different efficiency standards were defined at the river basin scale; b) at the same time, standards applied equally throughout Europe might lead to i) over-costs in basins with limited water scarcity and ii) insufficient effort in basins that are severely affected, leaving some ecosystems still damaged. But such an approach might have lower transaction costs than standards defined locally that would ensure water balance is achieved in each individual river basin in Europe.

With respect to the public water supply, which includes households, public sector and small businesses, water savings for different measures usually range from 20% to 50%. The measures are associated with rain water harvesting (rain water flowing from a roof is transferred via a pipe to a container in order to be used, for example, for gardening or car wash activities), with expected water savings up to 80% and 50% of household needs in France and UK, respectively. Another example

[46] Smart (education, knowledge and innovation); Sustainable (resource-efficiency, more competitive economy, offering well-paid jobs whereas whilst becoming less carbon intensive); Inclusive (an agenda for new skills and jobs, and an European platform against poverty and social exclusion).

[47] This Directive applies to supply and distribution of electricity, gas, heating and fuels to households, transport and industrial consumers.

[48] The term 'water-energy nexus' refers to the inextricably linked nature of water and energy (Rothausen and Conway 2011, WEF 2009): while supplying energy requires water and impacts water quality, supplying water requires energy (US DE 2006).

comes from Germany, where in Berlin a 3500 m3 tank is used to store rainwater falling from the roof of a large scale urban development (EEA, 2012). Additional water savings can be accomplished by waste water re-use for irrigation purposes with expected savings of 25% of the wastewater produced in Cyprus. Another example comes from Spain, the Llobregate site in Barcelona, where farmers by exchanging their current entitlements to freshwater against use of reclaimed water resulted in making the natural resource of freshwater available for drinking water demand (EEA, 2012). Additional measures that are of great significance for water savings are the reduction of water losses in the network supply and the use of more efficient household appliances. The leakage reduction programme can potentially result in the reduction of water losses from 29% to 20% in England and Wales and by 52% in Italy. Especially, in England and Wales additional measures for water savings have been recently promoted like the installation of meters, where 40% of the population is currently metered. Furthermore, significant potential savings in different household technologies can reach the level of 50%. Up to 25% savings can be achieved by improving the technological performance of household devices. For example, in UK water saving devices and more efficient household appliances for toilet flush and showering, can potentially lead up to 55% and 44% savings respectively, whereas for bath, taps and washing machines can reach up to 26%, 15% and 33%, respectively. In Germany, overall expected savings from water devices can potentially be at the level of 25%. While in Europe it has been estimated that the expected water savings from the use of efficient dish washer machines can be up to 40%.

Regarding agriculture, water savings can be achieved by improving the irrigation infrastructure and technology. Potential water savings from improving conveyance (distribution network) efficiency, such as open channels and furrows, can range from 10% to 25% (BIO IS et al., 2012). For example, in Spain it was estimated that potential water savings from improvements in water transportation for irrigation purposes can reach the level of 20% and in France up to 300 million m3 per year with an estimated cost of 15 million Euros. Moreover, additional water savings can be accomplished by improvements in the application of efficiency. For example, at a global level a shift from surface irrigation to sprinkler or drip irrigation can lead to 15% or 30% savings of water use respectively. For example, in Southern Europe drip irrigation can save up to 60% water compared to the traditional surface irrigation. In France the cost from shifting from furrow irrigation to sprinkler, pivot and drip irrigation can range from 140Euros/ha to 5142 Euros/ha compared to furrow irrigation. Significant potential water savings can also be obtained by the change of crop patterns and the use of more drought- resistant crops, up to 50% in France and changes in irrigation practices and awareness-raising and training, up to 34% in Turkey. For instance, in France the reduction in the production of high water consuming crops like maize and the switch from high water demanding crops to low water demanding crops to reduce the vulnerability to drought, can potentially lead to significant water savings. Moreover, in Spain the adoption of a contingency plan for irrigation improvement such as the implementation of new technology, automatic management of irrigation systems, efficiency enhancement measures to reduce water demand and abstractions required for agriculture can lead to up to 1162 hm3 of water savings, whereas its overall cost is estimated to be at the level of 2 344 Million Euros. Furthermore, the implementation of new technologies for the re-use of sewage effluent such as sand filtration or reverse osmosis led to significant water savings of up to 10% and 12% in Portugal and Italy respectively, whereas the overall investments ranged from 48 to 84 Euros/m3 and 151 to 191 Euros/m3, respectively.

As far as the industry sector is concerned, large amounts of water are used by pulp and paper, manufacturing, chemicals, textile, food, leather industry and transport. From all industrial sectors in UK water savings range from 15% to 90% and are mainly driven by implementing water metering, recycling and the re-use of wash water. Significant water savings (80%) in the transport industry occurred in Hungary thanks to the installation of a new water-saving wastewater treatment facility for wastewater resulting from the washing of vehicles. The initial investment cost was at the level of US $80 000, whereas the estimated period for recovery of the investments was 1.3 years. Furthermore, significant water savings (90%) in the leather industry were achieved in Spain thanks to the installation of a new water-saving recycling wastewater technology. Examples in the pulp and paper industry increased efficiency at the water purification plant in Sweden and aero-cooling towers in France[49], resulting in water savings which ranged from 15% to 62% respectively. With respect to the manufacturing industry, experiences in water savings ranged from 12.5% to 90%. In the UK electronics and furniture sectors[50], they were mainly driven by improvements in monitoring flow rinse lines and through the implementation of water saving measures in offices and washrooms. Significant water savings in French metal surfacing and car industry (90% and 35% respectively) were attributed to the implementation of rainwater harvesting measures. In the UK textile sector the installation[51] of a hot water boiler for more efficient warm water scouring, a computer-controlled management system to perform routine metering and analysis of electricity, gas, water and effluent and additional measures to reduce the pollution load from effluents led to significant reduction in water and energy consumption. With respect to the food industry, significant water saving measures such as the re-use of wastewater in the dairy sector in the Netherlands, the repair of leakages and the installation of a new defroster in the fishing industry in UK, resulted in water savings of 67% and 58% respectively. The adoption of the above measures will eventually result in significant savings in water bills; however, information on costs and benefits remains inadequate, maybe due to confidentially aspects which are of great importance for the industry sector.

Furthermore, a sub-sector industry that uses large amounts of water is the electricity sector. Thermoelectric generation plants produce almost 80% of the total electricity production therefore being the largest water consumer among other production activities like hydropower, nuclear, wind and solar plants. Traditional cooling techniques of thermal power plants are totally water intensive as they require large amounts of water from the sea and rivers. The implementation of advanced cooling technology such as dry cooling, evaporative cooling and hybrid cooling can reduce the dependence of power plants on natural water resources and therefore, can lead to reductions in water use and consumption. An economic analysis regarding the different costs of cooling systems showed that dry cooling systems can become profitable and thus can be justified economically if the cost of water is expensive and/or the cost of power is cheap (Ecologic, 2007).

Other water savings measures that can be applied in the thermoelectric generation is the use of recycling of cooling water. For example, in Latvia the introduction of this cooling system led to a substantial reduction in water consumption, from 30 Million m3 per year to 3.1 Million m3 per year. Similar projects are in progress in thermoelectric power plants in other countries such as in Poland, Ukraine and Hungary. Moreover, improvements in energy efficiency of new thermoelectric plants like natural gas combined-cycle plants can reduce both the amount of water abstracted and water consumption per MWh and hence can result in water savings up to 60%. Energy savings in the mining and preparation of coal for use in thermoelectric generation can also reduce the water used and therefore increase the availability of freshwater resources, while the production of electricity from other resources that require little water such as solar and wind should be further promoted. As far as the hydropower sector is concerned, the use of water to produce electricity interrupts the river continuum. This is caused by the construction of dams that reduce the water flow of a river and create artificial lakes, and therefore increase the surface area and evaporation. An increase in evaporation combined with changes in climate conditions such as temperature and precipitation can change the timing and magnitude of the river flows. As a result, the ability of hydropower plants to use water resources will be affected and thus, the production of electricity. Increasing the efficiency

[49] In France, the investment cost for the installation of aero-cooling towers for the recycling part of the water combined with specific monitoring of flows and conductivity for optimizing water use in each step of the production process was at the level of 5 Million Euros. The investment is expected to lead to a reduction in water abstraction costs of 6 Euros/ton of paper, whereas the estimated period for recovery of the investment was 2 years.

[50] 12.5% and 45% respectively

[51] Resulting cost savings were estimated to be more than £1 Million

of utilization of dam reservoirs for instance by reducing water losses can lead to water savings and thus, can be promoted, whereas the refurbishment and upgrade of existing hydropower plants needs to take into account the impact on water resources and the function of ecosystems.

Economic Impact

- *Water use sectors and households*: The establishment of water efficiency targets is expected to have short term economic impacts on water abstractors as a result of investments in water saving appliances and techniques. These costs however will be translated into better ecosystems overall that will benefit all sectors (see E-Flows above for a better understanding of the benefits expected from restored river flows) leading to an overall net-benefit for society in the mid-long term, that will likely compensate the short term costs. For sectors that are paying high water tariffs (e.g. households and industry connected to drinking water networks), saving in water bills (and potentially energy bills – see below) lead to short pay-back periods for operators who commit to water saving investments. Water tariffs might change because of new water saving technologies and efforts. However, increase in water tariffs are expected to be limited and compensated by a reduction in water abstraction or water demand (depending on the point at which water saving takes place – water supply companies or individual households). Overall, households might see their water bills reduced[52]. In some cases, water efficient appliances will deliver direct benefits to households as a result of reduced water bills and related reduced electricity bills (because of more limited use of energy for heating water – see below). Additionally, an increase in water efficient products resulting from mandatory efficiency requirements (the new legislation approach) are likely to create more competition within the market and provide more choice to the consumer compared to voluntary approaches (Bios, 2009).

- *Innovation and research*: Efficiency targets will likely increase the investment into research and innovation in water saving technology and application, and will likely increase cooperation between research/academy and the industry and private sector. To maintain the incentive for innovation, the efficiency criteria will have to be periodically revised; in order to prevent superseded standards acting as a barrier to further performance improvement (GTZ et al, 2006 in Bios, 2009).

- *Specific regions or sectors*: The regions impacted by the "water efficiency" policy area will depend on the sectors targeted with BAT in water efficiency. For example, regions with a higher share of water abstraction for industry as compared to other sectors will benefit more from increased uptake of BAT water efficiency if BAT water efficiency is the target of the sector-specific agreements or regulation. If all sectors and efficiency components are targeted at the same time, impacts will follow the relative importance of water abstractors in individual river basins.

- *Administrative burden* will depend on how water efficiency targets are implemented. If water efficiency targets are specified for individual appliances or technologies, then control is limited to controls at the level of the industries producing equipment. Defining water efficiency targets at the level of individual river basins in line with their water scarcity situation (each river basin situation will lead to a specific water efficiency target) will lead to larger administrative burden (because of the need to have specific processes and studies

[52] There are numerous examples of reductions in household water bills resulting from the implementation of water saving measures. In the Gironde region (South-West of France), for example, the impact of different water saving measures on household demand has been estimated at 60 m3 per year (from 155 m3 per year to 95 m3). This would lead to a reduction in a household water bill by 240 Euro per year (Dworak et al. 2007)

performed at the scale of individual river basins), but reducing the overall investment costs for achieving such targets.

Social impacts

- *Social impacts*: Limited social impacts are expected from this policy area. Low income groups (be it households or farmers) might face difficulties in investing in the most expensive water saving technologies and devices, requiring potentially dedicated "financing support".

- *Governance*: Efficiency standards will enhance public awareness and access to information. The promotion of good practices will benefit public understanding of water management issues and challenges, as well as better appreciation of own consumption patterns. Targeted communication campaigns are likely to be required for enhancing consumer understanding of the links between their own water saving efforts and the quality of aquatic ecosystems.

- *Public health and safety*: Public health will be affected only indirectly. In the domestic sector, the lower water consumption will increase the effectiveness of waste water treatment plants (pollutants at higher concentration in brackish waters can be removed more easily). In the case of distribution systems designed for large water demand, problems might arise when demand is significantly reduced requiring specific management responses (with limited costs) from water supply companies to ensure no additional health risk takes place.

Environmental impacts

- *Climate change*: The policy option will lead to a reduction of greenhouse gas emissions by reducing the energy needed to treat, convey and heat (for household water use – see above) water. By reducing the water demand or making the water use more (socially) beneficial, communities will be able to prepare for drought spells that may increase in intensity and frequency as climate change becomes more pronounced[53]. Increase in household water saving appliances following the setting up of water efficient standards could result in a 20% reduction in water heater use, or 0.6% of total EU primary energy supply. The mandatory introduction of new water appliances could therefore lead to yearly CO2 savings of 2.89 MtCO2eq. There is evidence that the increased use of water saving devices and technologies will reduce energy consumption overall[54].

- *Water quality and resources*: A study on the benefits of the European Ecolabel (AEAT, 2004)– which sets specifications for certain water using appliances – estimated the following potential water savings based on potential sales data: i) For washing machines, savings were forecast to be approximately 396 312 300 litres per year (based on 5% uptake), 1,585,249,200 litres/year (based on 20% uptake) and 3,963,122,900 litres per year (based on 50% uptake); ii) For dishwaters, savings were forecast to be approximately 20,185,400 litres/year (based on 5% uptake), 80,741,800 litres/year (based on 20% uptake) and 201,854,400 litres/year (based on 50% uptake). The introduction of an "EU Water Efficiency Award" could theoretically result in similar savings. Previous EU label was never awarded to

[53] A Study from Australia indicates that the use of water appliances with a rating 1 point higher for water and ½ point higher for energy can amount to annual savings of 80,000 tonnes of CO2 and 22ML of water. Using less water or water more efficient will also increase the resilience of urban areas and companies against climate change.

[54] It is estimated for example that if 1% of American households retrofited their houses with water-efficient fixtures, the country would save 100 Million kWh of electricity per year (equivalent to removing 15 000 vehicles from the road for one year) and reduce its greenhouse gas emissions by 75 000 tons of greenhouse gases (Dworak, 2007).

washing machines but limited to dishwasher, indicating very low acceptance or changes to appliance design. The policy option will lead to significant amount of water saved/conserved in river basins with water scarcity. If BAT and water efficiency standards are set at high (EU) level, water efficiency gains might not be sufficient for achieving water balance in river basins with severe water deficit today, requiring additional measures (and costs) for achieving E-flows and good ecological status.

- *Land use*: Indirect impacts on land use are possible given that measures to enhance water use efficiency in agriculture can lead to changes on other pressures in water scarce basins (e.g. as a result of shifts in farm practices), thus impacting the overall environment. It is unclear, however, whether such changes would be beneficial or negative. This will clearly depend on the natural context and the types of farming systems targeted by water saving measures.

Comparison of the delivery mechanisms

The diversity of sectors and water efficiency domains covered in this policy area makes it difficult to assess and compare policy options (indicative/mandatory targets at RB/national level, mandatory targets imposed on water utilities, etc.).

Under the voluntary mechanism, there is scope for introducing an “EU Water Efficiency Award”. A recent impact assessment on the EU Eco-label – an initiative to introduce water and energy minimum standards – revealed net economic benefits for the EU economy and positive gains in terms of EU competitiveness. A Water Efficiency Award is likely to produce a similar outcome. All basins with “severe” water deficit today and by 2030 (excluding basins that are only expected to face scarcity during the summer months) are expected to be influenced by this option, reaching an area of approximately 31.6% of the EU surface (instead of the 46.1% covered by all water scarce basins).

Enforcing compliance through the Cohesion policy is likely to produce larger benefits in terms of net water saving. However, it is associated with substantial administrative and regulatory changes. Structural and Cohesion Funds provide support to less developed regions among which only some are facing significant water scarcity. This requires structural fund projects to adhere to mandatory efficiency targets which might affect these regions and put constraints on the reduction of existing disparities. In some cases (specific sectors such as agriculture or sectors connected to the transformation of locally-produced raw materials), it will lead locally to the identification of sites that are better off in terms of water resources, thus having no economic impact overall.

The mandatory option through a new Directive has the largest potential to result in water savings. The incentive for manufacturers to increase efficiency of their products is highest in this case, creating more competition within the market and providing more choice to the consumer compared to voluntary approaches (Bios, 2009). The consumers are likely to be little affected, but there might be cases of price increases in particular if only a regional market exists. The benefit of a mandatory approach that sets minimum targets at EU level is that it harmonises approaches across the MS and reduces regional differences. Therefore, regions and sectors are affected similarly. On the other hand, regions or MS where no minimum standards, whether voluntary or mandatory, will be disproportionately affected as industry in these areas will have to spend more money to be in compliance with new standards. Another issue is that there will mostly likely be low acceptance of such a Directive in countries where there are no water quantity problems. At EU level, a legislative framework is already in place with the Eco-Design Directive. This can serve as a basis to establish a Water Efficiency Directive. To make reference to the time for putting the regulation in place, with temporary periods for those who have recently invested in water infrastructure and technology so they do not have significant costs. This option would mainly produce effects in the basins expected to be water scarce in the near future and making about 45% of the EU surface.

Mandatory targets would involve the replacement of all main water using appliances in commercial and industrial buildings. An assessment of similar mandatory requirements indicated that this could result in a total reduction of 14.8% of the annual EU public water supply or approximately 6.1 trillion litres of water (Bios, 2009); dishwashers and washing machines were excluded from this estimate.

	Policy area/ policy option	Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
	Geographic coverage				
	as % of EU-27 area	31,6%	33,7%	31.3%	46.1%
	As % pf EU-27 population	44.5% +/15%	27.2 +/-5%	25%	57 .3 +/-5%
Magnitude	Economic impacts	++	+/-	+/-	++
	Social impacts	+	+	+	+
	Environmental impacts	+	+	+	++
	Expected performance	medium	low	low	high
	Time frame for implementation	short	short to medium	short to medium	medium
	Feasibility and suitability	High	Low to moderate	medium to high	low
	Political acceptability	High	Low to moderate	medium to high	medium
	Overall rating	■■■	■□□	■■□	■■□

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes

10.1.3 Economic incentives for efficient water use

Economic Policy Instruments (EPIs) are incentives designed and implemented with the purpose of adapting individual decisions to collectively agreed goals of water policy in the European Union (EPI-Water, 2011). EPIs for sustainable water management are designed and implemented both to encourage some desired changes in the behaviour of all water users in the economy (individuals, firms or collective stakeholders) and to make a contribution to collectively agreed water policy objectives.

The present policy area addresses the potential of pricing schemes (i.e. changes in the tariffs for water services or the establishment of abstraction charges and taxes) to encourage a reduction of water demand/consumption for the benefit of the environmental health of river courses. It is acknowledged however, that water pricing and tariffs pursue multiple policy goals, seemingly at odds but reconcilable in principle: water use efficiency, that is avoiding wasteful use of water; allocation efficiency, thus maximising overall societal benefits from water uses; financial viability, meaning ability to deliver capital, skills and technology needed to ensure water services and sanitation; and social equity, standing for affordability of water as a public interest good.

The Water Framework Directive compels a water pricing system able to reflect the real cost of water use and consumption in Europe. Article 9 of the WFD includes specific provisions on the concept of cost recovery and incentive pricing: i) *recovery of the cost of water services* requires that water prices reflect the financial, environmental and resource costs of supplying water. WFD requires an "adequate contribution of the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services". Member States can also "have regard to the social, environmental and economic effects of the recovery as well as the geographic and climatic conditions" (EEA, 2012); ii) *incentive pricing* involves implementing water pricing policies that "provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive" (EEA, 2012).

Residential water use is characterised by low price-elasticity (Conley, 1967), particularly for indoor water use. It has been shown that the elasticity depends on household income (higher price elasticity has been observed in low-income households), family size, age and other demographic characteristics. The outdoor consumption is usually more (less) price-elastic in wet (dry) seasons (Mansur and Olmstead, 2007). The results of studies vary considerably, to a large extent as a result of differences in methodologies applied, data quality and aggregation (Dalhuisen et al. 2001; Productivity Commission. 2008). Dalhuisen et al. (2003) analysed 64 studies with 314 (mainly short-run) price elasticity estimates ranging from – 7.47 to + 7.90 (mean value –.41, median –.35). Most of the estimates fall within the range between 0 and – 1, thus providing evidence which supports the hypothesis of limited price elasticity. While a number of studies focus on the price-elasticity, less is known about the income elasticity, or namely, how the demand reacts to increases in income. As Dalhuisen et al. (2001) observed, a successful mix of demand management options decreases household expenses which, as an unintended outcome, in case of positive income elasticity may translate into higher water consumption.

With regards to agriculture, price elasticity depends clearly on the type of farming systems and the importance of high-value crops. When cereals are a large part of the cropping pattern, increases in water price might lead to a reduction in irrigated cereal and water savings. For high value crops, water tariff increases that would be required to encourage water savings are usually very high, and rarely acceptable under current contexts. Besides price ranges, however, there are different conditions at which the elasticity of demand is generally low: for example, when the water bill accounts only for a small part of farmers' total production costs or income, or when alternative crops or irrigation techniques are not available due to technical, social or economic constraints (Rieu, 2006, in EEA, 2009[55]). In systems where water efficiency is already high, as it is often the case with high-value crops, there is no possibility of reducing water use, so higher prices will only affect farmers' income (Berbel et al, 2007).

Still, 'getting the water price right' is fraught with many difficulties. Water meters are not installed everywhere, often on the ground of high implementation costs. For example, less than a third of UK households have a water meter (House of Commons Committee of Public Accounts, 2007). An additional difficulty is the fact that multi-dwelling buildings are often not fitted with a meter for each unit, and only a relatively small proportion of industrial users are connected to the public water supply system; most of them extract water directly (OECD, 1999).

Economic Impacts

- *Consumers and households*: Available data suggest that higher water prices are actually effective in regulating (reducing) domestic consumption (EEA, 2009). The resulting change in water demand will partly compensate the increase in water tariffs, leading to marginal impacts on the overall household water bill. For the agricultural sector, increases in water tariffs might have diverse economic impacts, depending on farmers' ability to adapt their irrigation water use and change their practices and farming systems. When water costs are small as compared to overall production costs and crop gross margins (e.g. for orchards or vegetables), increases in water tariffs will have limited economic impacts. In other cases, however, the economic impacts of increased water tariffs can be high[56]. As a result, it is extremely difficult to assess the overall potential impact of increasing water prices in agriculture at the broad EU level (Arcadis et al, 2012). Higher water tariffs or environmental charges/taxes will also deliver larger financial revenues for improvements in the infrastructure and the quality of the service provided, including in terms of reliability which might deliver positive economic benefits in particular to farmers. In this light, the sustained and sustainable investment into water infrastructure will also prevent steep price increases in the future (OECD, 2010a).

- *Innovation and research*: The policy will likely increase investments into research and boost innovation in new water saving technology and practices. In particular, significant attention will be given to solutions for the agricultural sector (the largest water abstractor). In domestic water supply the option may increase the deployment of novel technologies for real-time measuring of water consumption and automatic detection of water leakage. Targeted research sponsorship programmes can catalyse innovation. Effective use of modern communication instruments (e.g. online and in real time monitoring of own consumption) will help to improve the public awareness and response.

- *Specific regions or sectors*: The agricultural sector, by far the largest water consumer in particular in the Mediterranean area, will be the most affected by the policy area. As current water prices vary significantly across EU Member States, significant increases in water tariffs

[55] The elasticity of water demand for irrigation water at current rates presented in the literature is often low or negligible (de Fraiture and Perry, 2007). A study by Bos and Wolters (1990, in Molle and Merkoff, 2007) reviewed irrigation projects where water charges amounted to less than 10% of net farm income, and were found to be 'too low to have a significant impact'. In the Duero region in Spain, where limited crop types are available, it was found that price increases can have an impact on water demand only if farmers' income decreases by 25% to 40% (Gomez-Limon et al, 2007, in EEA, 2009).

[56] Some studies predict a severe impact of a price increase on the European agricultural sector, and especially on small and family farms. It was observed that, if price levels would reflect the true cost of water, thus including historical capital costs and external costs, the agricultural sector as a whole would be severely impacted (Hellegers and Perry, 2006, in Arcadis et al, 2012). For tariff increases ranging from 0.03 to 0.1 €/m3, different studies predicted reductions in farm income between 10% and 50% -and such tariff increases, however, would not be enough to reach full cost recovery (Garrido and Calatrava, 2005, in Berbel et al, 2007).

or the application of new (or higher) abstraction charges would be expected in countries with tariffs still below the EU average and without full recovery of O&M and investment costs, e.g. in most of Mediterranean countries.

- *Administrative burden*: Adaptation of existing economic instruments so they provide incentives for water saving is likely to require studies and policy processes for mobilising all water users. In some cases, adaptation in the existing institutional framework might be required (e.g. if new abstraction taxes or charges need to be established or if a specific water fund for earmarking financial revenues is proposed for enhancing acceptability). In other cases, when volumetric pricing is proposed, water metering will need to be put in place and this will add both direct costs imposed on water users and management costs. Part of the additional costs might be imposed on water service providers (public and private equally). Experience with the implementation of the WFD and green reforms, however, stresses that the main challenge might be more on political acceptability (and resulting transaction costs) than on the administrative burden of such policies. Furthermore, increased revenues in the domestic water supply sector would also imply higher cost recovery, thus relieving the government of a financial burden, in cases where domestic water services are provided and managed by the public sector.

- *Macro-economic impact*: it is expected that the application of economic instruments that provide better incentives for water saving will have limited macro-economic impacts. For policy options that affect the entire EU, the aggregated impacts on the agricultural sector might however lead to some macroeconomic impacts (although it is not possible to assess the order of magnitude of such impacts).

Social impacts

- *Social inclusion and protection of particular groups*: Significant increases in water tariffs and abstraction taxes/charges are expected to affect socially vulnerable groups. Indeed, some households already spend more than 3-5% of their disposable income on their water bill, and would face a rather difficult situation, requiring social tariffs whose costs are distributed among wealthier consumers, income support measures (connected or not to water consumption) or facilitated payments (OECD, 2010a). Increased irrigation water prices might also affect small-scale farming and low-income farmers with a narrower range of options for adapting their farming system and cropping pattern (OECD, 2010a, in Arcadis et al, 2012).

- *Governance*: The policy option produces some benefits in terms of public awareness and access to information: a higher price will in fact raise awareness on the real value of water, in contrast to the current situation where, especially with respect to irrigation, ‘’water is consistently undervalued, and as a result is chronically overused” (Postel, 1992, in Molle and Berkoff, 2007). The promotion of good practices through price signals is thus expected to benefit public understanding of water management issues and challenges, as well as better appreciation of own consumption patterns. Where volumetric water pricing is already in place, the policy option’s impact on public institutions and governance regimes may be negligible. Where this is not the case, it will be necessary to guarantee price regulation and compliance somehow. However it should be noted that higher water prices are difficult to enforce in certain sectors (e.g. agriculture (see Arcadis, 2012);

- *Public health and safety*: Public health will be affected only indirectly. In the domestic sector, as previously mentioned, higher revenues from increased water tariffs can lead to enhanced conveyance and sanitation infrastructures (OECD, 2010a), thus improving health conditions for all citizens. However, problems might arise when demand is significantly reduced as a result of new economic incentives, specific water management responses from water supply companies being required to avoid water stagnation in pipes for too long.

Environmental impacts

- *Climate change*: As a direct effect, and similar to water efficiency standards, the policy option is expected to lead to a reduction of greenhouse gases emissions by reducing the energy needed by households, economic sectors and water service providers to abstract, treat, convey and heat water. This option, however, it is not expected to have an influence on climate change, but will rather enhance preparedness and response to decreased water availability resulting from climate change (see discussion above). By reducing the water demand or making water use more (socially) beneficial, communities will be able to prepare for and respond better to drought events and water scarce periods, that may increase in intensity and frequency as climate change becomes more pronounced.

- *Water quality and resources*: As discussed in the session about the economic impact, pricing policies can contribute to achieving some degree of water savings, although the magnitude of such savings depend on sectors (domestic sector and agriculture) and, with respect to irrigation water, on a number of factors such as, for example, the type of crops and the incidence of water bills on farmers' income. In general terms, charges aiming at reducing water consumption are expected to deliver some positive environmental impact (Molle and Berkoff, 2007)[57]. The causal relationship between low prices and waste, however, seems weak, especially in those cases where wastage is caused by inefficient conveyance infrastructure rather than low prices (Molle and Berkoff, 2007). In some cases, water pricing policies will be effective only if technical measures aimed at the modernization of the irrigation systems are put in place (Strosser et al, 2007; Arcadis, 2012), and if these policies are implemented in conditions where water is in demand and farmers can actually adjust consumption as a response to changing prices. Some water savings could already be achieved by introducing binomial rates in some irrigation systems, including a fixed component covering the 'fixed costs' of the system and a variable component based on actual consumption[58]. Higher financial revenues obtained from changes in economic instruments could also result in higher investment in conveyance and water treatment infrastructure, contributing to better water quality. To achieve this, however, appropriate mechanisms must be set to ensure that revenues from the water sector are actually re-employed for enhancing water services: while this could be more "automatic" in the case of private companies managing these services, it might prove more difficult when management is carried out at the public, centralized level.

- *Land use*: Impact on land use changes may be significant especially in water scarce areas, where water is predominately used by agriculture. Depending on the landscape and natural

[57] It is a commonly held view that increasing irrigation water prices will lead to a reduction in the volume of water used in agriculture, and that underpricing is the major cause of waste (see, for example, Wolfehnsohn, 2000; Cosgrove and Rijsberman, 2000; WWF, 2002; in Molle and Berkoff, 2007). In this sector, water savings can be achieved through various farmer responses, such as for example improving irrigation efficiency, reducing the irrigated area or modifying agricultural practices (EEA, 2009).

[58] As flat rates are quite common in the EU, some water gains can already be achieved by introducing binomial rates, including a fixed component covering the 'fixed costs' of the system and a variable component based on actual consumption: it was shown, for example, that in the Guadalquivir basin those districts with binomial tariffs consume, on average, 10-20% less than district with flat rate pricing, regardless of the level of the flat rate (Rodriguez-Diaz, 2004, in EEA, 2009); another study observed that volumetric rates led to a 25-35% decrease in water use as compared to a flat rate (Hernandez and Lamas, 2001, in EEA, 2009). Similarly, in the figure above the water saving potential of shifting to volumetric pricing is estimated to reach 10-20% of current water use, while the expected savings associated to a price increase are expected to amount only to 1-5%.

context, the conversion of open irrigation channels into a pressurised system may negatively impact the riparian vegetation and dominant landscape pattern, besides imposing costs locally. On the other hand, the riverine ecosystems will benefit from reduced water abstraction.

Comparison of the delivery mechanism

Three policy options have been identified to promote the application of sound economic instruments that provide incentives for reducing water use so water balances are restored: a policy option based on a voluntary approach combining guidance and best practice sharing; a regulatory policy option underlining the role of article 9 in imposing volumetric and water scarcity pricing; and a cross-compliance option based on the revision of the application rules of the EU financing instruments.

In the preparation of the legal obligation to put in place effective water pricing schemes by 2010 under the WFD the scope of the voluntary policy option has already been exploited. Looking at the geographical coverage (basins with severe water scarcity today and by 2030), however, it can be noticed that many Mediterranean RBDs would be concerned by this option: as shown earlier, besides being water scarce areas, these are the countries where water pricing schemes are not yet fully in place, or where water prices are still (sometimes significantly) lower than the EU average. Therefore, at the overall EU level the impact of this policy option is likely to concern those areas where adequate water pricing schemes are most needed, and this would increase the magnitude of the impact.

The second option is likely to encounter opposition in countries in which volumetric pricing and abstraction taxes and charges are not yet in place. Water scarcity pricing might also be seen as seemingly at odds with the recent recognition of the ‘right to water’ as a fundamental human right. Besides these considerations, it must also be stressed that, although this option would concern the EU as a whole, its impact will be different in different countries: in some EU countries, in fact, water pricing schemes are already in place, and prices are already sufficiently high, so in these countries little will change as compared to the current situation. In other countries and RBDs, in contrast, water pricing schemes and water prices are still not in line with WFD provisions, as for example some Mediterranean countries, also mentioned above. Considering that some of the latter countries also suffer from water scarcity situations, it becomes clear that they are likely to be most impacted by this option.

Finally, the adaptation of the rules of the EU financing instruments is likely to be sensitive for countries receiving support from these funds. This would however be consistent with the application of the WFD. Today, financing through structural and cohesion funds requires the application of the cost-recovery principle (as specified in the WFD Article 9) in line with the polluter-pays principle. And this could be expanded to include also provision for “incentiveness” so water tariffs proposed give the right signal to water users in EU-supported investments and water supply infrastructure. Only the regions eligible to this type of funding are indicated in the geographical representation of the potential coverage of this mechanism, reaching 31.3% of the EU surface.

Policy area/ policy option		Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
Geographic coverage					
	as % of EU-27 area	31,6%		31.3%	46.1%
	as % of EU-27 population	44.5% +/-5%		25.0%	57.3 +/-5%
Magnitude	Economic impacts	++/--		+	++/--
	Social impacts	+		+	+
	Environmental impacts	++/-		+	++/-
Expected performance		medium		medium	Medium to high
Time frame for implementation		short		short to medium	medium
Feasibility and suitability		high		low	high
Political acceptability		Medium		medium	low
Overall rating		■■■		■■□	■■□

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes

10.1.4 Guiding land use to respond to water scarcity

Land use/change policies as an instrument for restoration of river environmental health complements, rather than substitutes, water demand management policies. Agriculture represents a significant part of EU's economy and land use. The EU-27 agricultural sector produced EUR 138 billion of gross value added at producer prices in 2010, whereas the utilized agricultural area (UAA) accounted for an estimated 40.1% of the total land area of the EU-27 (Eurostat, 2011 for the reference year 2007). Because agriculture ranks second (24%) among the water use sectors in the EU-27, and first (up to 80%) in Southern Europe, it holds great water saving potential. Besides, driving land use (changes) to restore water balance and alleviate the water stress can also be promoted by spatial development and environmental policies.

There are different possible ways to deploy land use management/change to protect or restore ecological health of water courses. This can include purchasing land and allocating specific land-uses with limited water demands[59]. Other land use driven policy instruments include the promotion of extensive agriculture/agronomic practices, water sensitive urban development/design, urban-rural partnership to reduce water abstraction and respond to water scarcity, etc.

Economic impacts

- *Consumers and households*: Options targeting the inclusion of water scarcity considerations into land use management affect the economy and consumers and businesses within. For land owners, options might result in extra costs or reduction in land value. When additional farm advice is necessary for adapting land use to water availability, administrative burden costs might increase[60]. While the necessary capital to comply with requirements – for example purchasing water saving technologies and new machinery – may be modest, farm incomes and profits in many parts of the EU are currently not sufficient to finance these costs (AEA, 2007). As small and medium sized enterprises were especially targeted by Structural Funds in the last programming period (EC, 2011), a restriction in funding to comply with water balances may greatly reduce finance to these farm groups. Furthermore, new administrative requirements will lead to higher reporting requirements (ibid) and thus some costs for farmers. A potential negative impact may result from farmers transferring their costs to consumers: if the reallocation of farm activities leads to additional costs or lower crop production, farmers may charge more for their products in order to maintain profits.

- *Regions and sectors*: While a new GAEC will help to ensure that internal competitiveness is more consistent as all farms must comply, the task of assessing the relative competitiveness of a farm, sector or Member is immensely difficult, not least because the various costs need to be aggregated and the contribution of cross compliance to these costs disaggregated (Farmer, 2007). Limiting Structural Funds to water rich areas or where a water balance can be achieved will affect specific regions disproportionately more than others. Between 2000-2006, the GDP growth in convergence regions was on average 2%/year compared to only 1.4%/year in regions not receiving assistance (EC, 2011). Disadvantaged areas are already struggling compared to their more economically sound counterparts and these additional restrictions may cut part of their growth potential. Moreover, the agricultural sector in

[59] The Everglades Restoration Plan - set to restore, protect and preserve the water resources of central and southern Florida - is one of the most expensive and comprehensive environmental restoration projects globally. The plan entails the purchase of privately hold agricultural land (ca. 760 sq.km) in order to recreate wetlands able to store early 1.2 cubic kilometres of water.

[60] Some countries provide farm advice for free (e.g. Austria, England), while others provide partial compensation for advice through their rural development programmes; in some countries advice is private and farmers have to cover all the costs (Berglund and Dworak, 2009).

regions with high water consumption will be impacted under both a new GAEC and project criteria on cohesion policy.

Social impacts

- *Social impacts*: For the most part, land use targeted options will results in few social impacts. Increased awareness will lead to positive social impacts through the creation of new jobs for water experts and better access to education. Jobs may however be lost due to income losses from the establishment of water quotas (Dworak, et al., 2009a) or the relocation of farming activities to river basins with higher water availability – although this will depend on the farm production differential. Young and small farmers might be particularly affected. Preventing the construction of water supply projects in disadvantaged areas could reduce job creation and the demand for labour[61].
- *Governance: I*n order to incorporate the concept of water balances in the CAP and the Structural Funds there is a need to develop a methodology on how to define water balances, as well as how to incorporate this into administrative decision-making and control systems. This will require training and awareness, both on the administrative side and on the side of the practitioners (e.g. farmers, construction companies), resulting in an increase in administrative burden for businesses and public authorities. In more extreme cases – for example where no local/regional authorization body for abstraction exists – a new public authority might need to be established or existing structures may need to be adapted. The integration of a new GAEC on water quotas can be more easily integrated into existing farm advisory services. Some additional budgetary considerations are to be expected (see for example Berglund and Dworak, 2009 on the costs of farm advisory services in different Member States) but in general this will not lead to a significant increase in administrative costs. Moreover, cross compliance leads to greater co-ordination between existing control bodies (Alliance Environment, 2007). There is also some evidence that cross compliance is more effective than awareness raising and advice (ibid).

Environmental impacts

- *Climate change*: by promoting the relocation of economic activities (in particular agriculture) to areas with higher water availability, the policy area will have a marginal impact on green house gas emissions. However, it will ensure that activities face lower water stress and thus can better respond to climate change variability and risk.

- *Water quality and resources*: Reducing water use through voluntary and mandatory criteria, or supporting the relocation of activities to relatively water rich river basins, will positively impact various aspects of the environment, with environmental benefits similar to those identified for the establishment of E-flows for example. When awareness raising and educational activities are concerned, these are expected to have overall benefits for those targeted by such activities, including in the field of adaption to climate change as it helps reduce vulnerability in regions facing water scarcity and droughts. (Flörke, et a., 2011). Water supply projects, such as the construction of reservoirs and dams or irrigation schemes, can have negative consequences on biodiversity, especially in water scarce areas. Thus, preventing irrigation projects in such areas, or promoting the relocation of these projects to basins with more ample water resources would help avoid negative impacts on aquatic biodiversity. Preventing water supply projects using groundwater in a region, whether it's for domestic, industrial or agricultural use will also positively benefit the groundwater table. On the other hand, some groundwater aquifers rely on water being leached down from

[61] Local projects carried out under Cohesion Policy have often led to local employment and led to an increase in qualifications of local works and companies to carry out such projects in the future (see for example ADE, 2009a)

agriculture use or through leakage from inefficient conveyance systems. These aquifers could be negatively impacted if such projects are not allowed. There is also some evidence that cross compliance has a positive effect on water quality and quantity (Alliance Environment, 2007). Finally, preventing new water supply and irrigation schemes to be constructed in water scarce areas could help avoiding some soil salinisation, as experienced in different basins in Greece, Spain and Portugal (IEEP, 2000). Indeed, additional water would be available for leaching salts adequately and avoiding salinisation.

- *Land*: In regions already with soil erosion problems – especially areas experiencing desertification due to water scarcity and droughts – irrigation can increase the rate of erosion of cultivated soils on slopes (IEEP, 2000). This can a) reduce soil cover and quality and b) increase water pollution through sedimentation. While other irrigation system can significantly reduce erosion rates, it is still necessary to avoid building new irrigation schemes. The prevention of new irrigation schemes in water scarce areas could possibly lead to a) land abandonment or b) extensification of production. Land abandonment would likely be located in south-eastern Europe. Increased awareness of water scarcity issues could result also in conversion of agriculture production from intensive to extensive production. A GAEC on water quotas has the potential to turn marginal land into agricultural land as farmers might compensate yield losses by expanding the area. In general restrictions in water use definitely change the type of crops grown. The changes can be either towards less irrigation requiring crops or towards more high value crops (e.g. fruits) where for the same amount of water a higher price can be achieved. In both cases a change in land use can be expected. (Dworak, et al. 2009a).

Comparison of the delivery mechanism

Literature and existing studies show that knowledge and education activities help to integrate water management into land use planning. Locally they can have a positive impact on water use and therefore on abstraction. However, given the very low expected geographic coverage of this option, its expected magnitude of impacts and performance is very low. This is currently limited to the Netherlands, a country with strong synergies and coherence between land and water planning. Nevertheless, the option is worth pursuing because of its recognized results and its relatively lost costs and administrative burden it places on businesses and public administrations. The cost-effectiveness of this measure is relatively high although its macro-economic and environmental impacts are low.

The introduction of a new GAEC that accounts for water scarcity is not expected to significantly affect the majority of Member States. Irrigation is still mainly widespread in the southern Member States and a GAEC linked to water quotas would not lead to significant water savings in central and northern Member States. However, the option would cover entire basins, so its impact on the environment is expected to be more significant as compared to the other options for river basins with significant water stress. A GAEC does lead to greater costs for both farmers and public administrations as compared to awareness raising. While ensuring a water balance in water scarce areas might impact farmer income and potentially affect job creation, it would ensure sustainable agriculture and therefore provide a more sustainable development for the sector in water scarce areas. Although potentially influencing all water scarce basins, this option is limited here to where agriculture water abstraction is above 5% of total water abstraction given the sectoral orientation of the option. This brings the potential area covered to 33.7% of the EU surface (instead of 46.1% if all water scarce basins were to be impacted).

Finally, although the option to restrict the use of structural funds has the greatest geographic coverage, its impacts are low as they target local areas. Individual projects within basins would be shifted to less water scarce water bodies, not necessarily to entirely different river basins. Therefore, its impacts on the environment are expected to be low and localised. The option is expected to lead primarily to a geographic relocation of economic and social benefits as projects may still take place but in alternative locations. If projects are banned from an entire river basin, however, economic and social impacts could be high and contradict cohesion objectives. The option's environmental benefits may be strong through ensuring sustainable water use but localised and clearly at the cost of improving disadvantaged regions in the EU. As for the other instruments, only the regions eligible to this type of funding are accounted for in its geographical coverage, reaching 31.3% of the EU surface.

Policy area/ policy option		Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
Geographic coverage					
	as % of EU-27 area	0.8%	33.7%	31.3%	
	as % of EU-27 population	3.0%	27.2 +/-5%	25.0%	
Magnitude	Economic impacts	+	+/-	+/-	
	Social impacts	+	+/-	+/-	
	Environmental impacts	+	++	+	
Expected performance		low	low	low	
Time frame for implementation		low	short to medium	short to medium	
Feasibility and suitability		high	high	high	
Political acceptability		high	low	medium	
Overall rating		■■□	■■□	■■■	

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes

10.1.5 Trading water use rights for the environment

The present policy area addresses the potential of introducing a water use rights market in river basins in Europe. Following an initial formal recognition of existing water abstraction rights and their possible adaptation to account for variability in water supply, specific mechanisms will be put in place to promote trading of water rights (be it permanently or for periods with low water supply – via option market like mechanisms). Tradable water entitlements are market based instruments – legally sanctioned rights or entitlements to use water that can be exchanged thus creating incentives to improve allocation (efficiency) of water quantity amongst different sectors (including the natural environment) (EPI-WATER, 2012). And financial resources (from public sources or from compensation mechanisms) will be used to purchase water rights for environmental purposes. Pre-conditions for trading water use rights for the environment include the establishment of E-Flows and the definition of a target (Cap) for water use rights to be purchased, along with clear protocols for translating water use rights into water use rights for the environment, taking into account in particular of all third party effects/positive and negative environmental impacts.

Economic Impacts

- *Consumers and households*: The purchase of water use rights for environmental purpose can have limited economic impact in itself if reduced water abstraction rights for water abstractors are compensated by revenues from the sale of water rights[62]. Households are unlikely to be affected significantly by the purchase of water use rights back for the environment[63], as such purchases will likely affect agriculture as the largest water abstractor. If trading of water use rights between water users is established in parallel, Tradable water use rights might lead to the reallocation of water to high value uses[64], delivering positive economic outcomes which importance will depend whether it is within or between sectors and the intensity of trading that could not take place otherwise. Overall, this might lead to some economic gains as illustrated by existing experiences in trading water rights from outside the EU[65]. There is evidence that transaction costs associated to the mechanism can be significant and at time have prevented trading[66].
- *Innovation and research*: Significant research will need to be carried out under this policy area as water trading has received limited attention in Europe so far. Key issues to be tackled include cultural values and social perception, existing water use rights and entitlements,

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62 However, such an impact will depend on how rights are actually allocated. If an initial sale does not take place but grandfathering based on a rule (i.e. prior appropriation doctrine, etc.), environmental purchase could come from the general budget as it has been the case for Australia (Connell and Grafton, 2011).

63 In parallel to purchasing water back to aquatic ecosystems, trading might take place among water use sectors, including from agriculture to municipalities and water supply companies (permanent or option markets).This might locally provide least-cost solutions to water supply companies for responding to an increasing urban water demand, limiting water tariff increases for households California (Grafton et al. 2011). It will also help responding to medium term changes in water demands without additional (transaction) costs.

64 Up to 20% of rights have been exchanged in the Chilean (Limarí valley) and the Australian (Murray-Darling basin) markets the other examples are not documented on this aspect (Hadjigeorgalis and Lillywhite 2004, p. 9; National Water Commission 2009b, p. 5 in Grafton et al., 2011).

65 Documented evidence so far (mainly in Australia, Chile and the US) shows that the gains from trade increase as water availability declines (Grafton et al., 2011).

66 Some early estimates have been put forward with respect to the transaction costs associated with the development of formal trading. In a Spanish case, transaction costs beyond 12% of the traded price trading and the gains from trade would be too small to justify the establishment of the system (Calatrava, 1997 in Easter et al. 1997), although this could also depend on the absolute gains. There is evidence that large transaction costs have prevented trading with potentially large gains from trade as some experiences in western US (Easter et al, 1997)

institutions, social, environmental and economic implications of tradable water use rights systems, or the definition of E-Flows as pre-requisite to this policy area.

- *Administrative burden*: The burden of establishing a tradable water use rights system is expected to be high. It is expected, however, that the administrative burden will be reduced once water trading is operational, as part of the information costs will be directly taken care of by participants in trading. The purchase of water use rights for the environment, however, will impose a clear additional burden on public budgets. This might require implementing a progressive approach to purchasing water rights first in rivers with high ecological value. Specific financing mechanisms, with sufficient revenues, will need to be put in place for purchasing the water rights that go back to the environment Costs for monitoring the trading and ensuring third-party effects and all environmental regulation will need to be considered.

- *Specific regions or sectors*: Purchasing water back for aquatic ecosystems will affect basins with water deficits, and mainly agriculture as the main water abstractor. As compared to the E-flow and the "economic incentive" policy areas, farmers will be compensated financially and their revenues will not be affected (and might in some cases increase, at least in the short term). If trading between economic operators take place (depending on differences between the marginal value of water among uses), a more economically-optimal water allocation will be obtained with additional economic benefits[67]. Experiences elsewhere with trading water would suggest that economic benefits are likely to be limited and localised.

- *Macro-economic impacts*: Macro-economic impacts are expected to be minimal as financial revenues from the sale of water use rights will help water sellers in investing in new opportunities. In the medium term, some economic impacts can be expected from trading water use rights among water users. However, the literature stresses that such trading are mostly localised, sometimes limited in time, and relatively marginal as compared to the overall economy.

Social impacts

- *Social impacts:* Social exclusion that would result from the permanent sale of water use rights is often mentioned as a possible social issue. Irrigators who sell their rights either to the authority for environmental purposes or to another user will be compensated at some level although they might experience adverse human and social effects from their decision[68]. The impact of the permanent sale of water use right on the overall economy of a territory, and on its ability to provide adequate services to its population, is also discussed. However, the negative effect on local economic life is contested[69] as limited evidence has emerged, despite some initial research in the same area.

[67] However, from the perspective of other irrigators in a district, the transfer of water out of a district can mean that the unit costs of supplying water to remaining irrigators can increase (Young, 2012) with both economic and social consequences.

[68] "*Moreover, communities that depend on irrigation might experience impacts of water entitlements leaving their region, for example via declining populations and loss of jobs and services. Community-level impacts are likely to be more significant in those communities whose economies have a greater reliance on irrigated agriculture, and that produce agricultural commodities with lower marginal value products of water*" (Edwards et al. 2007; Fenton 2006 in Connell and Grafton, 2011).

[69] Source: Young (2012)

- *Governance*: In many countries, the existing institutional and governance framework is far from the required framework for tradable water use rights to operate[70]. However, establishing tradable water use rights requires well established and enforceable water use rights and institutions for enforcing water use rights, supporting the establishment of transaction, ensuring that all externalities are considered into transactions, and establishing an organisation[71] to purchase water use rights for "aquatic ecosystems".

- *Public health and safety*: If all externalities are well take into accounts, then it is expected that public health and safety issues are not problematic.

Environmental impacts

- *Climate change*: Overall, the mechanism is expected to strengthen the adaptive capacity of river basins, within given constraints that will be imposed to ensure trading does not deliver negative outcomes. The definition of water use rights will need to account for a variable future water supply.

- *Water quality and resources:* Purchasing water use rights back for environmental purposes will help re-establishing balances[72] in deficit river basins and comply with E-flows[73].

- *Land use*: Purchasing water use rights might affect land use in the medium and long-term. Changes in the cropping pattern and the expansion of irrigated areas can be expected if water is purchased back for agriculture. If water use rights are purchased permanently from agriculture, this might further limit development opportunities for this sector in some river basins, thus affecting land use in the medium term.

Comparison of the delivery mechanism

As indicated above, three options are considered for promoting the establishment of tradable water use rights that can be purchased back for restoring water balance and ecological flows: Option 1 represents a voluntary implementation through common guidance and best practice sharing; Option 2 represents a mandatory consideration by MS within an expanded scope of the WFD; Option 3 is a mandatory approach to EU wide tradable water use right, with the launching of a specific EU initiative, starting from an EC Communication and followed by a WFD Daughter directive on tradable water use rights for the environment.

Option 1 will likely take place in river basins and countries that are affected by severe water deficits and where the institutional and regulatory framework is close to the required framework for trading water use rights to take place. Thus transaction costs are expected to be limited, probably reducing

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[70] In Spain, the existing regulatory framework provides rooms for trading water use rights, since 1999 (Calatrava and Garrido, 2005). More recent changes in France in terms of defining E-Flows, adapting water abstraction rights and establishing organisations (*organisme unique de basin*) for managing water allocation in water scarce basins can also be seen as changes in the regulatory and institutional framework enabling the trading of water use rights.

[71] A public body in general, but potentially a recognised non-governmental organisation with well designed mandate.

[72] Australia, Spain and (to a lesser extent) Mexico have turned towards using water markets to trade water entitlements and allocations. However, in both Australia and Spain the pressure on the ecosystems has risen, due to problems with over-allocation of water rights. (Bogart, et al, 2012) More specifically, in Australia, water resource allocation "*disproportionately favour water diversions that, typically, decline by a lesser amount than inflows in dry periods*" (CSIRO 2008, p. 43) generating environmental degradation (Wentworth Group of Concerned Scientists 2010, in Connell and Grafton, 2011).

[73] In situation of scarce financial resources, purchases could be targeted to river basins with highest ecological priority because of the presence of rare and protected ecosystems. If E-flows are restored, problems of poor water quality during some low flow periods might be addressed.

the time required for implementation. Countries currently having a set of compatible institutions for the development of water rights trading are Spain and Cyprus, hence the limited coverage of this approach.

Option 2 would have limited transaction costs if there would be a wide acceptance of the potential for trading water rights in general, and of the relevance of this instrument for purchasing water back to the environment in particular. Today, however, this acceptance is very limited, because of cultural factors, a wide-spread trust in technological solutions in contrast to concerns over market-based instruments. However, economic operators that face reduced water use rights because of the establishment of E-flows will locally see the benefits trading water could provide to them, and thus could be supportive of this policy.

Option 3 is unlikely to be accepted politically, because of the elements stressed above for option 2 and because of the transboundary dimension it includes that will affect national sovereignty on water resources considered as a public good and belonging to the nation in most (all) European Member States.

	Policy area/ policy option	Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
	Geographic coverage				
	as % of EU-27 area	12.2%			46.1%
	as % of EU-27 population	9.1%			57.3 +/-5%
Magnitude	Economic impacts	+			++
	Social impacts	-/+			-/+
	Environmental impacts	+			+++
	Expected performance	low			moderate
	Time frame for implementation	Medium			long
	Feasibility and suitability	medium			medium
	Political acceptability	High			Low
	Overall rating	■■□			■■□

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes.

10.2 Drought Policy Options

10.2.1 Drought Risk Assessment and Management

Droughts are natural, human-exacerbated disasters that affect, directly or indirectly, many people in and outside of drought-prone areas. They differ from other natural or human-created hazards in a number of ways which are relevant when trying to understand their impact (Kallis 2008; Karl, Meehl et al. 2008; ISDR 2009): First, areas prone to droughts are not confined to specific geophysical, geographic, hydrological or climate conditions; droughts may occur in water-rich as well as water-scarce regions. Second, droughts are slow and 'creeping' phenomena (Tannehill 1947), meaning their onset and end are hard to determine and their impacts accumulate with conditions persisting over time, and after the drought has ended. Third, impacts of drought are for the most part non-structural, with potentially large, but poorly understood, rippling effects on economy, society and environment.

In addition to deficient precipitation and social pressures, the intensity of drought is magnified (or attenuated) by a host of factors including temperature and wind (i.e. factors that influence evaporation rate); and water, land and soil management. High temperatures reduce crop yield (Battisti and Naylor 2009) and increase water demand (residential and irrigation), putting additional strain on scarce water resources. The magnitude of the impacts depends on the drought's intensity, spatial and temporal coverage, and the resilience of water users and markets.

The impact of drought on society results from the interplay between a physical event (e.g., less precipitation than expected) and the demands people place on the water supply (Karl, Meehl et al. 2008). Sometimes the impacts are exacerbated because few incentives exist to invest in preparedness measures. Part of this is moral hazard, a concept which explains choices which lead to higher future losses (e.g. cultivating crops with high water demand where water is scarce) because of the limited accountability for these choices.

Drought risk management plans (DRML) are planning instruments containing measures aimed at temporary and permanent reduction of water consumption or use. They help to identify and reduce societal vulnerability to drought by improving drought preparedness and reducing drought impacts. Drought and water scarcity knowledge systems capture, manage, analyze and display relevant meteorological, hydrological, agro-technical, social and other data. This information can help to better forecast drought events and their associated impacts

Economic Impacts

- *Consumers and households*: Consumers will be affected positively as a result of enhanced public awareness and perception of risk, related impacts of drought, and potential behavioural changes regarding water use. In the long run, the successfulness of identifying, planning and managing drought events will result in the safety of water resource provision and a reduction of the water rationing and restriction measures, leading to high costs being avoided[74].

- *Innovation and research*: Well organised drought risk management will foster knowledge transfer and uptake of research results in evidence based decision making. Concerted action

[74] Compulsory water restrictions can produce significant water savings in a short time, comparable only to significant price increases (Renwick and Green 2000). However, such measures are associated with welfare losses and significant enforcement costs, both poorly researched and documented (Hughes, Hafi et al. 2008). For example, the 2008 drought in Australia compelled authorities to impose water restrictions that affected 75 per cent of Australians (Grafton and Ward 2008). According to the Production Commission (2008), the order of magnitude of annual costs to Australian households due to water restriction was of some 'multi-billion dollars'. These losses include structural damage to buildings, deteriorated status of lawns, costs of new watering systems, and structural changes of the gardens.

in field of drought monitoring, forecasting and early warning system will trigger innovation in terms of data collection, transmission, and analysis. Climate change scenarios and their impact on basin hydrology, the societal transformation influencing water abstraction and use are equally indispensable for planning for drought. And research on the socio-economic impact of drought under specific basin conditions will shed light on patterns of unsustainable practices increasing the vulnerability to climate extremes[75]. Indirectly, drought management will foster a culture of water saving, resource efficiency and exploration of alternative water supplies such as wastewater re-use. Equally important will be the training of consumers and stakeholders, and their participation in establishing priorities and rules for water supply systems under drought conditions. Targeted research sponsorship programs should encourage innovation in fields holding greatest promise under the specific basin conditions.

- *Specific regions or sectors*: Proper management of drought will produce benefits for all water use sectors. Recognition of onset of drought early enough to take remedial action will help to reduce the ensuing impacts. The successful implementation of this policy option will result in higher efficiency use and availability of water resources which in turn will have a positive effect on all water related economic sectors.

Overall, the policy area is expected to have large economic impacts, with significant costs from droughts being avoided[76]. It is difficult however to assess the magnitude of the economic benefits of DMP, and the share of potential costs from droughts that would be avoided because of the implementation of DMP[77].

Social impacts

- *Social impacts*: the establishment and implementation of DMP will have positive social impacts, although these are difficult to assess and quantify.

- *Governance*: Proper drought management planning produces benefits in terms of public awareness and access to information. The establishment of drought monitoring and early warning system will enable rapid responses and increase general acceptance of water demand management measures. The revision of implemented drought risk management

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[75] The current knowledge of the economic and wider social impacts of natural disasters is all but satisfactory. The reported losses often refer to direct tangible effects only, leaving out higher-order (i.e. indirect or encouraged), intangible (e.g. life satisfaction) and non-market (e.g. environmental) effects. As a consequence, risk reduction policies are based on underestimated actual and/or potential losses and thus in many cases inadequate to mitigate the disaster risks.

[76] In Europe, the only existing large-scale study is based on a survey conducted by the Directorate General (DG) Environment in 2006-2007. The economic impacts of droughts over the past 30 years have been estimated to top 100 billion Euro. In recent years, annual costs soared to over 6.2 billion Euro or around 0.05 % of the 2006 European GDP. Ross and Lott (2003) provide an overview of 10 droughts in the U.S between 1980 and 2003 where the economic impact exceeded one billion USD (normalised to 2002 dollars). Back in 1995, the Federal Emergency Management Agency (FEMA) estimated the average annual drought-related economic losses to some six to eight billion (NOAA 2002). More recently, Howitt et al. (Cordova and Lehmann 2003; 2009) have estimated that in the short-run, the losses due to the 2009 drought in California (Central Valley) may amount to USD 2.2 billion and some 80.000 jobs may have been lost. The 2006/7 drought in Australia reduced the GDP by almost a one percent, but the farm GDP fell by around 20 percent (RBA 2006). As it came shortly after the 2002 drought, the limited recovery time in between conditioned the resilience of the agricultural sector with output, inflation and employment being hardly affected.

[77] As an anecdotal evidence, during the spring and the summer of 2003 and 2006-2007, severe droughts afflicted Northern Italy, including the otherwise water abundant river basin Po. The drought impacted all water use sectors, notably agriculture, thermoelectric and hydroelectric production, manufacturing industry, and in some cases the domestic water use. As a result of the 2003 agreement sponsored by the River Basin Po Authority, water was released from the reservoirs and dams to increase river levels and satisfy at least irrigation needs to some extent. A group of experts representing different uses was established and adopted an agreement toward mitigating the effects of drought-in-progress on July 18th. The agreement allowed to reduce the potential impact due to drought for agriculture from estimated Euro 1.9bn to Euro 1.3bn (AdBPo 2009).

plans will benefit the interaction between water-users in different sectors, and stakeholder involvement in governance issues.

- *Public health and safety*: Public health will be affected positively. The implementation of drought management plans (DMP) will reduce the amount of domestic water restriction. And DMP will have moderate losses in agricultural production, which could eventually be compensated for by imported food products.

Environmental impacts

- *Climate change*: Planning for drought will not lead to a straight reduction of greenhouse gas emissions, albeit the drought mitigation measures foreseen for the situation of emergency might have both positive and negative implications in terms of CO2 equivalent emissions. Thanks to this policy option, communities will be able to prepare for, and to handle, drought spells that may increase in intensity and frequency as climate change becomes more pronounced.

- *Water quality and resources*: Proper drought management will produce disincentives or restrict less efficient or less socially beneficial water use under drought conditions, while ensuring enough water for more important water uses, including environmental river flows.

- *Land use*: Indirect impact on land use changes may be significant especially in water scarce predominately agricultural areas. The implementation of the drought management plans could lead to radical change in both irrigation infrastructures and the type of agriculture.

Comparison of the delivery mechanism

The proposed delivery mechanisms include a voluntary approach based on best practice and knowledge sharing (option 1); and a mandatory instruments pursued by the revised Water Framework Directive and/or a new piece of legislation either in water resource management or the Community Disaster Risk Reduction policy (option 2).

The scope of the voluntary approach has already been exploited to some extent and is expected to be limited to the countries already having drought management being significantly considered in their national strategies and facing water scarcity in their basins. The European Network of Experts on Water Scarcity and Droughts (WS&D) produced a report on drought management plans as part of the Common Implementation Strategy (CIS) of the Water Framework Directive. This report was endorsed by the Water Directors of the Member States in November 2007. The 2010-2012 mandate of the WS&D Network include among others activities towards definition of commonly accepted indicators for water scarcity and for droughts, review of methods and scales for drought risk maps. Another CIS guidance document endorsed in 2009 addressed adaptation to climate change in water management (CIS 2009). The guidance document addresses among others the issue of drought and water scarcity, and the role of the drought risk management plans in climate adaptation efforts. The Drought Risk Management Plans are in place or under development in several Member States, either as a part of the River Basin District Management Plan (RBDMP) or as a separate, but interlinked planning instrument.

Under option 1, the drought risk management schemes are likely to be implemented especially in the water scarce river basins that have experienced significant drought spells recently. If implemented with the same rigour and depth, the induced effects of option 1 at the river basin scale will be of the same magnitude as under option 2. Throughout Europe, however, the full potential will not be realized. Because a drought's indirect effects may hit hard other economic activity down- and upstream of the production chain, the indirect losses may be felt beyond the drought-hit area.

The mandatory option, covering the whole of the EU, is more efficient in protecting communities and the environment, and produces higher benefits at the Community level. The Water Framework Directive laid down a framework for a holistic and coordinated water resource management throughout Europe, including droughts. While some positive benefits can be achieved on voluntary base, mandatory introduction of the DMP is the option yielding the largest impacts. In 2010, the European Parliament reiterated the request to introduce drought risk planning and management similar to the planning compelled for floods by the Directive 2007/60/EC.

Policy area/ policy option		Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
Geographic coverage					
	as % of EU-27 area	46.1%			100%
	as % of EU-27 population	57.3 +/-5%			100%
Magnitude	Economic impacts	+			++
	Social impacts	+			++
	Environmental impacts	+			+/++
Expected performance		Moderate			high
Time frame for implementation		Short			medium
Feasibility and suitability		High			high
Political acceptability		High			Moderate
Overall rating		■■□			■■■

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes

10.2.2 Strengthening the European Drought Emergency Response Capacity

The European Treaty sanctions cooperation between Member States (article 196) and assistance to Member States struggling to recover from serious impacts of natural disasters (article 122 and 222). Over the past decades, the Community disaster response mechanism extended to a multi-hazard, flexible and well coordinated instrument for managing natural and human-made emergencies. In the case of drought, the Community response capacity can be further improved by better coordination of seasonal forecast systems and extended use of Community Financial Instruments, notably the European Solidarity Fund, allowing for a prompt response and aiding recovery of the disproportionally impacted regions and/or sectors.

The 2007 Communication on water scarcity and drought (EC, 2007) highlighted the step change away from a crisis response to a modern, comprehensive risk management approach based among other things on an advanced monitoring and early warning system at the European level. The European Drought Observatory (EDO) for drought forecasting, assessment and monitoring has been developed at the Join Research Centre (JRC), Institute for Environment and Sustainability. Based on the efforts of the European Environmental Agency to develop water scarcity and drought indicators, the EDO is a web-based platform providing up-to-date drought-related information at different scales. Respecting the subsidiarity principle, the JRC processes information at the EU level, whereas national/regional datasets are managed at MS level/river basin or regional environmental authorities.

The European Solidarity fund (EUSF) was established by the Council Regulation No 2012/2002 of 11 November 2002 in order to provide assistance to EU member states, coping with large-scale disasters whose effects exceed their coping capacity. So far it has been activated for a case of drought only once for the 2008 drought in Cyprus. The persisting and severe drought conditions compromised public water supply and forced Cyprus to deploy exceptional emergency drought measures including temporary water shipping from Greece. To improve the performance of the EUSF, Hochrainer et al (2010) suggest the transfer of the upper layer of the Fund's risk through commercial reinsurance or directly to the capital markets, e.g., with catastrophe bonds. In addition, the access to EUSF should be linked to country-level risk-management measures and risk reduction as a way of reducing moral hazard inherent in post-disaster aid. Alternatively, the authors proposed to shift the focus of the Fund from a post-disaster response and aid to a pre-disaster, risk-based solidarity instrument. To this end, the EUSF would support public and private insurance systems in Europe.

At the request of the European Council, the Commission prepared a catalogue of EU financial instruments available for funding prevention activities. The catalogue includes 453 measures focusing on the ten most important instruments, i.e.: CPFI, LIFE+, ERDF, EUSF, Cohesion Fund, EAFRD, FP7, Instruments for Stability, for Pre-Accession, and European Neighbourhood, and related implementing acts.

In principle, an early-warning system would make it possible to avoid many of the adverse economic and human costs that arise from producers having to commit resources every year without knowing what the outcome of the rains will be (WMO, 2006).

Economic Impacts

Drought causes significant losses (see above sections) that are insufficiently understood and researched. Forecast systems can substantially reduce drought impacts if used by decision makers and if management measures and preparedness plans are in place. For example, the economic benefits of NOAA seasonal forecasts issued during 1995–2000 were estimated at 100–350 million USD in a state-declared drought year (2001, 2002) and 5–30 million USD in the other years (2003, 2004) (Steinemann, 2006). In addition, the optimisation of the density of the meteorological and hydrological data networks and joint data processing and sharing provide a cost saving potential.

Quick response capacity in the cases of major disaster hits help to limit the damage and assist a rapid recovery of the affected population and economic sectors. It is important to note that EUSF was established to provide exceptional financial aid to cover non-insurable damages, such as public expenses for restoring public infrastructure, providing services for relief and clean up, and protecting cultural heritage. On the other hand risk transfer and sharing mechanisms can improve resilience to disasters, but the ability to access such ex post strategies may provide disincentives for countries to take adequate ex ante measures to reduce their risk.

- *Consumers and households*: A reliable drought early warning allowing a more cautious use of remaining water resources can reduce the risk of imposing severe drought emergency rationing and restriction, or delay their adoption. In this sense, it contributes to water security strategy. Adequate response capacity measures for dealing with emergency droughts further protect consumers' life by avoiding compulsory water restrictions.

- *Specific regions or sectors*: Drought occurrence is not bound to any geographic region in Europe. Thus, this policy is expected to produce benefits to all regions and sector, in particular agriculture and energy generation but also drinking water supply. Water use and food provision are secured by the implementation of measures for dealing with emergency droughts.

- *Innovation and research:* The provision of drought monitoring, early warning systems and data sharing to all Member States will enhance co-operation and assistance in case of drought emergency. Research programs targeting innovation exploitation of the improved forecasts will be promoted[78].

Social impacts

- *Social impacts*: better forecasting and faster more adapted emergency responses to drought events are likely to significantly reduce the negative social impacts of droughts.

- *Governance*: The policy option produces benefits in terms of data sharing and data collection between Member States (MS). The coordination of data gathering procedures, early warning systems and civil protection interventions will strengthen European cohesion, promoting the activation of effective emergency responses. The adaptation of the rules for the application of support from the EU Solidarity Fund, and the establishment of bilateral agreement between MS, will promote the involvement of stakeholders in governance issues.

- *Public health and safety*: The coordination of National Civil Protection activities and the promotion of bilateral agreement for rising water security will reduce indirect impacts of droughts. They might not change however the broad impact on public health and security, which remains marginal as compared to other impacts.

[78] Such programmes are already promoted, as illustrated by the Joint Programming Initiatives (JPI) Water that recognises the value of, and need for, reinforcing shared foresight exercises, exchanging information, resources, best practices, methodologies and guidelines. Similarly, Europe 2020 Flagship Initiative Innovation Union recognises water as a growing societal challenge and an innovation priority. A number of research projects (e.g. Xerochore, Drought-SPI, WATCH, DEWFORA) addressing better understanding of drought, including EWS, have been funded under the Seventh and earlier Framework Programmes. Drought forecasting skills are high especially where strong teleconnections exist between sea surface temperature phenomena and hydro-climatic anomalies (Kallis, 2008).

Environmental impacts

- *Climate change*: Focused on emergency response, the policy area will address adaptation to climate change by reducing the impacts of drought. The set of measures addressing the drought emergency response capacity have no impact on greenhouse gas emissions.

- *Water quality and resources*: The policy will lead to possible increases in water availability in case of drought emergency by the introduction of temporary water transfer and re-allocation. The impact of the measure on water quality is not relevant, even if, to some extent, it could be slightly significant due to pollutant dilution.

- *Land use*: Land use is not significantly impacted by the introduction of the policy option addressing drought emergency response capacity.

Comparison of the delivery mechanism

The Water Framework Directive considers prolonged droughts a justifiable *force majeure* that may lead to a temporary deterioration in the status of bodies of water (Article 4) if, amongst others, exceptional or could not reasonably have been foreseen, and i) all practicable steps are taken to prevent further deterioration. Hence, the WFD, which covers the entire EU,does provide a regulatory basis for drought forecast and early warning system at the river basin scale.

The voluntary option is expected to yield positive results. But part of its potential has already been exploited to some extent. Drought monitoring and forecast are in place or under development in many EU Member States. Their closer interconnection with the European Drought Observatory may produce additional benefits for the Community but based on the current experience from the European Flood Alert System (EFAS), it is unlikely that the voluntary approach will alone be sufficient, even if in principle all EU basins could benefit from them. The integration of national drought monitoring and forecast system is better promoted through the revised role of the European Solidarity Fund (EUSF). The EUSF has been insufficiently used for drought risk so far. There is a substantial scope in further developing the EUSF as a practical instrument of risk pooling and aiding recovery. Given the EU-wide projection of such an instrument, this option is likely to benefit any basin, hence the 100% coverage in the summary table below.

An EU concerted action pursued by the Financial Instruments is expected to promote coordinated efforts to exchange information on weather and climate variability, to harmonize and disseminate data and assessments, and to facilitate region-wide coordination across all components of drought emergency. An extensive exchange program will allow for a transfer of experiences and best practices at technical and administrative level. And there is a substantial scope in advancing EUSF into a more efficient and effective disaster aid, along the suggestion by Hochrainer et al (2010).

Policy area/ policy option		Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
Geographic coverage					
	as % of EU-27 area	100		100	
	as % of EU-27 population	100		100	
Magnitude	Economic impacts	+		++	
	Social impacts	+		++	
	Environmental impacts	+		+	
Expected performance		low to medium		Medium	
Time frame for implementation		short		short	
Feasibility and suitability		high		medium	
Political acceptability		high		medium	
Overall rating		■■□		■■□	

Legend: Impacts ++ Very significant increase/positive change/benefit; + Slightly significant increase/positive change/benefit, 0 No change/no benefit; +/- Positive and negative impacts balance out or are uncertain; - slightly significant decrease/negative change/damage; -- Very significant decrease/negative change/damage; NOT INDICATED: Not relevant Impact type not relevant to this option (Source: IAG 2009). Additional criteria: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated). For the full maps see annexes.

11. Conclusions

The present report summarises the main results of the European wide assessment carried out to a) identify current gaps in the EU Water Scarcity and Drought (WS&D) policies and b) additional policy areas and options that can help tackling water scarcity and drought in Europe.

Overall, the assessment shows the **importance of water scarcity and drought in Europe**, both in terms of areas affected (a bit less than half of the total EU territory) and population affected (a bit less than two thirds of the EU population). The efforts taken by MS to tackle water scarcity and drought, including in the context of the WFD RBMPs, will not be sufficient to change this situation. WS&D problems will be more acute by 2030 than they are today. Results stress that WS&D will not be limited to Southern Europe as it is often believed: there will be an increasing number of Northern river basins and Eastern river basins along the Black Sea that will be affected in the future.

The assessments of MS efforts to tackle WS&D stress a diversity of "insufficiencies" or "gaps" for addressing fully water scarcity and droughts in Europe. Overall, four types of gaps have been identified. These include:

- **Conceptual gaps**, i.e. an inadequate understanding of the causal relationships between drivers, pressures, states and impacts that would help identify the adequate (most cost-effective) measures for addressing WS&D. This inadequate understanding is exacerbated by the common combination of assessments and measures of water scarcity and those of droughts. In this sense, over-simplified main indicators such as the WEI also present opportunities for important improvements

- **Information and assessment gaps**, i.e. insufficient information and assessments on the magnitude and recurrence of WS&D (including the socio-economic dimensions of impacts), on the measures effectively proposed for addressing it (measures are rarely "WS&D-flagged" and part of specific policy initiatives targeting WS&D) and on their (potential, expected or actual) effectiveness in reducing water scarcity and drought problems ;

- **Policy, governance and implementation gaps**, i.e. the lack of adequate policy response and governance (including those actions aiming to ensure that WS&D issues are internalised into water policy, sector policy and land-use planning) to tackle the WS&D challenge, and the absence of pre-conditions (allocation of adequate human and financial resources, monitoring and enforcement, etc) for effective implementation of measures and support actions. In some cases, the absence of the "right" pre-conditions questions the actual implementability or suitability of proposed measures to address WS&D

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Overall, additional policy efforts will be required in Europe for tackling WS&D in a cost-effective manner. Seven policy areas representing alternative policy approaches to WSand that could be promoted in Europe were identified. These include:

- The establishment of **E-flows**. The main purpose of this policy area is the establishment and enforcement of clear ecological river stream flows for all rivers in Europe. It requires the adaptation of current water use/abstraction rights and the enforcement of new abstraction rights that are coherent with ecological river stream flows.

- The establishment of **Efficiency targets**. The main purpose of this policy area is the application of well-defined efficiency targets for different water use sectors and components of the hydrological cycle (e.g. targets for conveyance efficiency in irrigation systems, for water use efficiency in buildings, etc.).

- The promotion of adequate **economic incentives** for efficient water use. The main purpose of this policy area is to widen the scope of economic instruments to ensure they provide incentives for "sustainable" water abstraction and use.

- **Guiding land use to respond to water scarcity**. The main purpose of this policy area is to support the relocation of economic activities and water abstractors away from water deficit areas to areas with sufficient water and no water deficit – or to ensure that new economic development takes place in water rich river basins and territories.

- **Trading water use rights for the environment**. The main purpose of this policy area is the consolidation of the existing water use rights system and the establishment of water market/trading mechanisms with a defined cap for the environment. It provides the opportunity to purchase water use rights for environmental purpose to achieve the balance for river basins with deficit. Incidental benefits include the reallocation of water use rights among economic users that can deliver economic benefits.

- **Strengthening the European Drought Emergency Response Capacity**. This policy area builds on a twin approach combining: the development of an European Drought Observatory and European Drought early-warning system for helping MS and economic operators to react and act as early as possible to forthcoming droughts; the adaptation of the EU Solidarity Fund to ensure an effective use of this fund in case of drought emergency (for supporting economic actors and citizens to cope with damages that could not be avoided).

- The development and implementation of **Drought Management Plans**. This policy option builds mainly on the development and implementation of a coherent set of actions for addressing drought at the river basin scale, in coherence with the planning process of the WFD.

Different **policy options** were proposed for each policy area, including voluntary approaches, adaptation to existing sector policies (e.g. cross-compliance in the context of the Common Agricultural Policy) and EU financial instruments (e.g. use of structural and cohesion funds) to the establishment of new regulation. The different policy areas and policy options identified were then assessed individually in terms of their economic, social and environmental impacts, following the IA guidelines of the EC.

The **Table** 19 below summarises the **aggregated assessment results** that compares policy options (delivery mechanisms) within each of the seven proposed policy areas, and suggests the most recommended policy option highlighted in gray in this table. In some cases, these most recommended options build on the revision of the Water Framework Directive (or the establishment of a new piece of legislation complementing the provisions of the WFD which could be further included in the WFD from 2018 onwards), while in others voluntary or non-binding approaches are favoured.

Table 19. A**ggregated assessment results**

Policy area/ policy option	Knowledge and awareness	Cross-compliance CAP	EU Financial instruments	WFD reform or new legislation
E-flows	■■□	■□□	■□□	■■□
Efficiency targets	■■■	■□□	■■□	■■□
Economic incentives for efficient water use	■■■		■■□	■■□
Guiding land use to respond to water scarcity	■■□	■■□	■■■	
Trading water use rights for the environment	■■□			■■□
Assess and manage Drought Risk	■■□			■■■
Strengthening the European Drought Emergency Response Capacity	■■□		■■□	

Legend: most recommended (■■■); recommended, second best option (■■□); least recommendable (■□□), not applicable (not indicated)

Figure 33: Summary of the assessment of different policy options (delivery mechanism) for the seven suggested policy areas. The most recommended option(s) for a given policy area are highlighted in grey in this table.

Because of the qualitative approach chosen for the assessment, and the combination of elements in this overall assessment, these aggregated results should be taken with caution, the more detailed elements provided in the previous chapters being of higher value for guiding future EU water policy including in the context of the Blue Print.
With regards to water scarcity issues:

- Policy areas differ in terms of the **"distribution of the burden"**. In economic terms, establishing E-flows accompanied by a reduction in water abstractions implies that current water abstractors adapt their activities to new water abstraction rules and bear the costs (although specific public support might be provided for reducing negative economic and social impact and thus enhance acceptability). Purchasing water use rights for the environment will lead to the same level of water abstraction (and thus economic activity) but compensated by positive financial flows to current water users. While economic instruments might imply financial revenues being taken out of current water users, these lead to more significant reductions in income as compared to the E-Flow option.

- With regards to **acceptability** by decision makers, E-flows are closer to the current regulatory framework of the WFD (fixing an ecological objective). The unsuccessful experience with the application of Article 9 of the WFD questions the possibility of a break-through with this policy area. The establishment of tradable water use rights remains a less preferable option for most stakeholders in Europe, whether as a result of expected impacts or concerns regarding market-based instruments and "liberalisation". However, it represents the best financial option for water abstractors, at least in the short term. And farmers (the largest water abstractors) are likely to be more willing to accept both options. The establishment of efficiency targets, in particular for household appliances and buildings with expected short payback periods, could be seen as having the highest acceptability. Overall, however, acceptability will depend on the support actions (such as awareness raising campaigns) and financial support given to water abstractors to "accompany changes".

- With regards to the **administrative burden**, all policy areas lead to administrative burdens for the European Commission and for Member States. However, these would not take place necessarily a) at the same time and b) at the same spatial scale depending also on the policy options chosen. The establishment of a new regulation on efficiency targets allocates administrative burden to the European scale, requiring further controls (by MS) of appliances and technologies for individual producers of appliances technologies. To the contrary, the establishment of E-flows might require a common definition at the EU scale, although its application will be targeted to the river basin scale, putting the administrative burden on local water administration and also on the EU (due to additional reporting and controls). With respect to economic incentives, it must be noted that in some countries they are already in line with Article 9 provisions, so the administrative burden will concern only those countries which still need to put in place adequate pricing schemes. Trading however can be the most demanding option at MS level as it requires a revision of water rights.

As indicated above, the synergies between the various policy areas and policy options have not been analysed in this report. However, a first matrix of possible synergies has drawn in figure. This exploratory exercise indicates potential complementarities and synergies between policy areas to ensure water scarcity and drought are addressed in a i) cost-effective manner, ii) Europe-wide and iii) acceptably so. As an illustration, it is expected that the implementation of E-flows offer synergies with the development of **land use guidance** and complement the requirements of **water use right trading** schemes. Conversely, **E-Flows** are not expected to complement **drought risk management** activities.

Further assessment would however be required to identify the "optimal combination" of policy areas and policy options for Europe.

Table 20: Potential synergies between the policy areas analysed in this study

Policy area/ policy area	**E-flows**	**Efficiency targets**	**Economic incentives**	**Guiding land use**	**Trading water use rights**	**European Drought Emergency Response**	**Assess and manage Drought Risk**
E-flows	n/a	0	+	++	++	0	0
Efficiency targets	0	n/a	++	++	++	+	0
Economic incentives for efficient water use	+	++	n/a	+	++	0	0
Guiding **land use** to respond to water scarcity	++	0	0	n/a	++	0	+
Trading water use rights for the environment	++	0	++	++	n/a	0	0
Strengthening the **European Drought Emergency Response** Capacity	0	+	0	0	0	n/a	++
Assess and manage Drought Risk	++	++	++	++	++	++	n/a

Legend: read the table as the policy option in row having beneficial and synergetic (++), little (+) or none (0) implication on the policy area in column

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Annexes

ANNEX 1. Key components of the methodology applied in the context of the Gap Analysis study

The following sections presents different components of the methodology applied in the context of the Gap Analysis study, in particular:

- The WaterGap model that has been applied to assess the impact of different scenarios on water scarcity;
- The baseline socio-economic scenario used as reference scenario;
- The database of measure/policy instrument that target WS&D ;
- The application of the DPSIR framework for reviewing the causes of WS&D and for assessing the "adequacy" of measures already proposed by MS for tackling WS&D;
- The steps taken for assessing the main sources of uncertainty and the robustness of results;
- The common template used to describe the policy areas and options considered as having high potential in addressing WS&D in Europe;
- The assumptions made for assessing the order of magnitude of impacts (in terms of number and location of river basins) expected from the application of policy areas and options.

The WaterGap model

For the purposes of this assessment, consistency is required so as to provide a coherent baseline on which testing the potential of recent (or to be implemented) policy instruments tackling waters scarcity in the EU is made. To ensure coherence, the assessment builds on data generated from modelling rather than from reporting, as the combination of existing reporting sources on water scarcity situations in MS highlighted incoherence and the difficulty to obtain a coherent picture on water scarcity and drought throughout Europe. For droughts, however, the assessment of today's situation is based on droughts reported in recent years.

The objective of this modelling is an attempt to identify the reach of such policy and measure mix to 2025 and establish a baseline scenario to identify gaps in terms of scope and type of responses. The modelling exercise combined an overall EU-wide assessment complemented by additional modelling on the potential impact of baseline measures for a sample of six countries, namely Cyprus, France, Germany, Italy, Malta, Spain and the United Kingdom.

To quantify freshwater resources and compute the potential impact of climate change and other important driving forces on future water resources the water model WaterGAP (Water – Global Assessment and Prognosis) was used (Alcamo et al., 2003; Döll et al., 2003; Flörke and Alcamo, 2004; Verzano, 2009). The model was also used to provide consistent results throughout Europe on today's situation in terms of water scarcity.

WaterGAP was developed and further improved at the Center for Environmental Systems Research and is designed for large-scale grid-based applications, and its capabilities to simulate water availability and water use are well tested in various scenario assessments [e.g. Global Environment Outlook GEO-4 (Rothman et al., 2007), State of the European Environment (EEA, 2005), Millennium Ecosystem Assessment (Alcamo et al., 2005)]. The model version, WaterGAP3 (Verzano, 2009), herein referred as WaterGAP, computes both water availability and water uses on a 5 by 5 arc minutes grid (longitude and latitude;) or grid cell sizes of 6 x 9 km respectively, covering whole Europe. WaterGAP consists of two main components, a Global Hydrology Model to simulate the terrestrial water cycle and a Global Water Use Model (Flörke and Alcamo 2004) to estimate water withdrawals and water consumption of the domestic, thermal electricity production, manufacturing, and agricultural sectors. The aim to use the Global Hydrology Model was to simulate the characteristic macro-scale behaviour of the terrestrial water cycle in order to estimate monthly and daily time series of water availability for Europe. Herein, water availability is defined as the total river discharge, which is the sum of surface runoff and groundwater recharge.

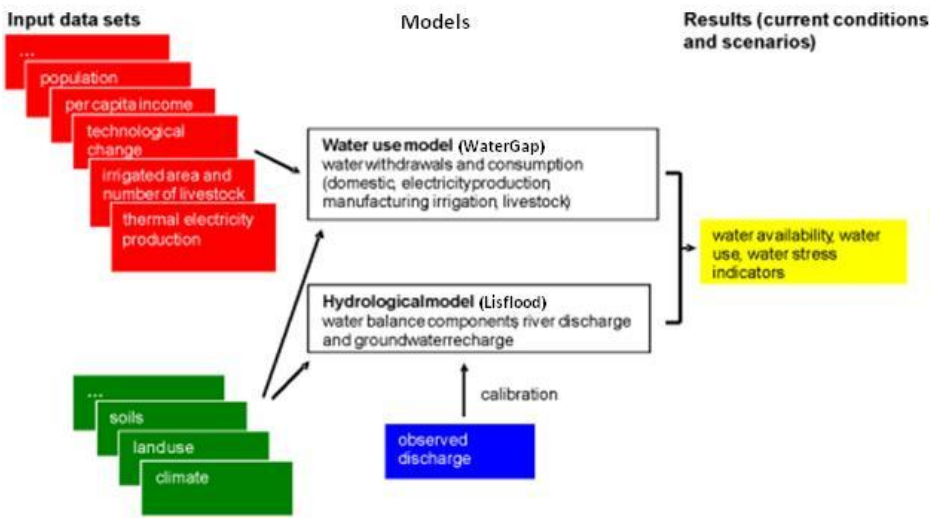


Figure 19. Overview of WaterGAP and its components. (Source: ClimWatAdapt project)

The total simulated runoff of a grid cell is composed of the runoff from land and from open freshwater bodies. The runoff produced inside one cell and the simulated inflow from upstream cells is transported through a series of storages representing groundwater, lakes and reservoirs, wetlands, and rivers. The upstream/downstream relationship among the grid cells is defined by a global drainage direction map (DDM5), which indicates the drainage direction of surface water. Additionally, the flow length per grid cell is enhanced by applying an individual meandering factor for each grid cell derived from a high-resolution DDM (HydroSHEDS, Lehner et al. 2008). The flow velocity is calculated dynamically, based on the Manning-Strickler-Formula (Verzano et al, 2010). In a standard model run, river discharges in approximately 180,000 grid cells (approximately 2000 river basins >140 km² drainage area) in Europe are simulated. The effect of changing climate on runoff is taken into account via the impacts of temperature and precipitation on the vertical water balance. Additionally, river discharge is affected by water withdrawals and return flows. In WaterGAP, natural cell discharge is therefore reduced by the consumptive water use in a grid cell as calculated by the Water Use Model of WaterGAP. For most water use sectors, except irrigation, only a small part of water is consumed, whereas most of the water withdrawn is returned, probably with reduced quality, to the environment for subsequent use. Water use for the agricultural and electricity production sectors are calculated on a 5 by 5 arc minutes grid scale, but for domestic and manufacturing sectors on a country scale. These country-scale estimates are then downscaled to the grid size within the respective countries using generic downscale algorithms.

The measure/policy instrument database

The assessment of whether MS efforts were in line with WS&D problems builds on the development of a "measure" database that summarised the wide range of technical and support actions currently proposed by MS for tackling WS&D under different policy areas and strategies (see below). Overall, the purpose of this database is:

- to create a structured pool of policy instruments that decision makers from European, national, and regional level can draw on when looking for options to deal with the issue of water scarcity and droughts;
- to provide information about the social, economic and environmental impacts and the feasibility of the measures;
- to support the development of the baseline scenario by providing material to interpret and readjust the models if necessary and possible. The measures catalogued (i.e. policy instruments database) also linked to the main model used so that their original scenario is duly revised; and
- to provide an updated picture of the current trends in active policies to tackle identified driver, pressures and impacts.

The database is based on the following sources of information:

- The database on climate change adaptation measures developed under the EU Project CLIMWATADAPT;
- The measures referred to in the "call for evidence" on WS&D;
- The annual reports from the MS on water scarcity and droughts;
- The assessment report of the River Basin Management Plans (RBMPs);
- Input from the expert group on WS&D and additional contacts with key experts in individual MS;
- Input from other DG Environment studies feeding into the Blueprint for water, the specific references being detailed in the references section of the report;
- General literature sources.

The database[79] is a matrix comprising **two** Microsoft Excel sheets, one for **measures** and one for **support actions**. Water scarcity and drought policy instruments have been first divided into two main categories:

- "Measures": This refers to technical, green infrastructure and land-use based measures that bring about actual water savings and reduce droughts.

[79] For more information see the section on operational definitions of the different attributes in the Annex 6. The database is available in Annex 1.

- "Support Actions": 'This refers to administrative controls, financial instruments, regulations, management plans, voluntary initiatives, and educational activities (research and awareness-raising) that support the implementation of "measures". These actions do not bring about concrete water savings themselves, but rather facilitate and support measures that do so.

Measures are sub-divided according to types such as technical (these relate to grey infrastructure such as dykes, water supply systems and water saving devices as well as measures to increase natural water retention and sustainable drainage), land use changes (e.g. afforestation) and changes in land management (e.g. changes in agriculture practices such as fertilizer application, tilling, etc.).

Support actions comprise the following types:

- Financial: E.g. subsidies, vouchers, financial incentive programmes;
- Administrative control: This refers to permits, licensing, setting limits, etc.;
- Policy actions: They refer to regulations and strategies implemented by national governments;
- Voluntary standards, such as EMAS, ISO, etc.;
- Management plans: RMPS, Drought Management Plans;
- Awareness/Information;
- Risk management;
- Research.

This typology combines the approaches of the ClimWatAdapt database and the database from the JRC on climate change adaptation and mitigation measures. This database developed for the Gap Analysis goes beyond the categories from ClimWatAdapt in order to refine the typology further with additional categories used by the JRC.

Water scarcity and drought measures/support actions can also be of different nature:

- **Preventing**- if the measure/support action reduces the risk and sensitivity of people, property or nature to WS&D events.
- **Preparatory**- if the measure/support action builds or enhances awareness about effects of WS&D in the region (Includes carrying out studies, awareness raising and communication exchange activities).
- **Reactive**- if the measure/support action includes the development of standards and processes to react to an extreme event.
- **Recovery**- if the measure/support action creates mechanisms such as establishing a funding instrument to support reconstruction or an insurance system.

They can be further divided in accordance to what stage of the DP(S)I(R) framework developed above the response is targeting:

- **Drivers** – measures/support actions targeting the main drivers of water use, i.e. climatic changes, population developments, economic, land use and technological changes.

- **Pressures** – measures/support actions targeting the main pressures on the water environment, i.e. anomalies in physical water availability, water demand and abstraction, pressure on water supply infrastructure and land cover change.

- **Impacts** – measures/support actions targeting the main impacts of water use, i.e. water resources, water deficit (demand vs. supply), environmental impacts and socio-economic impacts.

Most importantly, the database indicates the geographic scope. Where possible, the river basin or region has been identified where these measures/support actions have been or will be implemented; in some cases only the country level information was indicated. This detailed level of scope of implementation, along with information regarding the date range of implementation, is an important step in identifying 1) major trends and 2) to highlight gaps in actions taken with respect to water scarcity and droughts.

Finally, measures and support actions are linked measures to sector categories, the standard classification system of economic activities in the European Community; these codes are also used at aggregated level by the DPSIR framework. NACE codes group organisations according to their business activities in a uniform way to ensure the availability of reliable and comparable statistical data to operators in the internal market. There are 4 level categories: 21 umbrella categories with 3 sub levels classify all economic activities in the EU. The relevant umbrella categories for the database include: agriculture and forestry; water supply; energy; and industry. Furthermore, the database included the categories domestic/tourism, spatial planning and navigation/shipping, key sectors not defined in NACE but where measures/support actions have been found. Measures and support actions are categorized as specifically as possible according to the sub-level groups in so far as this information was available. However, it is important to note that many of the information sources used in the compilation of the database only indicate measure implementation at the 1st or 2nd order level; this is most often the case for measures/support actions found in the river basin management plans, in the WS&D questionnaires and measures taken from the ClimWatAdapt database, which only used general sector categories. A categorization of measures/support actions as the 3rd or 4th level is not possible given the information limitations.

In addition to the categorization of measures along the categories mentioned above, the database provides information – so far as available – regarding costs, time needed for implementation, impacts (environmental, economic, social), administrative level of implementation, adaptation ease and effectiveness. Unfortunately, much of this information is not yet available at measure/support action level.

Finally, it is important to highlight a deficiency in the NACE codification system which is that it only applies to economic sectors and does not account for activities undertaken to improve the environment. As such, a NACE code could not be applied to an important measure/support action: activities aimed at ensuring minimum flows.

Using the DPSIR framework for reviewing the causes of WS&D and for assessing the “adequacy” of existing measures

A significant part of the analysis aimed at assessing whether the measures already proposed by MS can be considered as “adequate” or sufficient as compared to current and future (under baseline) WS&D. To conduct the analysis, the Driver-Pressure-State-Impact-Response (DPSIR) framework was used as the theoretical base for reviewing the causes of water scarcity and droughts in Europe but also orientates the assessment of the policies stated to be tackling this particular policy domain.

The DPSIR framework is an approach to analyse "*environmental problems, with regards to sustainable developmen*t" (Borja et al., 2006) and has been identified as a suitable framework for determining pressures and impacts under the WFD. As such, it offers broad guidelines to assess the following dimensions which, in turn can be monitored with some of the following indicators:

- **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 and 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.[80]

These dimensions relate to each other following the causal relationship pattern that relates Drivers, Pressures and State to Impacts. To modify the Impacts, Responses initiatives can be developed and implemented at various levels through of measures and of support actions. Drivers lead to Pressures that change the State and have Impacts. Such Impacts are monitored through the State. In turn, Responses can change a Driver, be a driver and mitigate Impacts. The following figure depicts these relationships.

[80] At this stage, it is important to stress that responses presented are responses already put in place or proposed as part of the baseline scenario.

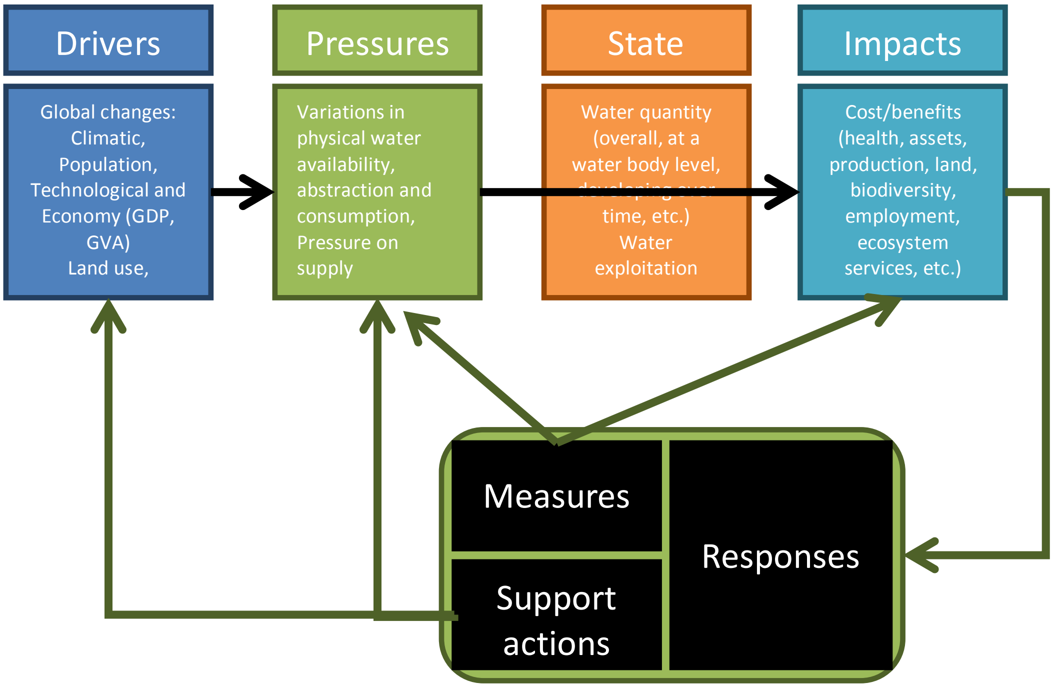


Figure 20. The DPSIR framework as applied in the WS&D Gap Analysis study
(adapted from: Kossida et al., 2009. Water Scarcity and Drought: Towards a European WS&D Network. ETC/ICM Report, available online: http://icm.eionet.europa.eu/ETC_Reports) and DG Environment, 2011)

The framework allows identifying the level and the factors to which Responses focus, and whether proposed Measures and Support Actions, are corresponding to the drivers, pressures and impacts identified. It further helps assessing (although in a very qualitative manner) the level of ambition of a particular water management policy in light of WS&D issues identified for a given country or river basin.

The analysis of the adequacy of proposed measures as compared to existing DPS, is complemented by a subsequent quantitative assessment using the WaterGap model presented above. For assessing whether responses put in place are sufficient to tackle WS&D, and as presented in Section 3.2, a separate modelling exercise has been performed using WaterGap for a sample of countries, namely Cyprus, France, Germany, Italy, Malta, Spain and the United Kingdom.

Assessing the main sources of uncertainty and the robustness of results

The robustness of the results obtained and the main sources of uncertainties have been addressed as follows.

- **Assessing the adequacy of the WaterGap Model for capturing the magnitude of WS&D**. Several different sources of error are derived from the model assumptions. Also, the use of the water stress indicator that imperfectly capture WS&D, as identified in the presentation of the WEI. To assess robustness, what is made is to compare the results of the model with other sources of information that capture WS&D in particular the reported WEI by countries in several documents of reference; i) water exploitation index (EEA 2011c); ii) some indications found in the river basin management plans; iii) MS self-reporting (2007 EC WS&D 2nd Interim Report). This exercise helps capturing basins or countries where all sources of information are in agreement with the outcome of the WaterGap model and those with differences with the outcome of the WaterGap model (with potentially differences between the different sources themselves) in the magnitude of water stress. This is then the basis for identifying possible explanations of the observed differences;

- Assessing the **uncertainty resulting from the choice of the socio-economic baseline scenario** "economy first". A sensitivity analysis on the baseline scenario is made by applying the other socio-economic scenarios of SCENES and analysing whether it affects the key results obtained (in terms of the prediction of current water scarcity, water scarcity by 2030 with and without proposed baseline measures);

- Assessing uncertainty because of the **difficulty to identify all existing measures** that tackle WS&D (whether all relevant measures have been included or not, whether some measures might have been included that have no impact, etc.). This has been tackled through a sensitivity analysis on parameters representing key measures for the selected river basins investigated with the WaterGap model;

- Identify the **limitations of the database** in terms of its representativeness and completeness. Although the database aimed at being as comprehensive as possible, it is expected that not all the measures policy options that are tackling WS&D have been retrieved, in particular those dealing with other sector policies that might impact indirectly on water balances.

Describing key policy areas and options

Following the identification of individual policy areas and options, individual options have been described in some details building on the consortium's own expertise and on examples of the applications of individual policies in individual MS or outside Europe. Specific attention has been given to **operational and implementation issues** along with pre-conditions for effective implementations. Indeed, these elements are the basis for assessing implications and impacts (social, environmental, economic) of policy areas and options. Each policy area has been described following a common template to ensure comparability between policy areas, this template including:

1. A detailed **qualitative description** of the policy area;

2. The identification and brief description of the different **policy options** that exist at the European level for effectively promoting the targets of the proposed policy areas at different levels (European, Member State, river basin or local levels). These policy options depend on the policy area, along with the time line for achieving full implementation of the policy option (in the short-term, medium-term and/or long-term). Broadly speaking, the policy options that have been considered range from **voluntary instruments** based on policy guidance and recommendations, knowledge management and best practice sharing to regulatory approaches based on the establishment e.g. of new directives ensuring **mandatory compliance**. Intermediately, some policy options lead to expected applications and impacts in selected Member States or river basins depending on expected levels of water scarcity, main water abstractors and existing institutional setups. For those, enforcement is guaranteed by coupling the policy requirements to Community payments from Cohesion, Structural or to the Common Agriculture Policy (CAP).

3. The identification of **pre-conditions** for the policy area/options to be implemented, and for securing their effectiveness, with regards to[81];

    a. **New knowledge** that would be required for "making the option work" and for supporting its implementation;
    b. **Monitoring and reporting to the EU;**
    c. **Technical requirements** in terms of infrastructure and equipment required for implementing the option (if relevant);
    d. **Governance and organisational issues;**

4. Possible **adaptations in existing EU instruments** that are not already part of the policy options considered.

The description of the policy areas and options has also stressed potential links between policy areas (e.g. combining the definition of E-flows and tradable water use rights that would favour flexibility and ensure optimum allocation of water), as well as the possibility to combine elements of different options in what could represent an optimal EU-wide policy response to WS&D. However, the grouping of policy areas and options has not been carried out here and is out of the scope of the present exercise.

Assessing the potential impacts of different policy areas and options

As indicated in Chapter 2, different policy options or delivery and enforcement mechanism for the proposed policy areas have been proposed, ranging from voluntary implementation to the establishment of new regulation that requires mandatory implementation. The level of effort required for different policy options to be adopted, and their timing, will depend on on-going or forthcoming policy processes which include the revision of existing European legislation. Indeed, revisions are expected to provide possible windows for specific policy options to be proposed and adopted.

At the end of 2011, the European Commission laid out plans to reform several Community policy instruments including some of those proposed as a delivery mechanism behind the policy options. In particular, the proposed reforms refer to the EU Solidarity Fund, the Common Agricultural Policy, and the Cohesion Policy. Also, the revision of the Water Framework Directive (2000/60/EC) is seen as relevant.

The **European Union Solidarity Fund** (EUSF) was set up to respond to major natural disasters and express European solidarity to disaster-stricken regions within Europe. The EUSF was created as a reaction to the severe floods in Central Europe in the summer of 2002. By the end of 2010, some 42 application were approved with the financial aid summing up to 2,4 billion (COM(2011) 613 final). Only in one case (Cyprus 2008 event) the Fund had been mobilised for addressing the impacts of drought). The EUSF can provide financial aid to Member States and countries engaged in accession negotiations in the event of a major natural disaster if total direct damage caused by the disaster exceeds 3 billion € (at 2002 prices) or 0.6% of the country's gross national income, whichever is the lower. Aid for extraordinary regional disasters below this threshold in truly exceptional cases is possible but is limited to 7.5% of the Fund's annual budget. Back in 2005 the Commission proposed to enlarge the scope and simplify the application and management of the payments from the Fund (COM(2005) 108 final). The proposal was not adopted by the European Council and in 2011 the Commission decided to withdraw the proposal. The 2011 Communication (COM(2011) 613 final) makes the case for a reform of the Fund but notes the opposition of the Member States to significantly change the rules and endowment of the Fund. We note that adjusting the application

[81] The template includes also the possibility to specify "other pre-conditions" that might be seen as relevant.

rules of the Fund in order to provide better incentives to manage water scarcity and droughts is not a currently discussed policy option.

In October 2011 the European Commission laid out a proposal for the **Cohesion Policy framework 2014-2020**. The European Financial Instruments introduced back in 1994 financial instruments are expected to play an even more important role in cohesion policy in the next programming period. The 2011 proposal among others contains greater flexibility to EU Member States and regions in terms of target sectors and strengthens synergies between existing financial instruments and other forms of support. Compared to the previous programming period (2007-2013), the proposed rules are non-prescriptive in regards to sectors, beneficiaries, types of projects and activities that are to be supported. As a result, the Member States benefit from a greater flexibility to design programmes and chose most appropriate financial instrument to meet the specific challenges. We note that the proposed rules are more suitable to tackle the regional differences in terms of water scarcity and drought (WS/D) and allow Member States to design WS/D related programmes in regions/river basin districts most in need. On the other hand the proposed rules make less likely to limit the provision of the resources from the Cohesion Policy to management practices sensible to water scarcity and drought challenges.

On 18 November 2010 the Commission tabled a Communication on "The CAP towards 2020" which outlines options for the future CAP and launches the debate with the other institutions and with stakeholders. Following this communication the Commission tabled legal proposal for a new CAP on the 12 October 2011[82]. According to this proposal, the following elements are highly relevant for water:

- A green component, going beyond the requirements of cross-compliance, is proposed to be introduced into the system of direct payments. Thirty percent of direct payments would be tied to this greening component, turning a substantial part of first pillar payments into payments for delivering ecosystem services. In particular, "Greening has the potential to improve the retention of soil carbon and grassland habitats associated with permanent grassland, deliver water and habitat protection through the establishment of ecological focus areas, and improve of the resilience of soil and ecosystems through crop diversification.
- Negative impacts can be expected due to the fact that partially coupled direct payments for cotton in Bulgaria, Greece, Spain and Portugal are proposed to be maintained.
- The role of farm advice is proposed to be strengthened. Thus, the scope of the Farm Advisory System would be broadened to cover among others actions related to the protection of water. This could be used to help farmers to become more efficient and by that to better cope with higher water prices.
- The existing GAEC according to which farmers have to comply with national abstraction rules would remain. This is an important element to tackle illegal abstraction, as farmers doing so would lose some or all of the direct payments, as well as possible payments received in the context of agri-environmental commitments, and would have to pay penalties for breaking the national law.
- As regards rural development, *ex ante* conditions would have to be fulfilled prior to the adoption of the programmes. One such condition is the existence of a) a water pricing policy and b) an adequate contribution of the different water uses to the recovery of the costs of water services.

One of the "priorities" of rural development policy would explicitly include improving the EU farm sector's water-efficiency. As in the current programming period, support for technical infrastructure

[82] http://ec.europa.eu/agriculture/cap-post-2013/legal-proposals/index_en.htm

investments (including irrigation facilities) would be maintained. This might help in situations where cost recovery rates are not 100%. However, it is important to note that only investments leading to a reduction of previous water use by at least 25% would be considered as eligible expenditure in the old Member States ("EU-15"). Derogation would be possible in the new MS on condition that the investment would have no negative impact on the environment.

It is important to note that this proposal is being subject to discussions in the Council and the European Parliament, and the baseline for what will be achieved by the CAP is therefore still not clear.

Directive 2000/60/EC (**Water Framework Directive**) of the European Parliament and of the Council of 23th October 2000 establishing a framework for Community action in the field of water policy has entered into force on 22th December 2000, the day of the publication in the *Official Journal of the European Communities*. According to Article 19 “Plans for future Community measures” paragraph one, once a year the Commission shall submit to the Committee (that assist the Commission on the implementation of the Directive– Article 21) a plan of measures for future actions or legislations which it intends to propose in the near future. In paragraph two the Commission preview to review the Directive at the latest nineteen years after the date of its entry into force, this means in 2019. Anyway after twelve years from the date of entry into force of the Directive and then each six years, the Commission shall publish a report on the level of the implementation (Article 18 “Commission Report”). However as stated in Article 20 technical adaptations to the Directive are possible also before the first general review of it. The revision of annexes are possible to adapt to scientific and technical progress, but to do it is necessary to take into account the period of review and updating of the river basin management plans (as referred in Article 13).

The assessment of policy areas and policy options has been carried out following the Impact Assessment Guidelines of the European Commission. The summary templates of these guidelines for social, economic and environmental impacts have been used as check list for listing potential impacts. Whenever possible, a review of available literature has then been carried out for illustrating the order of magnitude of potential impacts, the assessment remaining overall of a qualitative nature.

An important issue for the assessment of proposed policy areas and policy options is the order of magnitude of expected environmental, social and economic impacts. Indeed, different policy options will lead to different levels of improvements in the sustainability of water resources for different countries and river basins. Some basins that are currently under (water) deficit will see improvements in their water balance under a given policy area and policy option while others might continue to be “under deficit”. And this has implications for the magnitude of the environmental impact, but also on social and economic impacts (including potential macro-economic impacts[83]). It also has implications for the spatial location of impacts in Europe.

Assumptions that are proposed for deciding whether adequate water balance is achieved or not under a given policy area or policy option has built on the characteristics of:

- Individual river basins in terms of a) existing water deficit by 2030, b) total water withdrawal and c) the relative share of water users (agriculture and other uses) in the total water withdrawals (as this will explain whether internalising water scarcity within the CAP is expected to have some impact, and whether inter-sectoral trading might take place and thus deliver additional economic benefits)[84];

[83] If a large number of river basins are impacted by a given policy option, then the aggregation of their individual economic impacts might lead to macro-economic impacts at European scale. At the contrary, if only a few river basins are impacted, macro-economic impacts will be marginal and can be ignored.

[84] Using results from the simulation of the ClimWatAdapt model presented in the inception report of this study.

- Individual Member States in terms of a) their existing institutional and regulatory framework and how "close" this framework it is from frameworks required under different policy areas and policy options[85], b) whether the country is eligible to EU structural and cohesion fund financing, and c) the importance of crop-related CAP funding allocated to Member States (MS).

The following table presents the set of assumptions made for individual policy areas and policy options in terms of expected improvements in "ecological" water balance for river basins in deficit by 2030. These assumptions have been applied for identifying river basins that would be impacted by various policy areas and policy options, the results being presented in the assessment below in a map format. Once the river basins affected have been identified:

- The overall area affected by individual policy area and policy option have been estimated, using a GIS based software.

- The overall population affected by the policy area and policy option have been estimated. Whereas the approach used for the calculation of the population approximates well the share of the population at a large scale, errors might be significant at the level of an individual river basin[86]. Therefore, population data for individual river basin have not been estimated and reported in the present report.

[85] The assumption is that closer the framework of a country will be from the framework for a given policy area, easier it will be for the country to implement the policy implying high acceptability and low transaction costs.

[86] For the scope of this project the population was calculated using the Population Count Grid: Center for International Earth Science Information Network (CIESIN), Columbia University; and Centro Internacional de Agricultura Tropical (CIAT). 2005. Gridded Population of the World, Version 3 (GPWv3): Population Count Grid. Palisades, NY: Socioeconomic Data and Applications Center (SEDAC), Columbia University. Available at http://sedac.ciesin.columbia.edu/gpw.[3 May 2011]. The average error was calculated based on a sample of data.

Table. Main assumptions for selecting river basins and part of the EU territory affected by individual policy areas and options

Policy objective	Policy area	Strengthening knowledge and raising awareness	Cross-compliance for EU agriculture policy[87]	Guiding principles for EU financing instruments[88]	Strengthening the quantitative dimension of the WFD or adopting a new EU directive
Restoring the water balance in all European river basins	**E-flows**	All river basins with "severe" water deficit today and by 2030[89], excluding countries in which E-flows is already translated in the regulatory framework (France[90])) that is part of the baseline	All river basins with **water scarcity during the summer period** and where agriculture water abstraction is **above 5%** of total water abstraction	All river basins from MS that are targeted by cohesion funds[91]. For structural funds, it is assumed that they will contribute to improvements in all river basins as compared to the baseline, but not sufficiently to achieve E-flows in all basins	All river basins that are water scarce the year round and during the summer period
	Efficiency targets	All river basins with "severe" water deficit today and by 2030	All river basins with **water scarcity during the summer period** and where agriculture water abstraction is **above 5%** of total water abstraction	All river basins from MS that are targeted by cohesion funds. For structural funds, it is assumed that they will contribute to improvements in all river basins as compared to the baseline, but not sufficiently to achieve E-flows in all basins	All river basins that are water scarce the year round and during the summer period, with however improvements in water efficiency being too high as compared to existing water deficit for river basins with medium to low water deficit (this leading to higher implementation costs)
	Economic instruments	All river basins with "severe" water deficit today and by 2030 – and countries where volumetric pricing and volumetric "abstraction charges/taxes is already in place[92]		All river basins from MS that are targeted by cohesion funds. For structural funds, it is assumed that they will contribute to improvements in all river basins as compared to the baseline, but not sufficiently to achieve E-flows in all basins	

[87] European Agricultural Guarantee Fund and European Agricultural Fund for Rural Development

[88] Sructural Funds, Cohesion Funds, EU Solidarity Fund

[89] The threshold for defining "severe" water scarcity is similar for all policy areas. "Severe" water scarcity is defined as water scarcity the year round as opposed to water scarcity that affects river basins during the summer period only.

[90] E-flows is now part of the regulatory framework (*Loi sur l'Eau et les Milieux Aquatiques*), thus France will not be affected by this option. Other countries such as Spain and Italy are also defining minimum river flows, but these are cnot considered to be E-flows that would provide the right basis for the ecological functioning of rivers.

[91] Countries eligible to Cohesion funds include: the Czech Republic, Estonia, Greece, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Slovenia, Slovakia and Spain (that has a specific transition period). The feasibility of limiting the Cohesion policy payments to the conditions established under the different policy options would need to be examined more closely.

[92] Unitary rates of existing abstraction charges and taxes are usually too low. These would need to be increased as part of this policy option.

Policy objective	Policy area	Strengthening knowledge and raising awareness	Cross-compliance for EU agriculture policy[87]	Guiding principles for EU financing instruments[88]	Strengthening the quantitative dimension of the WFD or adopting a new EU directive
	Guiding **land use** to respond to water scarcity	Countries with already strong synergies and coherence between land and water planning (The Netherlands)[93]	All river basins with **water scarcity during the summer period** and where agriculture water abstraction is **above 5%** of total water abstraction	All river basins from MS that are targeted by cohesion funds. For structural funds, it is assumed that they will contribute to improvements in all river basins as compared to the baseline, but not sufficiently to achieve E-flows in all basins	
	Trading water use rights for the environment	All river basins with "severe" (threshold to be defined) water deficit "today" and by 2030 with at least one major water withdrawal in addition to agriculture (to allow inter-sector trading), and an institutional and regulatory framework that would make possible water trading with limited changes (Spain and Cyprus[94])			All river basins that are water scarce the year round and during the summer period throughout Europe
Enhancing drought management in Europe	Strengthen **Drought Emergency** responses	EU-wide initiative affecting all countries in the same manner, limited to countries with initial components of an early warning system and those who experienced severe drought in the past 10 years (all countries)		EU-wide initiative affecting all countries in the same manner (adaptation of the EU Solidarity Fund)	
	Assess and manage Drought Risk	Responses for selected countries with already drought management being significantly considered in national strategies			All countries

[93] In Italy, River Basin Management Plan (including water balance) is already closely linked to part of the spatial/territorial development planning. In practice, however, full synergy is not yet in place.

[94] Cyprus has traded water use rights when implementing certain major water development projects by exchanging them with the provision of considerably reduced quantities of water but of higher reliability of availability. This was possible due to the construction of a dam of interannual operation or other water works.

ANNEX 2. Similarities and differences between droughts and water scarcity

Aspect	Drought	Water scarcity
Causes	Natural, due to a reduction of precipitation over a certain time period. High Temperatures, strong winds, low relative humidity, timing (onset, duration and end) as well as characteristics of rain can increase the severity.	Man-made, due to an overuse of water resources, caused by consumption becoming significantly higher than the natural renewable availability, or their pollution (reducing their suitability for water uses).
Occurrence	Drought is a normal, recurrent feature of all climates and can happen in all parts of Europe.. Its occurrence can be related to large-scale changes in atmospheric circulation patterns.	Due to the increase of water consumption, water scarcity is increasingly relevant and recurrent across Europe.
Duration	Droughts are very variable in their duration. They can last from a few weeks to several years	Usually, water scarcity is characterised bya permanent and continued degradation of water ecosystems and less water availability for other (economic) functions
Impacts	Very variable according to occurrence, severity and duration of the event as well as the sensitivity of affected ecosystems, economy and society and influenced also by the relative humidity of soils, capacity of storage for groundwater and streamflow of surface waters. When occurring in already water scarce affected areas, droughts shall have the most severe effects If water scarcity and drought pass certain thresholds, they can significantly affect the environment (terrestrial and freshwater ecosystems, air, soils, salt intrusion), the economy (agriculture and water uses) and society (e.g. urban water shortages, welfare, recreational activities, cultural and aesthetic concerns)	
Spatial extent	Regarding the geographical extension, droughts and water scarcity can happen at local level or cover entire RBDs. Drought events are even reported for wide areas of the EU.	
Predictability	Drought forecasting is currently based both on statistical analysis of the historical occurrences and numerical weather forecast, with a timeframe from a few days up to several months (with increasing uncertainty). Its implementation is planned in the frame of EDO	Water scarcity is predictable for the mid- and long-term in the frame of RBMPs if adequate information on water availability and consumption and trends has been compiled, and considering the uncertainty e.g. of climate change predictions
Interaction	When droughts occurr in an area characterised by water scarcity, their impact will be more severe, as they are more vulnerable. Heat waves can aggravate droughts and water scarcity situations. Water scarcity can also be an effect of overexploitation due to (concurrent) drought events, but this does not apply vice versa (drought is not an effect of water scarcity)	
Environmental thresholds	(Freshwater) ecosystems are often characterised by and adapted to recurrent natural variations in precipitation and streamflow[95]. Nonetheless, exceptionally severe droughts -or the combined impact of droughts with man-made overabstraction/ water scarcity can result in irreversible changes in the ecosystems	Water scarcity usually affects the ecological status of ecosystems, depending on its duration, relevance and the sensitivity of the ecosystem (incl. functions and elements)
Costs	In general, few data are available about the precise costs of water scarcity or drought situations (for marketable sectors, like agriculture, energy,…). If data are available, they should evaluate the combined effects of a drought and geographically overlapping water-scarce area	
Public Awareness Indicators	The Standard Precipitation Index (SPI) reflects temporal deviations of rainfall with respect to the statistically expected rainfall derived from a reference period The Fraction of Absorbed Photosynthetically Active Radiation (fAPAR) reflects deviations in the fraction of solar energy absorbed by vegetation canopy respect to the statistically expected from a	The Water Exploitation Index (WEI+) reflects the relation between water availability and abstraction/consumption (still in testing phase)

[95] Note that the case of non permanent rivers should be carefully tackled.

Aspect	Drought	Water scarcity
	reference period	
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)	RBMPs, water management, metering and allocation, water demand management, increase water efficiency and reusing, protection of vulnerable species and habitats, pricing policies, etc.
DPSIR focus	Responses focus on Impacts	Responses focus on Drivers, Pressures, and Impacts
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: INTECSA-INARSA, S.A., based on a previous draft by TYPSA (2012). Working definitions of Water scarcity and Drought Report to the European Commission.

ANNEX 3. Assessing uncertainty in the context of the Gap Analysis project

Assessing the adequacy of the WaterGap Model for capturing the complexity of WS&D.

As it is the case for most modelling exercise, the results of the WaterGap used here are based on assumptions and faces certain bias. Opting for a model had the virtue of offering a coherent picture for the magnitude of water scarcity today and into the near future. However alternative, although not coherent or comprehensive sources of information exist and are briefly discussed here as to be used as comparison to what was identified from the model.

The indicator developed by the model is similar to the water exploitation index (WEI). As indicated in section 2.2.2, it suffers from important shortcomings, although the version developed in the model is at basin level and does include seasonal results. The objective of this section is to contrast the results for today's situation to assessments from several sources providing reported indications of water scarcity from the following sources i)water exploitation index (EEA,2012); ii) some indications found in the some river basin management plans; iii) MS self-reporting (EC 2007).

However, no consistent picture can directly be extracted from the reported water scarcity indicators gathered used as a baseline scenario from the three main sources. Either they contradict each other or they are not sufficiently complementary to provide an EU27 coherent picture (covering different river basins and using different definitions of WEI..). An illustration of this incoherence is illustrated with the maps in Figure below**Erreur ! Source du renvoi introuvable.** that present actual water scarcity as decrypted from different sources and further discussed below.

- The reported WEI (EEA,2011). The current situation described with the available river basin information is similar in general terms to that generated by the model with water scarcity. However not all basins have calculated their individual WEI. The quality of the information provided by the different sources is further discussed below.

- The Water Scarcity and Droughts Second Interim report (2007). An important source of information about water scarcity was gathered through the Water Scarcity and Droughts Second Interim report (2007) which compiles the reporting from the MS on the issue. In principle the resulting information should match the database on the RB WEI indicating that basins above 10% are considered as water scarce. However several additional basins were included and some of which were well below this local threshold. At the time it was attributed to "In some cases, the differences displayed between national replies may partially be due to different interpretations given by countries in data questionnaires they responded to (EC, 2007)." The report then gathers more basins potentially affected by water scarcity and rising their number to 13. This second source is more heterogeneous and accounts for different approaches to classifying whether a basin is experiencing scarcity or not.

- The WFD RBMPs as sources of the magnitude of water scarcity (WRC water scarcity). The expected advantage of this source was threefold: i) it can be seen as an up to date source, ii) it allows for local needs to be more clearly identified particularly when not reflected by the WEI; and iii) it projects where the phenomenon is the most acute so to trigger policy reaction through the plans associated programme of measures. Interestingly, when water scarcity was identified, this tends to be closer to the Interim Report than to the WEI, probably because it does reflect the relatively more precise considerations, therefore including more basins as scarce. However, only a portion of the approved RBMPs were assessed at the time of this report which limits its scope. Moreover, some questions have been raised as to whether the assessment was conducted in the manner to properly answer this specific question in the framework of the assessment of the RBMPs. An example of this is the identification of Scottish basins to be appraised as water scarce.[96]

This brief review of alternative sources shows that the model is compatible with most reported sources, although not always. The model does provide a solid and coherent baseline given the low coherence level among currently available data.

96 An updated and revised version of the assessment will be produced in early 2012.

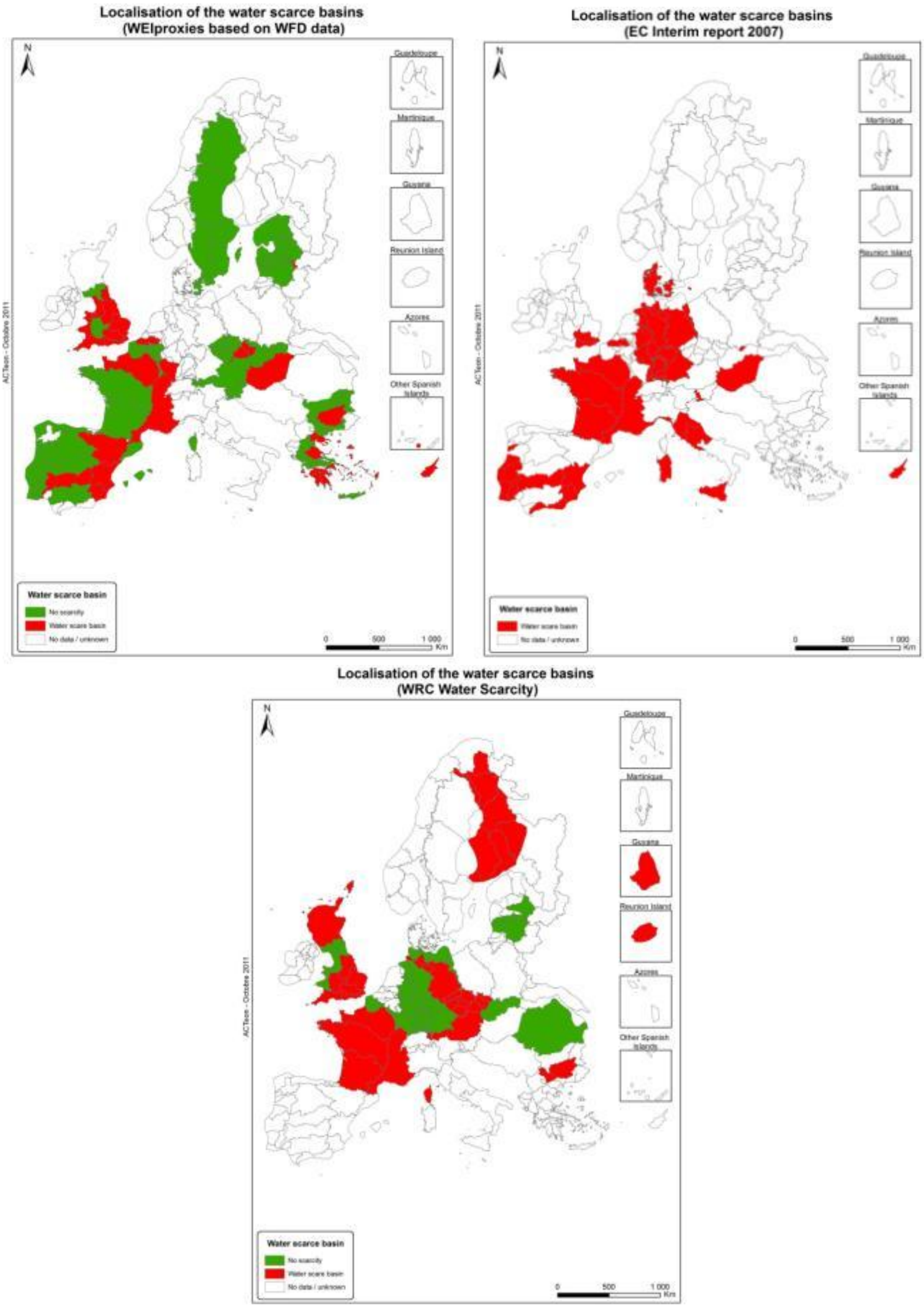


Figure : i) Localisation of the water scarce basin (WRC Water Scarcity), ii) Localisation of water scarce basins (WEIproxies based on WFD data), iii) Localisation of water scarce basins (EC interim report 2007)

Assessing the uncertainty resulting from the choice of the socio-economic baseline scenario

Given the importance of the assumptions mobilised to model the potential effect of the basket of policy instruments to the year 2025, particular attention should be given to the robustness of the baseline socio-economic scenario to capture the possible future world contexts. A systematic assessment of the robustness of the scenario chosen (Economy First) was however not possible in the framework of this study as the parameters of the Economy First scenario are not publicly available[97] and cannot be remodelled yet (Florke, 2012). This situation has then prevented to test whether possible changes in the wider policy context (i.e. energy, agriculture) may rise or reduce the sensitivity of the abstractors to a given policy instruments.

Partial results of the model can be manipulated to simulate changes in the scenario by redefining externally the expected water abstraction levels by main sector and water availability. However, these exercises only project variation of the importance of a given user in a given basin. What can be changed through these manipulations are only the expected levels of water stress, raising or lowering the challenge faced by policy instruments but not the effect of the policy instruments themselves, thus reducing the interest of this test, although not its importance

Assessing uncertainty linked to the assessment of existing measures

In addition to questions about and limitation of the used underlying socio-economic scenario highlighted above, two mutually reinforcing factors influence the robustness of the assessment. Uncertainty is generated both by limits to how accurately the influence of a single policy instrument (whether support action or measure) can be quantified. This uncertainty is not distributed evenly among the policy instruments implemented/recently launched. There is a difference between technological solutions and managerial ones on one hand and; between those aimed at demand management and those that increase supply.

A key component of uncertainty relates to the relative balance between demand management options as compared to technological options favouring supply increase (i.e. desalination). Although demand management options are expected to be preferable (production costs, including negative externalities linked to energy use), the uncertainty of their effect in a given situation may present them under an unfavourable light compared to desalination for which estimates are more precise[98].

To control this, simple sensitivity analyses were performed on the illustrative basins to test the hypothesis of an underestimation of the effect of demand management instruments. Table A presents the main sensitivity tests that have been performed on key parameters capturing demand management measures in the WaterGap model. The exercise was performed on the most developed models of France and Spain during the most critical months of the summer.

97 Potentially the results can be contrasted to less likely scenarios developed by the SCENES project. But they would only provide questions qbout contrasts and not robustness.

98 This does not meanthat under-used desalination plants are not accounted.It only shows that they tend to be more accurately represented.

TableA. Changes operated on the coefficient of measures for the sensitivity analysis.

Policy instruments	Changes used during the sensitivity analysis	Brief justification of choice
Water saving technical measure	50%	Some accuracy is expected from the modelling of these policy instrument
Water saving management measure/support action	100%	Potentially the less successfully modelled
If there is a basket of measures/support actions both technical and	100%	The bundling of measures is assumed to have more impact in the long-run.
Water supply increase	0%	Deemed accurate

The Table B below shows the reduction in water stress for the French river basins following the different sensitivity analysis. Overall, no fundamental difference was observed in the results of the water stress in the year 2025 compare to the baseline scenario (EcF). Although some change can be perceived, it is only of marginal importance compared to the current water scarcity challenge. And the same results are obtained for the Spanish river basins.

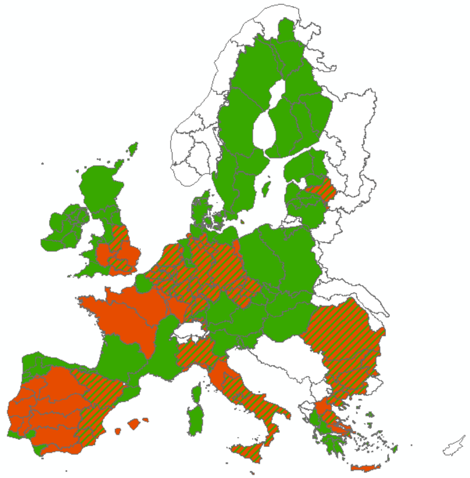
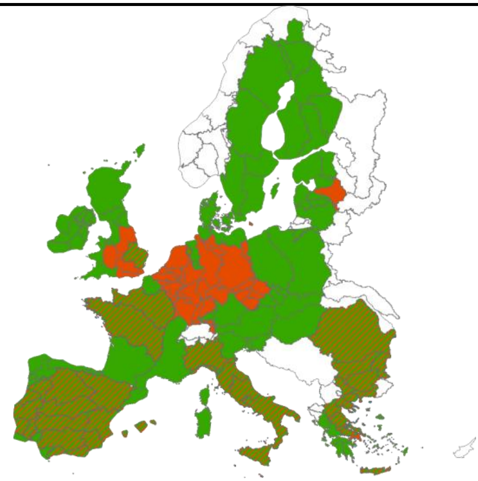
TableB. Differences between EcF, changes from the sensitivity analysis and the original results (Adaptation, and Adaptation with an additional measure restricting water abstraction quotas"cap"):

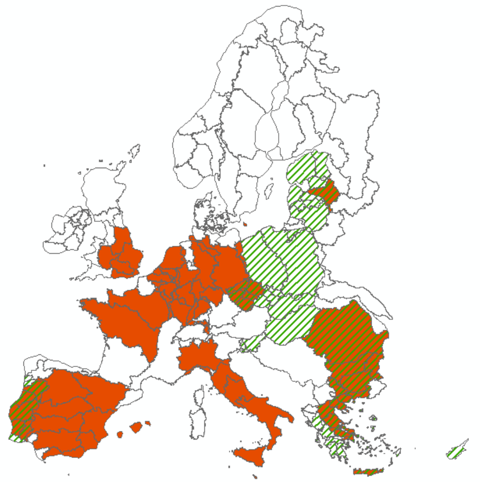
RBD/Water Stress	EcF	Sensitivity	Sensitivity + cap	Adaptation	Adaptation + cap
Escaut, Somme et cours d'eau côtiers de la Manche et de la mer du Nord	1.08	1.03		1.04	
Adour, Garonne, Dordogne, Charente et cours d'eau côtiers charentais et aquitains	0.64	0.64	0.60	0.64	0.60
Loire et cours d'eau côtiers vendéens et bretons	0.48	0.43	0.39	0.45	0.41
Seine et cours d'eau côtiers normands	0.57	0.57	0.54	0.57	0.54
Cours d'eau de la Corse	0.15	0.13		0.13	
Rhône et cours d'eau côtiers Méditerranéens	0.65	0.44	0.42	0.44	0.42

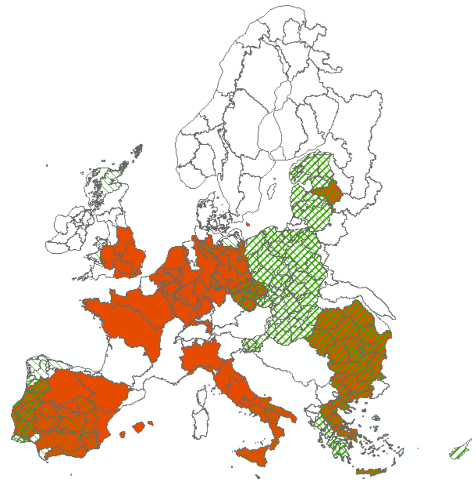
Thus, this sensivity analysis does not alter the general conclusions given above, pointing at the need for more decisive interventions, particularly more action tackling on the drivers of water scarcity.

ANNEX 4. Environmental, Social and Economic impact assessment template for individual policy areas and options

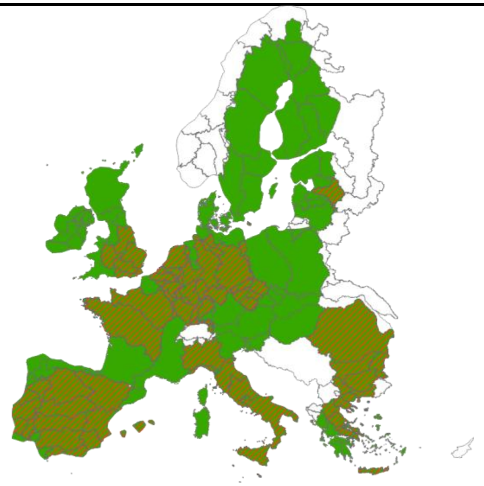
E-flows

E-Flows	
Knowledge and awareness	**Cross-compliance CAP**
	
EU Financial instruments [(1)]	**EU Financial instruments** [(2)]





WFD reform or new legislation



(1) Countries benefiting from the Cohesion Fund
(2) Regions benefiting from the Cohesion and Regional Development Fund

Indicator	Option 1 – Knowledge and Awareness raising	Option 2 – Cross-compliance between E-Flows and the CAP	Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy	Option 4 – New regulation or reform of the WFD
Spatial coverage (map)				
% of the EU territory potentially impacted by the policy option	28.6%	33.7%	31.3%	46.1%
% of the EU population potentially impacted by the policy option	40.0 +/-5%	27.2 +/-5%	25.0%	57 .3 +/-5%

Economic impact				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
Functioning of the internal market and competition	A diversity of river basins and MS are affected by this option. It is expected that new water abstraction constraints will lead to investments in water saving technologies that will limit	A limited number of river basins are affected by this option. Thus, impact on the functioning of the internal market will be marginal.	A limited number of river basins are affected by this option. Thus, impact on the functioning of the internal market will be marginal.	The same rule will apply to all EU MS. However, only high water abstractors from deficit river basins will be affected by the policy option. The impact will then be rather close to those of policy option 1.

Economic impact				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
	negative impacts on production of water-rich products. Thus, impact on the functioning of the internal market will be marginal.			
Competitiveness, trade and investment flows	Investments in water saving technologies will increase. Some negative impacts on the trade of water-rich agricultural products might arise and result in some less of competitiveness for these products.	No impact or very marginal impact is expected.	No impact or very marginal impact is expected.	Significant investments in water saving technologies are expected Europe-wide. This might result in EU business gaining importance world-wide and becoming more competitive on the international markets for water saving technology. Some negative impacts on the trade of water-rich agricultural products might arise and result in some less of competitiveness for these products.
Operating costs and conduct of business/Small and Medium Enterprises	Small farms from the concerned areas might be more affected than other farms, as they will have lower financial capacity to respond to the new challenges imposed by reduced water abstraction.	Small farms from the concerned areas might be more affected than other farms, as they will have lower financial capacity to respond to the new challenges imposed by reduced water abstraction.	Small farms from the concerned areas might be more affected than other farms, as they will have lower financial capacity to respond to the new challenges imposed by reduced water abstraction.	Small farms from the concerned areas might be more affected than other farms, as they will have lower financial capacity to respond to the new challenges imposed by reduced water abstraction.
Administrative burdens on businesses	No impact	No impact	No impact	No impact
Public authorities	Additional monitoring and enforcement burden will be imposed on public authorities in countries targeted by the policy option. Also, changes at MS level in water use	Additional monitoring and enforcement burden will be imposed on public authorities in countries targeted by the policy option. Also, changes at MS level in water use rights might be required for countries targeted by the policy option,.	Additional monitoring and enforcement burden will be imposed on public authorities in countries targeted by the policy option. Also, changes at MS level in water use rights might be required for countries	Additional monitoring and enforcement burden will be imposed on public authorities in countries targeted by the policy option. Because of the EU-wide initiative, the costs of defining the right E-Flow

Economic impact				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
	rights might be required even if only a couple of river basins are targeted by the policy option, leading to potentially significant high transaction costs for countries with only one or two basins concerned.		targeted by the policy option.	methodologies could be shared among all EU MS, thus leading to lower cost per MS/per individual public authority. Also, changes at MS level in water use rights might be required for most countries.
Property rights	Changes in water use rights might be required when existing abstraction rights are modified to comply with E-Flows. As mentioned above, even if only one or two basins from a given MS are targeted by the policy option, this might require national policy change.	Changes in water use rights will be required when existing abstraction rights are modified to comply with E-Flows.	Changes in water use rights will be required when existing abstraction rights are modified to comply with E-Flows.	Changes in water use rights will be required when existing abstraction rights are modified to comply with E-Flows.
Innovation and research	Funding to innovation and research will be limited to countries targeted by the policy option and that have a significant share of their river basins targeted. Overall, additional funding in innovation and research will be moderate, potentially targeted to sectors that might be the most affected (e.g. agriculture).	Funding to innovation and research will be limited to the search for new technologies and innovation in agricultural sector.	Funding to innovation and research will be limited to the MS targeted by the cohesion policy. However, it is expected it will remain limited in light of current funding in research and innovation in these countries facing less favorable economic conditions.	Funding to innovation and research, both at the EU scale or by MS, will increase and will be the highest among all policy options.
Consumers and households	Around a third of EU households will benefit from improvements in the ecological status of aquatic ecosystems and of the	A limited percentage of EU households (around 10%) will benefit from improvements in the ecological status of aquatic ecosystems and of the services provided by these ecosystems (including	A limited percentage of EU households will benefit from some improvements in the ecological status of aquatic ecosystems and of the services provided by these ecosystems	A larger number of EU households will benefit from improvements in the ecological status of aquatic ecosystems and of the services provided by these ecosystems

Economic impact				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
	services provided by these ecosystems (including leisure, etc.). In river basins where alternative resources might be searched for drinking water, drinking water tariffs might increase. However, this is expected to be marginal because of the priority given in MS to drinking water abstraction over other abstractors. Although changes in production costs of water-rich products might take place, it is unlikely this result in changes in products(consumer price.	leisure, etc.). Although changes in production costs of irrigated agriculture products might take place, this will result in marginal changes in products' consumer prices as a limited number of agricultural areas are concerned by the option.	(including leisure, etc.). – in basins where investments supported by cohesion funds have a significant "water" component. At the aggregated scale, this will remain marginal. Impacts on consumers and households will be very marginal and be very localised, limited to a few (agriculture) products sold in loca markets.	(including leisure, etc.). In river basins where alternative resources might be searched for drinking water, drinking water tariffs might increase. However, this is expected to be marginal because of the priority given in MS to drinking water abstraction over other abstractors. Although changes in production costs of water-rich products might take place, it is unlikely this result in significant changes in products' consumer price. Only a few products (e.g. fruits and vegetables requireding significant irrigation) might be affected.
Specific regions or sectors	As indicated in the map above, around 30% of the EU will be affected by the policy option. Most significant negative impact in these basins will be for the agricultural sector that is by far the largest water abstractor – with possible negative impacts on agro-industry. Some sectors such as fishing will benefit from the policy option.	As indicated in the map above, around 10% of the EU will be affected by the policy option. Most significant impact in these basins will be for the agricultural sector that is by far the largest water abstractor. In these regions, agro-industry might also be affected.	As indicated in the map above, around 10% of the EU will be affected by the policy option. Most significant impact in these basins will be for the agricultural sector that is by far the largest water abstractor. In these regions, agro-industry might also be affected.	As indicated in the map above, around all of the EU will be affected by the policy option. However, only water scarce basins by 2030 will see changes as other basisn are expected to be already "water balanced". Most significant impact in these basins will be for the agricultural sector that is by far the largest water abstractor. In these regions, agro-industry might also be affected. Some sectors such as fishing will benefit from the policy option.

Economic impact				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
Third countries and international relations	Impact on third countries might be limited to countries that are directly competing with EU agriculture products that are irrigated (fruits, maize…) and that will be affected by new abstraction that complies with E-Flows. Overall, as 30% of the EU area will be affected, it is expected that this impact will be positive and moderate overall (partially limited by new investments by EU farmers for new technologies), potentially significant for specific third countries such as Mediterranean countries.	Impact on third countries might be limited to countries that are directly competing with agriculture products that are irrigated (fruits, maize…). Overall, it will remain marginal minimal because of the small share of the EU that is targeted by this polity option.	Impact on third countries might be limited to countries that are directly competing with agriculture products that are irrigated (fruits, maize…). Overall, it will remain marginal minimal because of the small share of the EU that is targeted by this polity option.	Impact on third countries might be limited to countries that are directly competing with EU agriculture products that are irrigated (fruits, maize…) and that will be affected by new abstraction that complies with E-Flows. Overall, this is expected to be similar than for the Option 1 (as additional river basins concerned by this option have limited irrigated) for most crops, apart for cereals which aggregated EU impact might be slightly higher than for option 1. Third countries that are producting water saving technologies might be negatively affected.
Macroeconomic environment	As a third of Europe will be affected by the policy option, some macro-economic impacts might be expected	No impact		As all river basins wih water scarcity will be affected by the policy option, some macro-economic impacts might be expected

Social impacts				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
Employment and labour markets	Some impacts might be expected for temporary labor employed on farms and for some agro-industry sectors.	No or marginal impact might be expected for temporary labor employed on farms and for some agro-industry sectors	No or very localized impact.	Some impacts might be expected for temporary labor employed on farms and for some agro-industry sectors.
Standards and rights related to job quality	No impact	No impact	No impact	No impact
Social inclusion and protection of particular groups	Restoring the quality of aquatic ecosystems everywhere might increase the access to services provided by these ecosystems by a wider group.	No impact	No impact	Restoring the quality of aquatic ecosystems everywhere might increase the access to services provided by these ecosystems by a wider group.
Gender equality, equality treatment and opportunities, non - discrimination	No impact	No impact	No impact	No impact
Individuals, private and family life, personal data	No impact	No impact	No impact	No impact

Governance, participation, good administration, access to justice, media and ethics	No impact[99]	No impact	No impact	No impact
Public health and safety	The establishment of E-flows will limit periods with low river water quality, limiting health risks for bathing, drinking, leisure, crop irrigation. Due to existing standards and controls in the EU, this impact is expected to be moderate.	No impact to very localized.	No impact to very localized.	The establishment of E-flows will limit periods with low river water quality, limiting health risks for bathing, drinking, leisure, crop irrigation. Due to existing standards and controls in the EU, this impact is expected to be moderate.
Crime, Terrorism and Security	No impact	No impact	No impact	No impact
Access to and effects on social protection, health and educational systems	No impact	No impact	No impact	No impact
Culture	No impact	No impact	No impact	No impact
Social impacts in third countries	Positive social impacts can be expected from developing countries who will see their competitive advantage increased, and be able to sell larger quantity of (mainly agriculture) products	No impact (see too limited area targeted by the option)	No impact	Positive social impacts can be expected from developing countries who will see their competitive advantage increased, and be able to sell larger quantity of (mainly agriculture) products in the EU

[99] The transparency and the process put in place for defining E-Flows might however be important. It is expected however that it will follow the general governance in place in individual MS. Thus, the establishment of E-flows will not in itself impact governance.

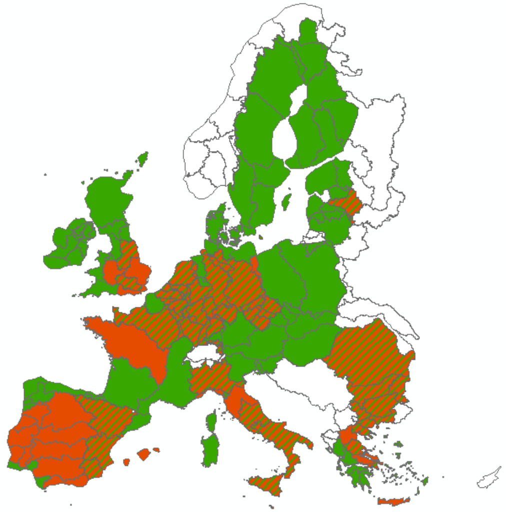
	in the EU market – with a marginal contribution to their job markets. However, this is expected to remain marginal.			market – with a marginal contribution to their job markets. However, this is expected to remain marginal.

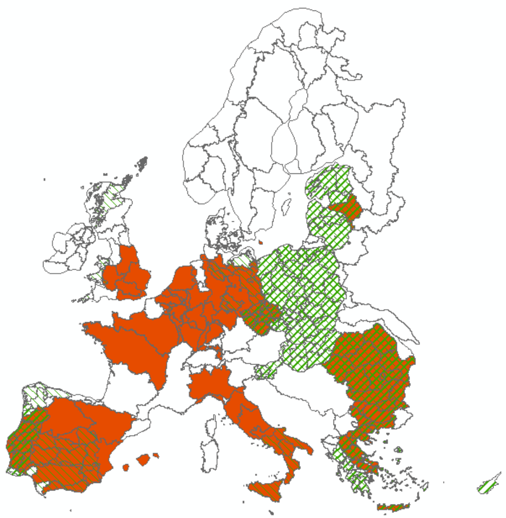
Environmental impacts				
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between E-Flows and the CAP**	**Option 3: Introducing E-flow related criteria into project selection under Cohesion Policy**	**Option 4 – New regulation or reform of the WFD**
The climate				
Transport and the use of energy	Water savings that results from the establishment of E-flows can lead to energy savings (for households). However, this will remain limited to the river basin affected. Overall, the energy use reduction will remain marginal as compared to overall energy use in Europe.	No impact	No impact	Water savings that results from the establishment of E-flows can lead to energy savings (for households). However, this will remain limited to the river basin affected. Overall, the energy use reduction will remain marginal in relative terms as compared to overall energy use in Europe.
Air quality	No impact	No impact	No impact	No impact
Biodiversity, flora, fauna and landscapes	The biodiversity of aquatic and connected ecosystems (e.g. wetlands) will be significantly improved for the river basins affected by the policy option. The overall impact for the EU will be moderate.	The biodiversity of aquatic and connected ecosystems (e.g. wetlands) will be significantly improved for the river basins affected by the policy option. The overall impact for the EU will be marginal to moderate.	The biodiversity of aquatic and connected ecosystems (e.g. wetlands) will be significantly improved for the river basins targeted by cohesion funds of projects with significant water dimension.. The overall impact for the EU will marginal.	The biodiversity of aquatic and connected ecosystems (e.g. wetlands) will be significantly improved for the river basins affected by the policy option. The overall impact for the EU will be moderate.
Water quality and resources	River water quality will improve for river basins for which E-Flows will be defined.	River water quality will improve for river basins for which E-Flows will be defined.	River water quality will improve for river basins for which E-Flows will be defined.	River water quality will improve for river basins for which E-Flows will be defined.
Soil quality or resources	Some positive impacts on soil quality might take place if reduction in agricultural water abstraction leads	Some positive impacts on soil quality might take place if reduction in agricultural water abstraction leads	No impact	Some positive impacts on soil quality might take place if reduction in agricultural water abstraction leads

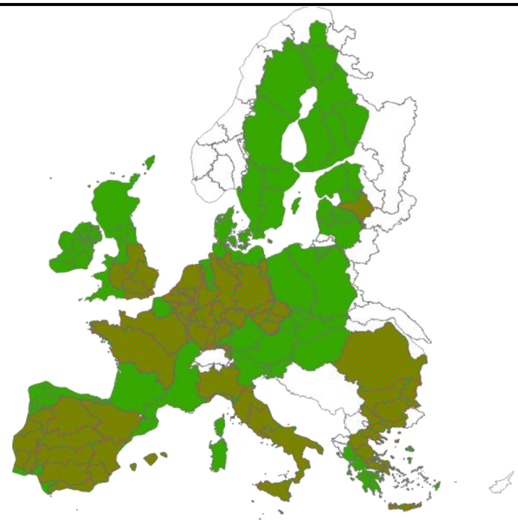
	to less intensive farming – which will be the case only for some farming systems/farmers/river basins. Overall, the impact will remain marginal.	to less intensive farming.		to less intensive farming. Overall, the impact will remain marginal.
Land use	More extensive farming might develop in areas where severe water abstraction limits are established. This might lead to overall positive impacts in terms of land use. At the aggregated level, this is likely to have a marginal impact.	More extensive farming might develop in areas where severe water abstraction limits are established. This might lead to overall positive impacts in terms of land use. Because of the limited area targeted by this policy option, no overall impact is expected.	More extensive farming might develop in areas where severe water abstraction limits are established. This might lead to overall positive impacts in terms of land use. Because of the limited area targeted by this policy option, no overall impact is expected.	More extensive farming might develop in areas where severe water abstraction limits are established. This might lead to overall positive impacts in terms of land use. At the aggregated level, this is likely to have a marginal impact.
Renewable or non-renewable resources	The definition of E-Flows could affect the management of hydro-power plants for the river basins targeted. Overall, the expected impact on hydro-power production is expected to be marginal, possible losses in hydropower production being compensated by investments in new or additional turbines for making the best of the existing production potential.	No impact	No impact (would affect only cohesion funding in the hydropower sector)	The definition of E-Flows could affect the management of hydro-power plants for the river basins targeted. Overall, the expected impact on hydro-power production is expected to be marginal, possible losses in hydropower production being compensated by investments in new or additional turbines for making the best of the existing production potential.
The environmental consequences of firms and consumers	This depends on the environmental consequences of producing with new water-saving technologies. It is expected that less intensive agriculture will replace locally intensive agriculture: this will result in some (although limited) use of fertilizers and other inputs, with a positive environmental impact.	This depends on the environmental consequences of producing with new water-saving technologies. It is expected that less intensive agriculture will replace locally intensive agriculture: this will result in some (although limited) use of fertilizers and other inputs, with a positive environmental impact.	No impact expected	This depends on the environmental consequences of producing with new water-saving technologies. It is expected that less intensive agriculture will replace locally intensive agriculture: this will result in some (although limited) use of fertilizers and other inputs, with a positive environmental impact.
Waste production / generation / recycling	This will depend on the quantity of waste produced from new water-saving technologies (e.g. drip using large amounts of plastics). Can be (negatively) moderate in river basins affected, but marginal when taking a	No impact to marginal negative impact	No impact	This will depend on the quantity of waste produced from new water-saving technologies (e.g. drip using large amounts of plastics). Can be negatively moderate in river basins affected, thus moderate overall in

	European view.			Europe.
The likelihood or scale of environmental risks	The establishment of E-flows might impact on the management of large storage dams, thus with expected positive impacts for flood management.	No impact expected.	No impact expected.	The establishment of E-flows might impact on the management of large storage dams, thus with expected positive impacts for flood management.
Animal welfare	No impact	No impact	No impact	No impact
International environ-mental impacts	No impact	No impact	No impact	No impact

Efficiency targets

Efficiency targets	
Knowledge and awareness	**Cross-compliance CAP**
	
EU Financial instruments	**WFD reform or new legislation**





Indicator	Option 1 – Voluntary implementation through common guidance and best practice sharing	Option 2 – Cross-compliance for EU financing instruments	Option 3- Mandatory application of efficiency targets through new regulation
Spatial coverage (map)			
% of the EU territory potentially impacted by the policy option	31.6%	31.3%	46.1%
% of the EU population potentially impacted by the policy option	44.5 +/- 5%	25.0%	57 .3 +/-5%

Economic impact			
Issues	**Option 1 – Voluntary implementation through common guidance and best practice sharing**	**Option 2 - Cross-compliance for EU financing instruments**	**Option 3 – Mandatory application of efficiency targets through new regulation.**
Functioning of the internal market and competition	Companies that qualify for the Blue Award will most likely also benefit through increased value added and the positive response by consumers. However, one important concern is that while marketing opportunities encourage companies to commit to producing more water efficient products, it might hinder the innovation process. If efficiency criteria are not continuously evaluated and updated, there is little incentive for manufacturers to improve performance beyond the specification of current standards (GTZ et al, 2006 in Bios, 2009). Overall, the introduction of an "EU Water Efficiency Award" is most likely to lead on the one hand to a considerable increase in companies using the label and will also increase the number of consumers that will know about it. It also has the potential to increase the use of water saving criteria in public procurement. A recent impact assessment of the EU Eco-label – an initiative to introduce water and energy minimum standards – concluded that such an Eco-label can have net economic benefits for the EU economy and increase both competition and competitiveness (AEAT, 2004). The EU Water Efficiency Award is likely to produce a similar outcome.	No impact expected	No impact expected
Competitiveness, trade and investment flows	Improved water use efficiency of appliances will make EU firms producing such appliance more competitive on the market.	No impact expected	No impact expected

Operating costs and conduct of business/Small and Medium Enterprises	Business will incur costs through marketing of their new and/or improve water using appliances. However, the costs of marketing will most likely be recouped through sales and increased prices for appliance.	This option could greatly affect the investment cycle of structural funds in less economically developed regions in the EU. In the 2000-2006 period, the Regional Development Fund spent €25.5 billion on environment-related interventions, including water supply. In addition, the ex-post evaluation of Structural Funds between 2000-2006 found that funding especially targeted small and medium sized enterprises and start-ups (EC, 2011). Such investments could be greatly reduced if water scarce areas cannot ensure a water balance for new projects.	The mandatory option through a new Directive has the largest potential to result in water savings. The incentive for manufacturers to increase efficiency of their products is highest in this case, creating more competition within the market and providing more choice to the consumer compared to voluntary approaches (Bios, 2009). However, operating costs could potentially increase for firms that need to implement water saving appliances or other water efficiency measures in order to comply with the Directive
Administrative burdens on businesses	Labelling will result in an increase in administrative burden for companies. They will have to make sure they are complying with criteria in order to apply for the Eco-label.	Businesses that are involved in projects funded by Structural Funds would have to learn the new rules and be subject to a water balance analysis, thus requiring new knowledge and expertise. The burden would not be significant	The mandatory nature of a new Directive would significantly increase the administrative burden of businesses. They would have to learn the new rules and make changes in order to be in compliance.
Public authorities	This policy option would lead to minor increases in administrative burden through the development of criteria for the award as well as time spent evaluating companies that apply for the award.	This policy option will require changes to the existing regulations governing structural and cohesion funding. It will also require increased administrative capacity to deal with the new changes. Construction projects dealing with water supply already require public authorities to tender or carry out themselves environmental impact assessments. The introduction of the concept of water balance or maintaining environmental flows in water scarce areas would increase government administration burden in so far as these water management issues are not yet taken into account in impact assessments.	At EU level, a legislative framework is already place with the EcoDesign Directive. This can serve as a basis to establish a Water Efficiency Directive. Introducing a penalty system is associated with high costs, for example for monitoring and enforcement.
Property rights	No impacts foreseen	No impacts foreseen	No impacts foreseen
Innovation and research	The policy option considered will likely increase the investment into research and boost innovation in water saving technology or application, as well as boost cooperation	The policy option considered will likely increase the share of Cohesion Funding that goes towards supporting the investment into research and boost innovation in water saving technology or	One of the drawbacks of mandatory standards is that they offer little incentive for innovation. They have to be constantly revised and updated to ensure that companies move beyond existing

	between research and the private sector.	application. One of the drawbacks of mandatory standards is that they offer little incentive for innovation. They have to be constantly revised and updated to ensure that companies move beyond existing standards (Bios, 2009).	standards (Bios, 2009).
Consumers and households	Through the Eco-label, consumers will have better access to water efficient appliances. They will benefit from competition between businesses to produce more efficient appliances. These appliances, however, may be more expensive but the savings incurred will outweigh the extra costs.	No impacts foreseen	Mandatory approaches provide higher incentives for manufacturers to increase the efficiency of their products, creating more competition within the market and providing more choice to the consumer compared to voluntary approaches (Bios, 2009). The consumers are likely to be little affected, but there might be cases that prices increase in particular if only a regional market exists.
Specific regions or sectors	Regions with a higher share of water abstraction for industry compared to other sectors, for example agriculture, will benefit more from increased uptake of BAT through voluntary agreements than compared to regions where industrial water abstraction is lower.	Structural and Cohesion Funds are only applicable in certain regions. Requiring that structural fund projects adhere to mandatory efficiency targets disproportionally affects those regions that need Cohesion funding to carry out such projects. Regions that implement similar projects without the use of Cohesion funding would not have to comply with these rules.	The benefit of a mandatory approach that sets minimum targets at EU level is that it harmonises approaches across the MS and reduces regional differences. Therefore, regions and sectors are affected similarly. On the other hand, regions or MS where no minimum standards, whether voluntary or mandatory, will be disproportionately affected as industry in these areas will have to spend more money to be in compliance with new standards. Another issue that they will mostly likely be low acceptance of such a Directive in countries where there are no water quantity problems.
Third countries and international relations	No impacts foreseen	No impacts foreseen	No impacts foreseen

Macroeconomic environment	No impact expected		

SOCIAL IMPACTS			
Issues	**Option 1 – Voluntary implementation through common guidance and best practice sharing**	**Option 2 - Cross-compliance for EU financing instruments**	**Option 3 – Mandatory application of efficiency targets through new regulation.**
Employment and labour markets	No impacts foreseen	No impacts foreseen	No impacts foreseen
Standards and rights related to job quality	No impacts foreseen	No impacts foreseen	No impacts foreseen
Social inclusion and protection of particular groups	The use of awards and labelling makes the public more informed about water	The use of awards and labelling makes the public more informed about water	The use of awards and labelling makes the public more informed about water
Gender equality, equality treatment and opportunities, non - discrimination	No impacts foreseen	No impacts foreseen	No impacts foreseen
Individuals, private and family life, personal data	No impacts foreseen	No impacts foreseen	No impacts foreseen

Governance, participation, good administration, access to justice, media and ethics	No impacts foreseen	No impacts foreseen	No impacts foreseen
Public health and safety	Public health will be affected only indirectly. In domestic sector, the lower water consumption will increase the effectiveness of waste water treatment plants (pollutants at higher concentration in brackish waters can be removed more easily). However, in cases of distribution systems dimensioned for large water demand, problems might arise when demand is significantly reduced. This might require specific management responses from water supply companies to ensure no additional health risk takes place.	Public health will be affected only indirectly. In domestic sector, the lower water consumption will increase the effectiveness of waste water treatment plants (pollutants at higher concentration in brackish waters can be removed more easily). However, in cases of distribution systems dimensioned for large water demand, problems might arise when demand is significantly reduced. This might require specific management responses from water supply companies to ensure no additional health risk takes place.	Public health will be affected only indirectly. In domestic sector, the lower water consumption will increase the effectiveness of waste water treatment plants (pollutants at higher concentration in brackish waters can be removed more easily). However, in cases of distribution systems dimensioned for large water demand, problems might arise when demand is significantly reduced. This might require specific management responses from water supply companies to ensure no additional health risk takes place.
Crime, Terrorism and Security	No impacts foreseen	No impacts foreseen	No impacts foreseen
Access to and effects on social protection, health and educational systems	No impacts foreseen	No impacts foreseen	No impacts foreseen
Culture	No impacts foreseen	No impacts foreseen	No impacts foreseen
Social impacts in third countries	No impacts foreseen	No impacts foreseen	No impacts foreseen

Environmental impacts			
Issues	**Option 1 – Voluntary implementation through common**	**Option 2 - Cross-compliance for EU financing instruments**	**Option 3 – Mandatory application of**

	guidance and best practice sharing		efficiency targets through new regulation.
The climate	The policy option will lead to a reduction of greenhouse gases emissions by reducing the energy needed to treat and convey water. By reducing the water demand or making the water use more (socially) beneficial, the communities will be able to prepare for drought spells that may increase in intensity and frequency as the climate change becomes more pronounced. A Study from Australia indicates that the use of water appliances with a rating 1 point higher for water and ½ point higher for energy can amount to annual savings of 80,000 tonnes of CO2 and 22ML of water. Using less water or water more efficient will also increase the resilience of urban areas and companies against climate change.	The policy option will lead to a reduction of greenhouse gases emissions by reducing the energy needed to treat and convey water. It will also benefit communities by ensuring their water related projects are more water efficient and thus they will be more equipped to deal with changes resulting from climate change. The measure is also an adaptation measure towards climate change. The impacts of droughts can be mitigated if the water is returned to the environment and stored in wetlands.	The policy option will lead to a reduction of greenhouse gases emissions by reducing the energy needed to treat and convey water. By reducing the water demand or making the water use more (socially) beneficial, the communities will be able to prepare for drought spells that may increase in intensity and frequency as the climate change becomes more pronounced. An assessment of the water consumption of household appliances indicates that setting water efficient standards for these appliances could result in a potential 20% reduction in water heater use, or .59% of total EU primary energy supply. Introducing mandatory water saving measures would therefore correspond to yearly CO_2 savings of approximately 2.89 $MtCO_{2eq}$ if these water appliances are replaced with more efficient ones. The measure is also an adaptation measure towards climate change.
Transport and the use of energy	No impact foreseen	No impact foreseen	No impact foreseen
Air quality	No impact foreseen	No impact foreseen	No impact foreseen
Biodiversity, flora, fauna and landscapes	No impact foreseen	No impact foreseen	No impact foreseen

Water quality and resources	A study[100] on the benefits of the European Ecolabel – which sets specifications for certain water using appliance – estimated the following potential water savings based on potential sales data: • For washing machines, savings were forecast to be approximately 396 312 300 litres per year (based on 5% uptake), 1,585,249,200 litres/year (based on 20% uptake) and 3,963,122,900 litres per year (based on 50% uptake) • For dishwaters, savings were forecast to be approximately 20,185,400 litres/year (based on 5% uptake), 80,741,800 litres/year (based on 20% uptake) and 201,854,400 litres/year (based on 50% uptake). The introduction of and "EU Water Efficiency Award" could theoretically result in similar savings so long as products are developed that meet the standards. However, the previous EU label was never awards to a washing machine and to only dishwasher, indicating very low acceptance or changes to appliance design. The policy option will lead to in some places significant amount of water saved/conserved. The effect on the groundwater and drinking water quality and availability is very positive. The introduction of and "EU Water Efficiency Award" could theoretically result in similar savings so long as products are developed that meet the standards. However, the previous EU label was never awarded to washing machines but limited to dishwasher, indicating very low acceptance or changes to appliance design. Depending on the levels at which BAT and water efficiency standards are set, efficiency gains might not	A study[101] on the benefits of the European Ecolabel – which sets specifications for certain water using appliance – estimated the following potential water savings based on potential sales data: • For washing machines, savings were forecast to be approximately 396 312 300 litres per year (based on 5% uptake), 1,585,249,200 litres/year (based on 20% uptake) and 3,963,122,900 litres per year (based on 50% uptake) • For dishwaters, savings were forecast to be approximately 20,185,400 litres/year (based on 5% uptake), 80,741,800 litres/year (based on 20% uptake) and 201,854,400 litres/year (based on 50% uptake). The introduction of and "EU Water Efficiency Award" could theoretically result in similar savings so long as products are developed that meet the standards. However, the previous EU label was never awards to a washing machine and to only dishwasher, indicating very low acceptance or changes to appliance design. The policy option will lead to in some places significant amount of water saved/conserved. The effect on the groundwater and drinking water quality and availability is very positive.	Mandatory targets would involve the replacement of all main water using appliances in commercial and industrial buildings. An assessment of similar mandatory requirements indicated that this could result in a total reduction of 14.8% of the annual EU public water supply or approximately 6.1 trillion litres of water (Bios, 2009); dishwashers and washing machines were excluded from this estimate.

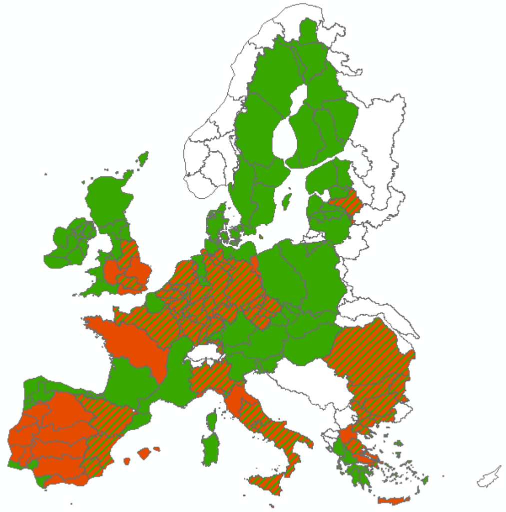
100 AEAT (2004): The direct and indirect benefits of the European Ecolabel.

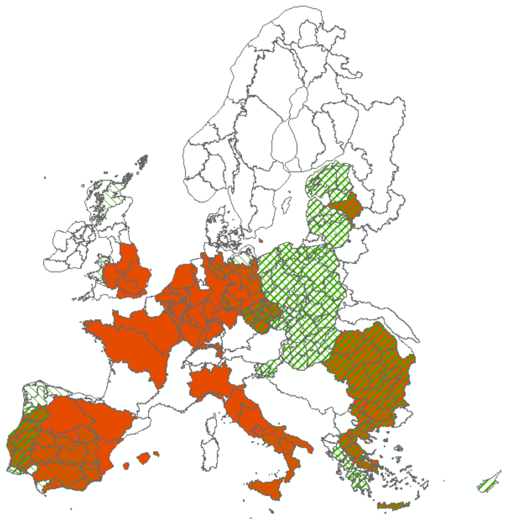
101 AEAT (2004): The direct and indirect benefits of the European Ecolabel.

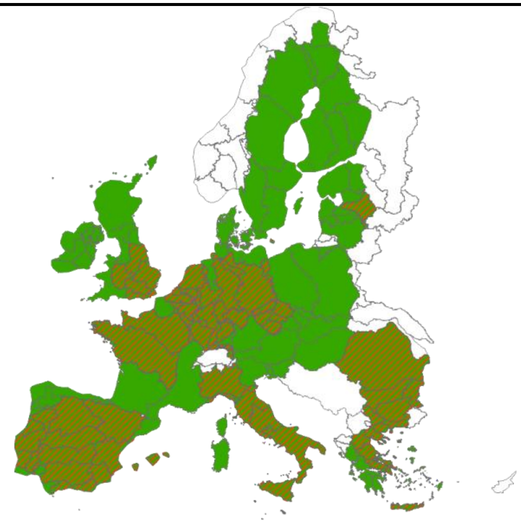
	be sufficient for achieving water balance in river basins with severe water deficit today. For example, in some river basins in France, reduction in agricultural water demand by 80% are required to re-establish E-Flows, a reduction that cannot be achieved by any water efficiency improvement in irrigation systems.		
Soil quality or resources	No impacts foreseen	No impacts foreseen	No impacts foreseen
Land use	Impact on land use changes is likely to be low. Indirect benefits are possible given that measures to enhance water us efficiency can help to reduce pressure in water scarce basins, thus positively impacting the water environment.	Impact on land use changes is depending on the type of project affected. E.g. in some cases new irrigation project will not be funded which will limit the further development of the agricultural sector (which is a major land user). The retuned water might add value to other sectors using land (e.g. increased recreational values).	Impact on land use changes is likely to be low. Indirect benefits are possible given that measures to enhance water us efficiency can help to reduce pressure in water scarce basins, thus positively impacting the water environment.
Renewable or non-renewable resources	No impacts foreseen	No impacts foreseen	No impacts foreseen
The environmental consequences of firms and consumers	See information on Water Quality and Resources	See information on Water Quality and Resources	See information on Water Quality and Resources
Waste production / generation / recycling	No impacts foreseen	No impacts foreseen	No impacts foreseen
The likelihood or scale of	No impacts foreseen	No impacts foreseen	No impacts foreseen

environmental risks			
Animal welfare	No impacts foreseen	No impacts foreseen	No impacts foreseen
International environ-mental impacts	No impacts foreseen	No impacts foreseen	No impacts foreseen

Economic incentives for efficient water use

Economic instruments	
Knowledge and awareness	**Cross-compliance CAP**
	
EU Financial instruments	**WFD reform or new legislation**





Indicator	Option 1 – Knowledge and awareness raising	Option 2 – Cross-compliance for EU financing instruments	Option 3- Reform of the WFD or new regulation
Spatial coverage (map)			
% of the EU territory potentially impacted by the policy option	31.6%	31.3%	46.1%
% of the EU population potentially impacted by the policy option	44.5 +/- 5%	25.0%	57 .3 +/-5%

Economic impacts			
Issues	**Option 1 – Knowledge and awareness raising**	**Option 2 – Cross-compliance for EU financing instruments**	**Option 3- Reform of the WFD or new regulation**
Functioning of the internal market and competition	Marginal to no impact is expected (production costs for only a few agricultural products might be affected by proposed changes). On the other hand, a higher water price should lead to a more efficient water use and, in turn, to a more efficient resource allocation at the farm level, thus improving market functioning and competition in the agricultural sector.	No impact is expected.	Marginal to no impact is expected (production costs for only a few agricultural products might be affected by proposed changes). On the other hand, a higher water price should lead to a more efficient water use and, in turn, to a more efficient resource allocation at the farm level, thus improving market functioning and competition in the agricultural sector. Limited difference as compared to option 1
Competitiveness, trade and investment flows	Marginal to no impact is expected. Trade of selected agricultural products where irrigation costs are significant as compared to total production costs (cereals) might be affected.	No impact expected	Marginal to no impact is expected. Trade of selected agricultural products where irrigation costs are significant as compared to total production costs (cereals) might be affected.
Operating costs and conduct of business/ SMEs	Possible negative impacts on agro-industry transforming water-intensive products but also milk products (importance of irrigated fodder/forage). In general, however, these are not SMEs but large businesses. Very locally, possible negative impact on farm input sellers if the application of economic instruments lead to changes in farm practices and reduced input use.	No impact expected	Possible impacts on agro-industry transforming water-intensive products but also milk products (importance of irrigated fodder/forage). In general, however, these are not SMEs but large businesses. Very locally, possible negative impact on farm input sellers if the application of economic instruments lead to changes in farm practices and reduced input use.
Administrative burdens on businesses	No administrative burden on business	No administrative burden on business	No administrative burden on business
Public authorities	Limited impact on public authorities for countries with already well established "incentive pricing structure" and "abstraction charges/taxes (studies required for defining the right incentive level, for mobilising stakeholders, for passing a new regulation, for ensuring water saved is left for the natural environment and not captured by other	No administrative burden. Possible delays however in the adoption of projects if specific requirements in terms of "water tariff incentiveness" needs to be negotiated locally?	Limited impact on public authorities for countries with already well established "incentive pricing structure" and "abstraction charges/taxes (studies required for defining the right incentive level, for mobilising stakeholders, for passing a new regulation, for ensuring water saved is left for the natural environment and not captured by other abstractors, etc.). Larger administrative burden for

	abstractors, etc.). Larger administrative burden for other MS that can be significant if the MS administration is of small size with no experience in economic instruments. In contrast, higher water prices, close to cost-recovery, will increase public revenues where water provision is administered by the public sector, decreasing public expenditures on water provision and making new funds available for maintenance and improvement of existing infrastructures.		other MS that can be significant if the MS administration is of small size with no experience in economic instruments. In contrast, higher water prices, close to cost-recovery, will increase public revenues where water provision is administered by the public sector, decreasing public expenditures on water provision and making new funds available for maintenance and improvement of existing infrastructures.
Property rights	Implementing economic instruments that lead to water saving/reduced water abstraction might be a de facto change in "water use rights". In the majority of MS, water is of a public good character with no individual property rights.	No impact – project based changes only.	Implementing economic instruments that lead to water saving/reduced water abstraction might be a de facto change in "water use rights". In the majority of MS, water is of a public good character with no individual property rights
Innovation and research	Changes in water price levels and structure to ensure incentiveness is expected to promote innovation and research in water saving techniques (e.g. new irrigation technologies, crops that are water scarcity resistant and have a better "value per drop", etc.). This will mainly be done however at the MS level, with potentially some collaboration under existing mechanisms such as IWRM.Net funding.	No particular impact expected (as project based impact that is unlikely to requires MS effort in innovation and research).	Changes in water price levels and structure to ensure incentiveness is expected to promote innovation and research in water saving techniques (e.g. new irrigation technologies, crops that are water scarcity resistant and have a better "value per drop", etc.). This will mainly be done at both the EU and MS levels, leading to higher impact on innovation and research than option 1.
Consumers and households	Water tariffs for households will increase in targeted river basins. As a result, water demand will decrease. In parallel, energy demands of households will decrease. Overall, in the medium term, reductions in water and energy bills are expected. This will imply a more efficient water use at the household level. In addition, higher revenues for water companies and/or authorities will allow more investment in maintenance and improvement of existing infrastructures, resulting in improved water services for households. Consumers of water intensive products might be indirectly affected, as producers (farmers, industry) pass their cost increase to the final	Water tariffs for beneficiaries of projects funded by the EU instruments will be affected. However, it is expected that targeted groups will be marginal as compared to the entire population of the MS that will be affected by this option.	Water tariffs for households will increase in targeted river basins. As a result, water demand will decrease. In parallel, energy demands of households will decrease. Overall, in the medium term, reductions in water and energy bills are expected. This will imply a more efficient water use at the household level. In addition, higher revenues for water companies and/or authorities will allow more investment in maintenance and improvement of existing infrastructures, resulting in improved water services for households. Consumers of water intensive products might be indirectly affected, as producers (farmers, industry) pass their cost increase to the final consumers. However, in the current internal market and with

	consumers. However, in the current internal market and with the existing competition, this impact is expected to be marginal – and limited to specific products (e.g. agricultural products like fruits/vegetables produced at specific periods of time with limited competition) and to local markets.		the existing competition, this impact is expected to be marginal – and limited to specific products (e.g. agricultural products like fruits/vegetables produced at specific periods of time with limited competition) and to local markets.
Specific regions or sectors	All river basins specified in the map above and with significant water stress will be affected. Agriculture as largest water user will be the sector the most affected. Reduction in farm income will take place, leading to possible negative (short-term) impacts (locally) on agro-business. On the other hand, higher water prices should lead to a more efficient water use and, in turn, to a more efficient resource allocation at the farm level, thus improving market functioning and competition in the agricultural sector.	Impacts will be limited to specific projects, thus unlikely to be important at the sector scale of for specific regions. The instrument is expected not to affect the implementation of projects but adapt their financial sustainability and ensure water is used efficiently.	Agriculture as largest water user will be the sector the most affected. Reduction in farm income will take place, leading to possible negative (short-term) impacts (locally) on agro-business. Although the focus is on water scarce river basins, it is expected that other river basins will also be affected – in particular if MS decide to promote water abstraction charges/taxes that are usually adopted and specified at the MS level. On the other hand, higher water prices should lead to a more efficient water use and, in turn, to a more efficient resource allocation at the farm level, thus improving market functioning and competition in the agricultural sector.
Third countries and international relations	Third countries producing agricultural products that compete with EU products might benefit from this. This will be limited however to some crops/agricultural products that depend significantly on irrigation (e.g. strawberry), or for which irrigation costs represent an important part of total agricultural production costs (e.g. irrigated wheat). As compared to the overall international relations, this will be marginal.	No impact expected	Third countries producing agricultural products that compete with EU products might benefit from this. This will be limited however to some crops/agricultural products that depend significantly on irrigation (e.g. strawberry), or for which irrigation costs represent an important part of total agricultural production costs (e.g. irrigated wheat). As compared to the overall international relations, this will be marginal.
Macroeconomic environment	Marginal impact expected	No impact	Marginal impact expected

Social impacts			
Issues	**Option 1 – Knowledge and awareness raising**	**Option 2 – Cross-compliance for EU financing**	**Option 3- Reform of the WFD or new regulation**

		instruments	
Employment and labour markets	Marginal and very localized impacts on the labour market might be expected, in particular for temporary labour involved in farm activities (harvesting/picking e.g.) and labour for agro-industry.	No impact	Marginal and very localized impacts on the labour market might be expected, in particular for temporary labour involved in farm activities (harvesting/picking e.g.) and labour for agro-industry.
Standards and rights related to job quality	No impact	No impact	No impact
Social inclusion and protection of particular groups	No impact	No impact	No impact
Gender equality, equality treatment and opportunities, non -discrimination	Some marginal impacts might take place if there is a gender-bias in the labour affected by the instrument.	No impact	Some marginal impacts might take place if there is a gender-bias in the labour affected by the instrument.
Individuals, private and family life, personal data	No impact	No impact	No impact
Governance, participation, good administration, access to justice, media and ethics	The establishment of "incentive economic instruments" leading to a fair use of water by all, including agriculture (often exempted or benefiting today from lower water tariffs or exemptions in water abstraction taxes in some countries), is expected to indirectly strengthen the governance of water management. In addition, some of the financial revenues collected could support governance activities and facilitate the involvement of all stakeholders in participatory water	No impact expected as the change is project-based. In the medium term, the new approach taken for projects that are supported by EU funds could become the rule and be considered in other parts of the country.	The establishment of "incentive economic instruments" leading to a fair use of water by all, including agriculture (often exempted or benefiting today from lower water tariffs or exemptions in water abstraction taxes in some countries), is expected to indirectly strengthen the governance of water management. In addition, some of the financial revenues collected could support governance activities and facilitate the involvement of all stakeholders in participatory water management.

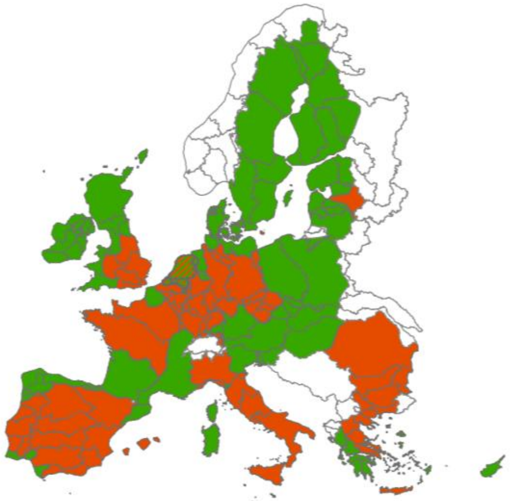
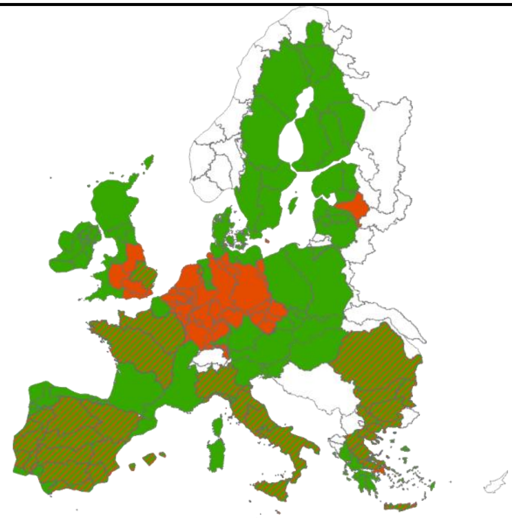
	management.		
Public health and safety	Improvements in the state of rivers (as more water will be left for the environment leading to dilution of existing pollutants) will have positive impacts for the beneficiaries of these rivers (bathers, fishermen, etc.)	Improvements in the state of rivers (as more water will be left for the environment leading to dilution of existing pollutants) will have positive impacts for the beneficiaries of these rivers (bathers, fishermen, etc.). However, this will be very marginal as only river reaches nearby funded projects will be affected.	Improvements in the state of rivers (as more water will be left for the environment leading to dilution of existing pollutants) will have positive impacts for the beneficiaries of these rivers (bathers, fishermen, etc.). Expected impacts will be higher than for option 1.
Crime, Terrorism and Security	No impact	No impact	No impact
Access to and effects on social protection, health and educational systems	No impact	No impact	No impact
Culture	No impact	No impact	No impact
Social impacts in third countries	No impact	No impact	No impact

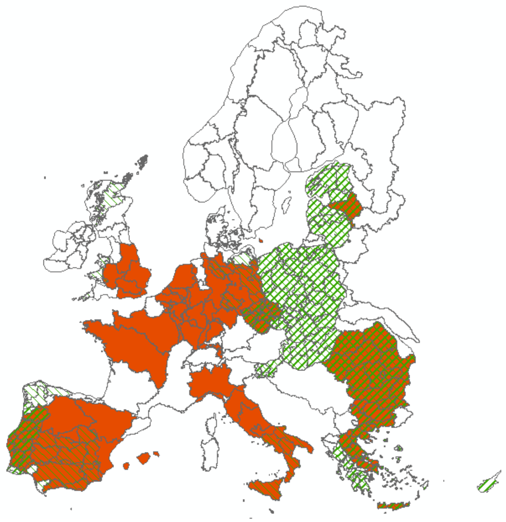
Environmental impacts			
Issues	**Option 1 – Knowledge and awareness raising**	**Option 2 – Cross-compliance for EU financing instruments**	**Option 3- Reform of the WFD or new regulation**
The climate	By reducing water consumption, societies will enhance their adaptability to climate change. At the same time, reduced water consumption will be accompanied by a reduction in energy use, thus contributing to strategies for tackling climate change.	Marginal impact expected	By reducing water consumption, societies will enhance their adaptability to climate change. At the same time, reduced water consumption will be accompanied by a reduction in energy use, thus contributing to strategies for tackling climate change.

	In some cases, reduction in water use will avoid putting in place new high-energy use options for capturing water resources such as desalination along the coast. Overall, this impact will remain marginal as compared to energy use in MS.		In some cases, reduction in water use will avoid putting in place new high-energy use options for capturing water resources such as desalination along the coast. Overall, this impact will remain marginal as compared to energy use in MS.
Transport and the use of energy	Reduced water consumption will be accompanied by a reduction in energy use, thus contributing to strategies for tackling climate change. In some cases, reduction in water use will avoid putting in place new high-energy use options for capturing water resources such as desalination along the coast. Overall, this impact will remain marginal as compared to energy use in MS.	Localised impact expected	Reduced water consumption will be accompanied by a reduction in energy use, thus contributing to strategies for tackling climate change. In some cases, reduction in water use will avoid putting in place new high-energy use options for capturing water resources such as desalination along the coast. Overall, this impact will remain marginal as compared to energy use in MS.
Air quality	Marginal impact because of reduced energy use	No or localized impact expected	Marginal impact because of reduced energy use
Biodiversity, flora, fauna and landscapes	The reduction in water demand will leave more water into the aquatic ecosystems, this having a significant positive impact on biodiversity for these ecosystems and connected ecosystems (wetlands, terrestrial ecosystems).	The reduction in water demand will leave more water into the aquatic ecosystems, this having a significant positive impact on biodiversity for these ecosystems and connected ecosystems (wetlands, terrestrial ecosystems).	The reduction in water demand will leave more water into the aquatic ecosystems, this having a significant positive impact on biodiversity for these ecosystems and connected ecosystems (wetlands, terrestrial ecosystems).
Water quality and resources	Water quality will improve as more water will be left for the environment. This option is in fact expected to result in more efficient water use, improving water efficiency and reducing wasteful use, especially in the agricultural sector, which is responsible for about 70% of total water use.	Water quality will improve as more water will be left for the environment. However, this impact will be very localised in the vicinity of projects funded by the EU financing instruments.	Water quality will improve as more water will be left for the environment. This option is in fact expected to result in more efficient water use, improving water efficiency and reducing wasteful use, especially in the agricultural sector, which is responsible for about 70% of total water use.
Soil quality or resources	Some positive impacts on soil quality might take place if reduction in agricultural water abstraction leads to less intensive farming – which will be the case only for some farming systems/farmers/river basins. Overall, the impact will remain marginal.	No or very localized impacts	Some positive impacts on soil quality might take place if reduction in agricultural water abstraction leads to less intensive farming – which will be the case only for some farming systems/farmers/river basins. Overall, the impact will remain marginal.
Land use	More extensive farming might develop in areas where severe water abstraction limits are established. This might lead to overall positive impacts in terms of land use. At the aggregated level, this is likely to have a marginal impact.	No or very localized impacts	More extensive farming might develop in areas where severe water abstraction limits are established. This might lead to overall positive impacts in terms of land use. At the aggregated level, this is likely to have a marginal impact.
Renewable or non-renewable resources	The definition of E-Flows could affect the management of hydro-power plants for the river basins targeted. Overall, the expected impact on	No or very localized impacts	The definition of E-Flows could affect the management of hydro-power plants for the river basins targeted. Overall, the expected impact on hydro-power production is

	hydro-power production is expected to be marginal, possible losses in hydropower production being compensated by investments in new or additional turbines for making the best of the existing production potential.		expected to be marginal, possible losses in hydropower production being compensated by investments in new or additional turbines for making the best of the existing production potential.
The environmental consequences of firms and consumers	This depends on the environmental consequences of producing with new water-saving technologies. It is expected that less intensive agriculture will replace locally intensive agriculture: this will result in some (although limited) use of fertilizers and other inputs, with a positive environmental impact.	No or very localized impacts	This depends on the environmental consequences of producing with new water-saving technologies. It is expected that less intensive agriculture will replace locally intensive agriculture: this will result in some (although limited) use of fertilizers and other inputs, with a positive environmental impact.
Waste production / generation / recycling	This will depend on the quantity of waste produced from new water-saving technologies (e.g. drip using large amounts of plastics). Can be (negatively) moderate in river basins affected, but marginal when taking an European view.	No or very localized impacts	This will depend on the quantity of waste produced from new water-saving technologies (e.g. drip using large amounts of plastics). Can be (negatively) moderate in river basins affected, but marginal when taking an European view.
The likelihood or scale of environmental risks	No impact	No impact	No impact
Animal welfare	No impact	No impact	No impact
International environ-mental impacts	No impact	No impact	No impact

Guiding land use to respond to water scarcity

Guiding land use to respond to water scarcity	
Knowledge and awareness	**Cross-compliance CAP**
	
EU Financial instruments	**WFD reform or new legislation**



Indicator	Option 1 – Knowledge and Awareness raising	Option 2 – Cross-compliance between water scarcity and the CAP	Option 3: Introducing water-related criteria into project selection under Cohesion Policy
Spatial coverage (map)			
% of the EU territory potentially impacted by the policy option	0.8%	33.7%	31.3%
% of the EU population potentially impacted by the policy option	3.0%	27.2 +/-5%	25.0%

Economic impact			
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between water scarcity and the CAP**	**Option 3: Introducing water-related criteria into project selection under Cohesion Policy**
Functioning of the internal market and competition	No impact	Due the GAEC some local products might disappear (seasonally) giving new opportunities to new suppliers. However no impact or limited impact of such a new GAEC on competitiveness in the internal market is expected (Alliance Environment, 2007).	No impact expected
Competitiveness, trade and investment flows	No impact	Within the EU's common market, cross compliance should help to ensure that internal competitiveness is more consistent as all farms become compliant with legal requirements. However there is no doubt that the task of assessing the relative competitiveness of a farm, a sector or a Member State is immensely difficult, not least because the various costs need to be aggregated, and the precise contribution of cross compliance to these costs disaggregated (to Farmer, 2007). No information on the trade and investment flows within the EU was found, but it can be assumed that large agro-industrial companies might invest in those areas where water is not a limiting factor. However this would be the case with or without this GAEC.	No impact expected
Operating costs and conduct of business/Small and Medium Enterprises	In most Member States, making use of farm advisory services leads to costs. Some Member States offer partial payment of these services under their RDPs (measure 114) between 50% and 80% and usually with a maximum threshold (e.g. no more than 1,500€) (Berglund and Dworak, 2009): • Estonia: Farmers can apply for a subsidy of up to 80% of eligible expenses for advisory services but not more than 1500€/year • In the Netherlands, Wales and Denmark the support for farmers is 50% of the costs of using FAS	The GAEC will clearly put some additional administrative and financial burden on business. New investments into water saving technology but also new machinery (because of new crops with less water demand to be grown) might be needed. The introduction of on-farm harvesting and storage of rainwater as an adaptation to less allowed abstraction might also trigger additional costs. While the necessary capital outlay may appear modest (e.g. adding guttering to the roofs of farm buildings and collecting water in an earth-banked reservoir), farm incomes and profits in many parts of the EU are not currently sufficient to finance such a measure (AEA, 2007). Energy costs (an important cost factor in irrigation) will decrease. Arable farms will be less impacted than mixed farms. The initial costs arising only from obligations newly introduced by cross compliance, are stated to be substantial in some cases for farmers (and the authorities). Some of these costs may be considered as start-up costs which will reduce once the system is fully up and running (Alliance Environment, 2007).	This option could greatly affect the investment cycle of structural funds in less economically developed regions in the EU. In the 2000-2006 period, the Regional Development Fund spent €25.5 billion on environment-related interventions, including water supply. In addition, the ex-post evaluation of Structural Funds between 2000-2006 found that funding especially targeted small and medium sized enterprises and start-ups (EC, 2001). Such investments could be greatly reduced if water scarce areas cannot ensure a water balance for new projects.

	• Latvia: the maximum rate of support is 60% but not more than 1000€ Countries like Austria and England provide free advisory services so there would be no extra operating costs as a result of getting guidance through advisory services.		
Administrative burdens on businesses	Does it affect the nature of information obligations placed on businesses (for example, the type of data required, reporting frequency, the complexity of submission process)? What is the impact of these burdens on SMEs in particular?	In order to ensure that the water balance is not turned negative companies/farmers have to report their water demand. This will increase the administrative burden for them by having additional calculations and reporting requirements. (see also above)	No impact expected
Public authorities	Budgetary consequences for public authorities in implementing guidance and awareness programmes depend whether programmes already exist. The introduction of new material into existing advisory services, for example, is less costly than introducing an entirely new programme. Advisory services tend to be more expensive than awareness campaigns, both of which are not always funded by governments themselves but from private initiatives. In the agricultural sector, all countries already have advisory services in place for a range of topics, usually focusing on farm management and adherence to minimum and mandatory requirements. Depending on the country, these services are either integrated into public administrations or are managed by private advisory	Yes as there is need to develop a methodology how to define water balances and additional controls (in particular to reduce the risk of illegal abstraction) have to be carried out. Awareness arising and additional farm advice on the issue will also be needed to make farmers aware of the new rules. In cases where no local/regional authorization body for abstraction exists the option require the creation of new or restructuring of existing public authorities However it might also be that as for other cross compliance requirements this might led to greater co-ordination between existing control bodies. (Alliance Environment, 2007) Such co-ordination would be enhanced by the establishment of protocols setting out the arrangements for defining water balance and controls and methods of communication between the different bodies. Costs and benefits of using cross compliance for enforcing obligations vary widely among regions and Member States and regions. High costs of CC compared to the realized benefits are linked to areas with already high compliance. There is some evidence that cross compliance is more effective than other types of legal enforcement of obligations due to reduced administrative and legal costs. Its mandatory character also gives it a comparative advantage over voluntary schemes, such as agri-environmental	Construction projects like drinking water reservoirs and irrigation schemes already require public authorities to tender or carry out themselves environmental impact assessments. The introduction of the concept of water balance or maintaining environmental flows in water scarce areas would increase government administration burden in so far as these water management issues are not yet taken into account in impact assessments.

	companies. The costs of farm advisory services for public administrations were collated in 2009 in a Handbook for administrations. For example, in England costs were estimated at around £2.2 million/year, whereas in Sweden costs were estimated at around €4 million/year (Berglund and Dworak, 2009). The share of water related advice in the services is unclear. However, a proxy estimate can be made from numbers supplied from the Water Agency in Adour-Garonne, France. This region alone provides €1 Million in financial support annually to foresee a weekly advice to farmers regarding irrigation information (Arcadis, et al., 2012).	measures due to the budgetary costs of payments linked to their implementation and advisory/information based (Alliance Environment, 2007).	
Property rights	No impact	This option might impact existing water use rights which are linked to property rights	No impact expected
Innovation and research	The promotion of guidance and best practice sharing stimulates research and development into new and existing water saving technologies.	Yes more efficient technology might be developed, because of the pressure to save water.	No impact expected
Consumers and households	Awareness raising campaigns on water use that lead to the implementation of water saving measures can reduce household water bills. For example, in Gironde, France water savings measures can reduce household water bills by 240€/year (Ecologic, et al., 2007). In Zaragosa, Spain[102], the information campaign to save water	Regional products might be produced less and therefore prices could become higher.	No impact expected

[102] http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPageandn_proj_id=1123anddocType=pdf

	increased the sale of domestic appliances with built-in water savers by 15%.		
Specific regions or sectors	No impact	The agricultural sector in regions with high water consumption due to agriculture will be impacted (southern European countries). Production losses can be expected in these regions.	Cohesion Policy focuses on improving the economic conditions in disadvantaged areas. The inclusion of ensuring/maintaining water balance for projects will disproportionately affect these regions compared to regions and Member States where structural funds are not applicable. Additionally, regions with water scarcity will be more affected that regions that are water rich, as projects may shift to the latter. This policy option could significantly impact a disadvantaged region to take advantage of structural funds.
Third countries and international relations	No impact	Impacts cannot be estimated, as it it is hard to judge the equivalence of legal requirements between EU countries and non-EU countries. According to Farmer (2007) the effect of cross compliance SMRs and GAEC standards on international competitiveness would appear to be minimal when comparing the competing influences of other factors.	No impact
Macroeconomic environment	No impact	No impact	The main goal of Structural Funds is to ensure solidarity with less developed countries and increase their competiveness and economic growth. Preventing projects from taking place in water scarce countries would also prevent the EU from addressing some territorial disparities and could have impacts on macro-economic stabilisation if these regions could be disadvantaged. For example, between 2000-2006 GDP growth in convergence regions was on average 2%/year compared to only 1.4%/year in regions not receiving assistance from Structural Funds (EC, 2011).

Social impacts			
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between water scarcity and the CAP**	**Option 3: Introducing water-related criteria into project selection under Cohesion Policy**
Employment and labour markets	The introduction of water issues into farm advisory services has the potential to create jobs as new experts are needed. This, however, cannot be confirmed by any studies.	Depending on how often and to which quotas need to be set (annually, one out of 5 Years) there is a risk of permanent income losses (Dworak, et al, 2009a) which will result in the fact that farmers have to drop out of business. This might in particular effect young and small farmers as the loose long term perspective.	Preventing the construction of water supply projects in disadvantaged areas could reduce job creation and the demand for labour. This could reduce the number of construction jobs and lead to layoffs at construction companies or cause construction companies to fold due the lack of projects. As an example, a wastewater and treatment project in the Norte region of Portugal employed many local workers during its construction and helped increase significantly the qualifications of local workers and companies to carry out such projects again in the future (ADE, 2009a).
Standards and rights related to job quality	No impact	Considering the farm as a workplace the option will also drive innovation as farmers will seek for more efficient water management covering technological and management changes.	No impact
Social inclusion and protection of particular groups	No impact	No impacts are expected	Access to drinking water and the general available of water tends to be greatly enhanced through water supply projects carried out under Cohesion policy. For example, the water and wastewater project in Valencia, Spain enabled the region to reach the national average of water supplied per habitant; previously access was quite poor. The indicators of this particular project indicated that the quality of life was improved for 4 million people (ADE, 2009b). Preventing such projects to take place in water scarce regions – where ensuring a water balance may not be possible and thus requiring the project to be located elsewhere – could negatively impact the population as a whole and vulnerable groups especially.
Gender equality, equality treatment and opportunities,	No impact	No impacts are expected	No impact

non - discrimination			
Individuals, private and family life, personal data	No impact	No impacts are expected	No impact
Governance, participation, good administration, access to justice, media and ethics	No impact	No impacts are expected	No impact
Public health and safety	No impact	No impacts on Public health and safety are expected.	No impact
Crime, Terrorism and Security	No impact	No impacts are expected	No impact
Access to and effects on social protection, health and educational systems	The introduction of new topics – for example water management targeting water savings and efficiency – will positively impact an individual's access to advice and training, especially in regions or Member States where farm advice is delivered free of charge.	No impacts are expected	No impact
Culture	No impact	If agricultural production is seen as a cultural heritage per se, a change in historical production patterns and crop types might be seen as an impact on cultural heritage.	No impact

Social impacts in third countries	No impact	No impacts are expected	No impact

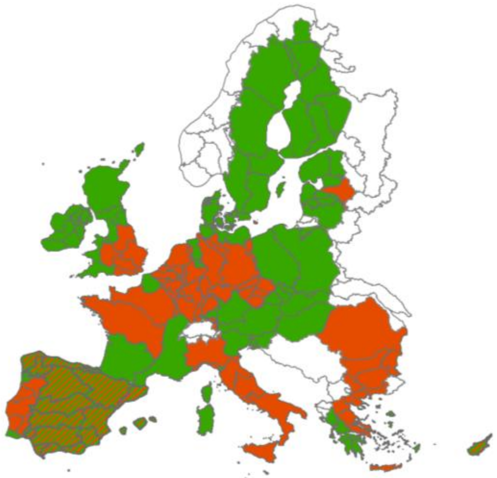
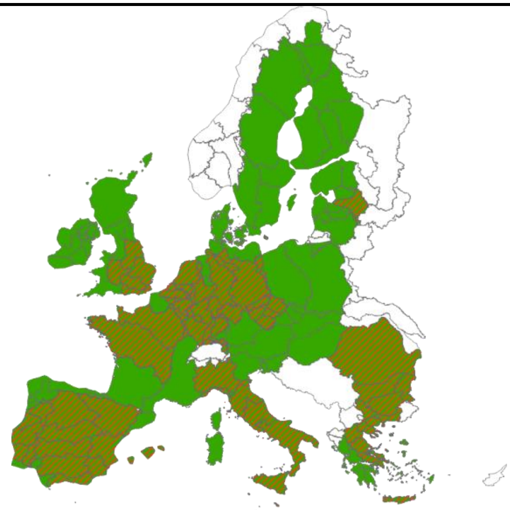
Environmental impacts			
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – Cross-compliance between water scarcity and the CAP**	**Option 3: Introducing water-related criteria into project selection under Cohesion Policy**
The climate	Awareness campaigns in the domestic sector that lead to the implementation of water saving devices have the potential to lead to a reduction in GHG emissions through the link to energy savings. Information is not widespread. Investigations in the US found that if 1% of American households retrofitted their houses with water-efficient fixtures the country would save 100 Million kWh of electricity to year and reduce GHG emission by 75,000 tons (EPA data *in* Ecologic, et al., 2007). Awareness raising and educational activities have been confirmed as important measures for adaption to climate change helps to reduce vulnerability in regions facing water scarcity and droughts. (Flörke, et a., 2011).	Less pumping of water will result in less energy use, leading to less CO2 emission. For example approximately 5.8% of total electricity demand in Spain is due to the water sector. Irrigated agriculture is one of the Spanish water sectors that show the largest growth in energy requirements (Hardy, et al, 2012). So if less water becomes available for irrigation, less energy will be used. Impact on emission of ozone-depleting substances are not expected. In relation to adaptation the option is considered as an adaptation option as climate change might increase the problem (Flörke et al, 2011)	No impact
Transport and the use of energy	Awareness campaigns in the domestic sector that lead to the implementation of water saving devices have the potential to lead to energy savings as well. Information is not widespread. Investigations in the US found that if 1% of American households retrofitted their houses with water-efficient fixtures the country would save 100 Million kWh of electricity to year and reduce GHG emission by 75,000 tons (EPA data *in* Ecologic, et al., 2007).	See above	No impact
Air quality	No impact	No impacts are expected	No impact

Biodiversity, flora, fauna and landscapes	advise and awareness of water-land use reduces water use and therefore ensure environmental or minimum flows.	Sufficient water is vital for biodiversity.	Water supply projects, such as the construction of reservoirs and dams or irrigation schemes, can have negative consequences on biodiversity, especially in water scarce areas. As an example, planned irrigation schemes in the water poor Ebro basin in Spain were linked to significant declines in bird distribution (Brotons, L., et al., 2004; IEEP, 2000). This proposed option could help to minimize these impacts. Water abstraction for irrigation can also impact aquatic and wetland species if the water balance is not maintained, wich leads to the destruction of wetlands or lowered river flow (IEEP, 2000).
Water quality and resources	Locally, guidance and awareness campaigns can have a positive impact on reducing freshwater use across various sectors. Data from Adour-Garrone, France estimates that their irrigation advisory services can result in 10% water savings or 70-80Mm^3 (Arcadis, et al, 2012). Water savings through advice was confirmed by the Water Savings in Agriculture project by BIO Intelligence Services. They found: • Irrigation scheduling advice in Adour-Garonne led to water savings. • IRRINET, an information platform established in the Po River Basin in Italy that provides information on irrigation water management, also led to water savings. The CER – the organisation that developed the platform - estimated that between 2006 and 2007 the system resulted in water savings o falmost 50 million m^3 or 20% of water used in agriculture (Mannini, et al, 2008 *in* BIO, 2012) • In Crete irrigation advice that included precise data on when and how to apply water on crops could lead to water savings from 9-20% compared to empirical water application. Importantly, this study found that without advice	Improving water quality and resources is the main objective of the option. There is evidence to suggest that the cross compliance system is having a positive effect in terms of ensuring compliance with obligations(Alliance Environment, 2007).	Water abstraction from surface or groundwater can reduce the quantity of water if it is not regulated well and if a water balance is not maintained. Water abstraction for irrigation can negatively impact the physical and chemical characteristics, including the biodiversity, of the water bodies (IEEP, 2000). For example, if irrigation abstraction of groundwater exceeds the natural recharge rate of the aquifer, water tables can be lowered as well as impact the interchange between groundwater and surface water (ibid). This is especially the case in summers, where precipitation does not recharge surface and groundwaters. There is also a like to water quality problems, as reduced flow can lead to reduced dilution of pollutants such as pesticides and nutrients coming from agriculture fertilization. Preventing new water supply and irrigation schemes to be constructed in water scarce areas should help to prevent these problems. Salinisation of water and soils as a result of irrigation is also a major issue, for example in Greece, Spain and Portugual. This is especially a problem in Greece where 25% of existing irrigation land experience salinisation (IEEP, 2000). Structural funds and Cohesion policy have the potential to improve water supply and water management. The inclusion of project selection criteria geared towards ensuring/maintaining a proper water balance would to avoid projects being implemented that have a negative impact on water resources. For example, a water supply project in Portugal funded under Cohesion most likely led to an increase in water demand in an already water scarce region due to a current water charging policy that does not seem to ensure full cost recovery and to reduce water consumption in the long-run (Hjerb, et al., 2011). This policy option would prevent such projects from being carried out, thus helping to ensure sustainable water supply.

	and management support, the implementation of more efficient drip irrigation systems did not lead to water savings, e.g. in Spain and Crete (Garcia, 2002 and OECD, 2006, *in* BIO, 2012). Water conservation awareness also leads to savings in the domestic sector and industrial sectors. An awareness campaign in Zaragosa, Spain at end of the 1990s led to a saving of 592 million liters in domestic water consumption (Ecologic, et al., 2007). Water use campaigns in Copenhagen have led to total water consumption reduction by 10 million m^3/year, in particular in the domestic sector where water use per inhabitant has decreased to around 131 litres/inhabitant/day from 168/litres/inhabitant/day (ibid). Although these local examples point to a range of range of water saving potential due to guidance and awareness campaigns, the macro impacts of this option on water resources remain low given the small geographic scope of this option.		
Soil quality or resources	Salinisation of water and soils as a result of irrigation and overexploitation of water sources is also a major issue, for example in Greece, Spain and Portugal. This is especially a problem in Greece where 25% of existing irrigation land experience salinisation (IEEP, 2000).		In regions with already soil erosion problems – especially areas experiencing desertification due to water scarcity and droughts – irrigation can increase the rate of erosion of cultivated soils on slopes (IEEP, 2000). This can a) reduce soil cover and quality and b) increase water pollution through sedimentation. These impacts have been especially problematic in Greece and other Mediterranean regions where agriculture is often located on slopes and the fields are usually irrigated with pressure systems (ibid). While other irrigation system can significant reduce erosion rates, it is still necessary to avoid building new irrigation schemes with Structural Funds in these areas. Salinisation of soils as a result of irrigation is also a major issue, for example in Greece, Spain and Portugal. This is especially a problem in Greece where 25% of existing irrigation land experience salinisation (IEEP, 2000).
Land use	Increased awareness of water scarcity issues could result in conversion of agriculture production from intensive to extensive production.	The option has the potential to turn marginal land into agricultural land as farmers might compensate yield losses by expanding the area. Restrictions in water use definitely change the type of	The prevention of new irrigation schemes in water scarce areas could possibly lead to a) land abandonment or b) extensification of production. Land abandonment was widespread in south-eastern Europe as a result of the collapse of irrigation

		crops grown. The changes can be either towards less irrigation requiring crops or towards more high value crops (e.g. fruits) where for the same amount of water a higher price can be achieved. In both cases a change in land use can be expected. (see Dworak, et al. 2009a).	management following independence (IEEP and Veen (2005).
Renewable or non-renewable resources	Reduced water use through awareness and education could have a positive impact on groundwater resources.	At the moment bioenergy feedstocks in Europe are mostly rain fed; however, with increasing water scarcity as well as uncertainty regarding future climate conditions, the irrigated area for these crops will most likely increase (Dworak et all, 2009b). So the proposed option might limit these developments leading to a less yields which might have an impact on the renewable energy coming from bioenergy. However due to technological development in the area these limitations might be compensated.	Preventing water supply projects to use groundwater in a region, whether it's for domestic, industrial or agriculture use, will positively benefit the groundwater table. On the other hand, some groundwater aquifers rely on water being leached down from agriculture use or through leakage from inefficient conveyance systems. These aquifers could be negatively impacted if such projects are not allowed.
The environmental consequences of firms and consumers	This option could lead to more sustainable production and consumption. Awareness campaigns have been known to increase the sale of water saving devices in both households and industry (for multiple examples see Ecologic, et al., 2007).	No impacts are seen.	Irrigation agriculture is not necessarily unsustainable; it depends on where it is taking place. In water scarce areas, however, irrigation agriculture can comprise over 80% of water abstractions in a region (EEA, 2009). The prevention of new irrigation projects in water scarce areas will lead to more sustainable production.
Waste production / generation / recycling	No impact	No impacts are seen.	No impact
The likelihood or scale of environmental risks	No impact	No impacts are seen.	No impact
Animal welfare	No impact	No impacts are seen.	No impact
International environ-mental impacts	No impact	No impacts are seen.	No impact

Trading water use rights for the environment

Trading water use rights for the environment	
Knowledge and awareness	WFD reform or new legislation
	

Indicator	Option 1 – Knowledge and Awareness raising	Option 2 – WFD reform or new legislation
Spatial coverage (map)		
% of the EU territory potentially impacted by the policy option	12.2%	46.1%
% of the EU population potentially impacted by the policy option	9.1%	57 .3 +/-5%

Economic impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – WFD reform or new legislation**
Functioning of the internal market and competition	The initiative is not expected to have a direct impact. However, if the trading water use rights for the environment scheme is implemented, limited additional efficient allocation of the resource is expected, favouring the most valuable uses of the resources while accounting for the needs of ecosystems in probably a few basins of country, Spain.	A more efficient allocation of the resource is expected from the scheme, favouring the most valuable uses of the resources while accounting for the needs of ecosystems. The benefits from markets are expected to be higher when scarcity increases (i.e. drought) as exchanges spreads its economic impact (Miller, 1996 in Calatrava and Garrido, 2005)
Competitiveness, trade and investment flows	The voluntary nature of the initiative is only expected to promote the development of a trade scheme where such gains can be foreseen.	The most active markets have shown gains from trade (Grafton et al., 2011) and this should contribute to increased flows and favour the more productive activities.
Operating costs and conduct of business/Small and Medium Enterprises	The impact of the measure is probably going to be limited geographically to Spain, if the trading scheme is adopted following the awareness raising efforts. However, the impact of the potentially higher water prices on operating costs of farmers will depend on: – Magnitude of price increase – Reliance on irrigation water – Irrigation techniques in place – Type of crops grown – Size of the farm It is therefore impossible to predict at a general level the expected impact of the policy measures.	The impact of the potentially higher water prices on operating costs of farmers will depend on: – Magnitude of price increase – Reliance on irrigation water – Irrigation techniques in place – Type of crops grown – Size of the farm It is therefore impossible to predict at a general level the expected impact of the policy measures.
Administrative burdens on businesses	The initiative is not expected to have direct implication for businesses but can have some if the trading scheme is implemented following the awareness campaign. However, such cost are expected to be lower than the gains from trade as trading is voluntary.	Some extra administrative burdens for farms are expected but if incurred, they are expected to be lower than the gains from trade as trading is voluntary.
Public authorities	The information campaign will represent a burden to the public authorities and, if successful in areas where water rights have to be reformed, will be increased by formalisation of compatible water rights, and depending on the system of initial right allocation, public authorities may	In addition to invest in the formalisation of compatible water rights, and depending on the system of initial right allocation, public authorities may have to either finance the buyout system through the general budget. However, initial investments are expected to benefit from economies of scale. However important costs will remain none the less for enforcing and monitoring the

	have to either finance the buyout system through the general budget. However, initial investments are expected to benefit from economies of scale. However important costs will remain none the less for enforcing and monitoring the market. The creation of autonomous bodies for the management of the market can alleviate such costs.	market. The creation of autonomous bodies for the management of the market can alleviate such costs.
Property rights	The initiative does not look at reviewing rights and is most likely to have success in places where water rights are already compatible with trading. In Spain, the existing regulatory framework provides rooms for trading water use rights, following the 1999 Water Law reform (Calatrava and Garrido, 2006), making the costs of this adjustment marginal compared to other EU countries.	Property right definition is at the heart of a functioning water trading system. Most efforts in the development of any system of this type, irrelevant of its scale, are expected to be, particularly important at the beginning. When existing rights are not well defined or too connected to other rights, substantial efforts are expected to be needed and will impact the cost for public authorities.
Innovation and research	Through prices, water markets incentive agents to innovate and adopt water saving technologies (Calatrava and Garrido,2005 in Qureshi et al.2009)) The policy option considered will likely increase the investment into research and boost innovation in new institutional arrangements for water management but also water saving technology or application (potential). Innovation will benefit from the option but is likely to be limited to Spain in the short run.	As with the completely voluntary approach, through prices, water markets incentive agents to innovate and adopt water saving technologies (Calatrava and Garrido,2005 in Qureshi eta.2009)) The policy option considered will likely increase the investment into research and boost innovation in new institutional arrangements for water management but also water saving technology or application (potential).
Consumers and households	No direct impact is expected	By opening trading possibilities, it is likely that domestic water suppliers could access cheaper sources of water through this system (US case) in water scarce areas.
Specific regions or sectors	Agriculture is potentially the sector most affected by this scheme, generally being the largest water user and the one currently holding different types of rights on water usage but not only, depending on the setting. The restriction in the total available water is expected to introduce potentially higher pricing in the context of tradable water rights were water is to be attracted by the most valuable uses, and possessing the higher willingness to pay.	Agriculture is potentially the sector most affected by this scheme, generally being the largest water user and the one currently holding different types of rights on water usage but not only, depending on the setting. The restriction in the total available water is expected to introduce potentially higher pricing in the context of tradable water rights were water is to be attracted by the most valuable uses, and possessing the higher willingness to pay. Trading has a combined effect. For the buyer, it is similar to the case for pricing instruments with the impact of changes in pricing. The second is offered by the possibility of selling those rights and therefore potentially earning a rent. Assessing the impact of higher prices on water use on the one hand, and on

		farmers' income on the other, it is a challenging task. In general, increased water prices will be effective in reducing consumption if three conditions are met: – Higher prices are associated to technical measures to increase irrigation efficiency; – Clear monitoring of volumes; – The demand for irrigation water is elastic, i.e. is responsive to price changes. In general, it was observed that increased water prices are likely to have a negative impact on farmers' income, especially small and family farms. Nonetheless, in contrast to simple pricing, trading offers the potential of increasing of income a through the sale of temporary users or definitive property rights.
Third countries and international relations	No impact is expected in this respect.	No impact is expected in this respect.
Macroeconomic environment	Gains from trade have been documented, yet not all costs may have been captures by the current literature and the overall gains from an EU perspective are expected to be marginal, as only Spain is expected to develop the trading scheme following the implementation of the voluntary policy option.	Gains from trade have been documented, yet not all costs may have been captures by the current literature.

Social impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – WFD reform or new legislation**

Employment and labour markets	No effect but for research and facilitation of the awareness raising efforts. However, the implementation of the trading scheme, is adopted is expected to have impacts. Employment is expected to benefit from trade, however this will depend if the most profitable activities are the labour intensive ones, as these are the ones that will secure the rights, potentially driving out marginal activities.	Employment is expected to benefit from trade, however this will depend if the most profitable activities are the labour intensive ones, as these are the ones that will secure the rights, potentially driving out marginal activities. This has been the case in Australia as extensive farming was less labour intensive that the most productive parts of the sectors that have thrived under the trading scheme (Barthélémy, 2008).
Standards and rights related to job quality	Not relevant in this case.	Not relevant in this case.
Social inclusion and protection of particular groups	An awareness campaign is to contribute to a more informed participation on the delicate matter of water trading rights.	Lower income groups are likely to be affected by increased water prices, but this impact can be offset by the possibility of selling rights if profitable. Irrigators that sell will be compensated at some level although they might experience adverse human and social effects from their decision. "*Moreover, communities that depend on irrigation might experience impacts of water entitlements leaving their region, for example via declining populations and loss of jobs and services. Community-level impacts are likely to be more significant in those communities whose economies have a greater reliance on irrigated agriculture, and that produce agricultural commodities with lower marginal value products of water, such as irrigated broadacre, Murray-Darling Basin*" (Edwards et al. 2007; Fenton 2006 in Connell and Grafton, 2011). However, it is documented that intra-sector trading occurs among increasingly larger farms in Australia (Barthélémy, 2008)., although some groups have been protected like the aboriginal people.
Gender equality, equality treatment and opportunities, non -discrimination	Not relevant in this case.	In principle this is not relevant in this case. However, if there is a marginal activity that is linked to a particular social group, the changes in allocation may disproportionally affect certain social groups.
Individuals, private and family life, personal data	Not relevant in this case.	Not relevant in this case.

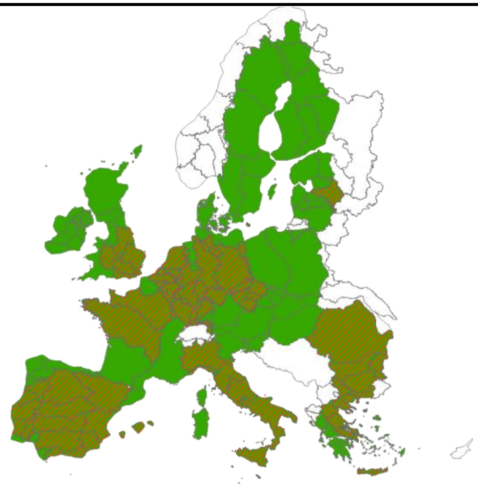
Governance, participation, good administration, access to justice, media and ethics	An awareness campaign is to contribute to a more informed participation on the delicate matter of water trading rights.	The initial structuring of the system through the probable revision of the important institution such as property rights requires a space for participation (Young, 2012) to be successful.
Public health and safety	No direct impact is expected from the initiative, although the development of Trading water use rights for the environment is expected to have positive impacts but limited geographically to Spain.	A healthier aquatic environment is expected to have positive impacts.
Crime, Terrorism and Security	Not relevant in this case.	Not relevant in this case.
Access to and effects on social protection, health and educational systems	Not relevant in this case.	Not relevant in this case.
Culture	The awareness campaign can have a cultural impact as to clarify the perceptions about tradable water rights which are new institutions in most EU countries. Although the initiative is not expected to directly contribute to the development of water markets, the awareness campaign should aim at enriching the perspectives on these new institutions. It is acknowledged that social acceptability of the concept is a precondition for water trading development (Simpson, 1994; Brown, 1997 in Bjornlund, 2003).	Property rights deep changes and the effect on certain marginal activities socially valued (if not their deep transformation or relocation) can have cultural repercussions that can be perceived as negative (Connell and Grafton, 2011; Young, 2012). It is acknowledged that social acceptability of the concept is a precondition for water trading development (Simpson, 1994; Brown, 1997 in Bjornlund, 2003).
Social impacts in third countries	Not relevant in this case.	Probably not relevant in this case.

Environmental impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – WFD reform or new legislation**
The climate	Limited impact, given the limited impact of the measure to the only country in the EU with water markets rights that are compatible with trading.	The options might bring about a reduction in greenhouse gases emissions by reducing the consumption of energy needed to convey and treat water (the magnitude of this impact, however, is expected to be marginal). In addition, a more efficient water use enhance preparedness towards drought and water scarcity events, which are expected to increase as a result of climate change. Moreover, water trading systems increase their benefits as water scarcity becomes more acute, a likely scenario under the assumption of climate change.
Transport and the use of energy	Potentially positive, yet geographically limited impact.	A reduction in water consumption might lead to energy savings, as less energy will be needed to convey and treat water.
Air quality	Not relevant in this case.	Not relevant in this case.
Biodiversity, flora, fauna and landscapes	No direct impact is expected by the policy option but an eventual uptake of the trading scheme is expected to ensure that more water is made available for ecosystems, thus benefiting biodiversity, flora, fauna and landscapes. This positive effect is limited to the likely areas to develop the scheme (i.e. Spain)	The system is expected to ensure that more water is made available for ecosystems, thus benefiting biodiversity, flora, fauna and landscapes.
Water quality and resources	The full implementation of E-flows id to have a substantial effect on this dimension but this effect is likely to be limited to Spain under this form.	This mechanism is a compensated way of implementing E-flows in the most effective manner. As such water quality and quantity are expected to directly benefit from it. It is important to note that simple trading system (without formal environmental dimensions) have failed in allocating water by favouring human uses over ecosystems (Grafton et al., 2011). This case is however very environmentally orientated.
Soil quality or resources	No direct effects are expected from the voluntary initiative. However, limited to Spain, land use changes towards more intensive agriculture as less tradable/valuable crops are displaced could have negative effects. However, positive effects can be expected if agriculture is replaced by non-agriculture uses such as forests. This effect has not been reviewed by the effects are potential.	Land use changes towards more intensive agriculture as less tradable/valuable crops are displaced could have negative effects. However, positive effects can be expected if agriculture is replaced by non-agriculture uses such as forests. This effect has not been reviewed by the effects are potential.
Land use	No direct effects are expected from the voluntary initiative. However, limited to Spain, impact on land use changes may be significant especially in water scarce areas, where water is predominately used by agriculture. Depending on the activities, trading opportunities may encourage land	Impact on land use changes may be significant especially in water scarce areas, where water is predominately used by agriculture. Depending on the activities, trading opportunities may encourage land abandonment in the cases of Australia and the US (this is has not been reported for Spain nor Chile). The most likely direct

	abandonment in the cases of Australia and the US (this is has not been reported for Spain nor Chile). The most likely direct impact is therefore the intensification of agriculture.	impact is therefore the intensification of agriculture.
Renewable or non-renewable resources	Not relevant in this case	Not relevant in this case.
The environmental consequences of firms and consumers	No direct effects are expected.	The combination of the E-flows, compensation and the option of trading is expected to bring about a more efficient use of water in the agricultural sector. However, it is documented that more intensive forms of agriculture are favoured with a less certain impact in the long term.
Waste production / generation / recycling	Positive yet limited reuse of water is an option to fully benefit from trading opportunities.	Reuse of water is an option to fully benefit from trading opportunities. This linked to the degree of incentives provided by the scheme for agents to adopt water-saving technologies, as expected (Calatrava and Garrido, 2005)
The likelihood or scale of environmental risks	Not relevant in this case.	Not relevant in this case.
Animal welfare	Not relevant in this case.	Not relevant in this case.
International environ-mental impacts	Not relevant in this case.	To be identified as trade could take an international dimension.

Assess and manage Drought Risk

Assess and manage Drought Risk	
Knowledge and awareness	WFD reform or new legislation



Indicator	Option 1 – Knowledge and Awareness raising	Option 2 – New regulation or reform of the WFD
Spatial coverage (map)		
% of the EU territory potentially impacted by the policy option	46.1%	46.1%
% of the EU population potentially impacted by the policy option	57 .3 +/-5%	57 .3 +/-5%

Economic impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – New regulation or reform of the WFD**
Functioning of the internal market and competition	No impact	No impact
Competitiveness, trade and investment flows	Selective implementation of the drought risk management can contribute to variability in business environment, and consumer prices for goods and services.	As an indirect effect, one might expect that the drought risk management plans contribute to a greater transparency of business environment and better appreciation of the business risk across Europe.
Operating costs and conduct of business/Small and Medium Enterprises	In case of voluntary adoption of drought management plans, the ensuing costs for of industries and utilities may increased regionally. Because these costs are eventually passed on to customers, this option may lead to a greater variation of consumer prices for good and services.	Under the conditions of drought-compelled emergencies, the operation costs of businesses may increase as a result of more frequent monitoring of water quality, higher costs of water treatment, compelled public information campaign towards reduced water consumption etc. Because of the critical importance of water or communities and business these costs are legitimate and justified, and in medium to long term contributing to economic sustainability of the enterprises. Following the principle of full cost recovery, these costs are or should be included in the final price.
Administrative burdens on businesses	Under the voluntary scheme the administrative business burden is likely to the same or lower than in the option 2 (see on the right side)	Water intensive sectors will or may be obliged to translate the provision of the higher level drought management plans into own businesses, and identify preventive and contingency measures for the case of emergency. A proper planning, coordination with public authorities and reporting may inflict substantial costs on the business operation and necessitate capacity development. Irrigation associations, water utilities, and power plant operating companies are likely to be affected others, although each differently.
Public authorities	Where implemented on voluntary basis, the drought management burden (see the option 2 on the right side) is under this policy option the same or less stringent, likely to focus primarily on public water supply and sanitation services and the river basin wide drought management rules.	Proper drought management marks a step change from emergency to risk contingency planning, with all implied benefits (e.g. cost/impact reduction, better protection of people and environment, more efficient resource use). On the other hand, drought governance and plans, to be effective in reducing the adverse impacts of drought, are to be defined and implemented across multiple management levels, from national though river basin up to individual water sectors level (EC, 2008). This requires significant efforts and resources. An effective risk response relies on an early identification of drought onset which requires a reliable monitoring and forecast early warning system. Planning for drought and risk management involves significant coordination, public information campaign and consensus steering, enforcement and compliance assurance, and least capacity building. Often, Drought Management Plans may fall within the scope of the Strategic Environmental Assessment Directive (SEA Directive 2001/42/EC) (EC, 2008). It is widely accepted

		however that the implied costs of a proper drought management are lower in short to medium term than the costs of unanticipated droughts.
Property rights	Where implemented on voluntary basis, the drought risk management and plan may impose the same or less stringent restrictions of the water property right execution as in the option 2 (see on the right side).	Water right permits or entitlements may be temporarily compromised during the drought, depending on how they are defined and which priority is assigned to their realization. For example, more than 1,200 water rights permits have been suspended or curtailed in 2012 as a result of a prolonged drought period in Texas (Galbraith, 2012). The affected 'junior' water right holders include recreational uses, agricultural irrigation, industrial, and mining uses. Proper drought management specifies the management and implementation rules applicable to execution of water rights/entitlements and by doing so contribute to a predictable business environment and resource management during the drought spells.
Innovation and research	Locally driven innovation and research boosted by the voluntary implementation of the drought risk management policy may not reach the same economy of scale as if the provision is implemented throughout Europe.	Well defined and executed drought management can trigger research and innovation in terms of monitoring and seasonal forecast, water saving devices, innovative public-private partnership for risk sharing. Drought emergency measures can compel a improved and rapid detection of losses, efficient water pricing schemes based on volumetric charges. The market with smart water meters and water quality/loss detection devices is expected to grow as a result. Similarly, the preventive water demand management will steer innovation in water efficiency in other sectors.
Consumers and households	Under the voluntary scheme, not all consumers and households will benefit from the same protection and risk reduction level.	Drought management reduces the risk of serious water supply disruption and the frequency/severity of imposed water restrictions/rationing. Although commonly applied in situation of drought, water restrictions are associated with welfare losses and significant enforcement costs, both poorly researched and documented (Hughes, Hafi et al. 2008). According to the Production Commission (2008) the order of magnitude of annual costs to Australian households due to water restriction was of some 'multi-billion dollars'. These losses include structural damage to buildings, deteriorated status of lawns, costs of new watering systems, and structural changes of the gardens.
Specific regions or sectors	Voluntary implementation will lead to differentiated approaches to drought risk management.	Under this option, planning for drought situations pertains to all regions and key water using sectors, with management rigor that reflect the intensity and frequency of drought, and existing level of water scarcity/overexploitation.
Third countries and international relations	No impact	No impact
Macroeconomic environment	The drought risk management schemes are likely to be implemented especially in the water scarce river basins that have experienced significant drought spells recently. If implemented	Depending on the regional vulnerabilities, the cost of drought may be more or less significant in terms of GDP (up to several percentage points) (Mysiak et al., 2010). There are even more significant in terms of agricultural GDP (RBA, 2006). In Europe,

	with the same rigor and depth, the macroeconomic effects in these most vulnerable river basins may be of the same magnitude as in those of the option 2. Throughout Europe, however, the full economic potential will not be realized. Because droughts' indirect effects may hit hard other economic subjects down- and upstream the production chain, the indirect losses may be felt beyond the drought-hit area.	the only existing large-scale study is based on a survey conducted by the Directorate General (DG) Environment in 2006-2007. The economic impacts of droughts over the past 30 years have been estimated to top 100 billion Euro. In recent years the annual costs soared to over 6.2 billion Euro, which would be around 0.05 % of the GDP of the European area in 2006 (Mysiak et al., 2010). These estimates are to be considered lower bound because in most cases they don't account for the indirect and intangible losses, including the social and environmental losses. There is a little evidence though about the avoided damage though an appropriate risk management. The anecdotal evidence though shed light on the economic benefits of well designed anticipatory drought management.

Social impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – New regulation or reform of the WFD**
Employment and labour markets	Where implemented, the better appreciation of the business risk will lead to a higher security and less seasonal variation of employment.	In agriculture and other water intensive sectors, droughts may lead to seasonal variations of employment. Howitt et al. (Cordova and Lehmann 2003; 2009) have estimated that in short-run, the losses due to the 2009 drought in California (Central Valley) caused loss of some 80.000 jobs. It is difficult to estimate the impacts on agricultural labour in Europe, subject of transformation due to a host of factors different from drought risk.
Standards and rights related to job quality	No impact expected	No impact expected
Social inclusion and protection of particular groups	No impact beyond health safety, and water security	No impact beyond health safety, and water security
Gender equality, equality treatment and opportunities, non-discrimination	No impacts expected in Europe	No impacts expected in Europe
Individuals, private and family life, personal data	Selective implementation of drought risk management approach will lead to different levels of protection throughout Europe.	Drought inflict a hardship with different manifestations and symptoms affecting physical and mental health; social fabric and capital. The knock-on or ripple effects of droughts impinge on almost all aspects of individual and social life, including nutrition, education, life satisfaction and wellbeing, social cohesion and order,

		relationships, population displacement, and public safety. A well designed drought risk management, paying due attention to specific vulnerabilities of rural/agricultural and urban communities, is vital for wellbeing and social policies. Under conditions of droughts, farm work-loads increase as workers are laid off and/or farmers have to look for additional income often off-farm. Financial hardship and anxiety regarding future prospects strain family life. Domestic violence, mental disorder and antisocial behavior, poor parenting practices, depression and substance abuse are some of the corollaries. Health effects are combined consequences of “stressors breaking through personal defenses” (Dean and Stain 2007). Even in the absence of apparent health consequences, droughts cause discernable effects on well-being, satisfaction and the quality of life, whilst increasing risk levels for family break-down and social isolation - often with adverse mental health outcomes (Stain, Kelly et al. 2008). These impacts, amplified by a number of additional factors, such as the decline of rural population, deficit of job opportunities and a drop in social cohesion, make rural communities and farm families particularly vulnerable.
Governance, participation, good administration, access to justice, media and ethics	Selective implementation of the drought risk management will lead to an incoherent and fragmented risk governance.	Proper drought risk management contributes the up-to-the-standard risk governance (and citizen protection) and entails public engagement activities to increase the awareness and to communicate the risk. The provisions of the plan, including the different emergency alert levels, are to be widely communicated in order to reach the expected responses. A public debate into prioritization of water uses within the river basin belong to the good practice of the risk management.
Public health and safety	Selective implementation of drought risk management approach will lead to different levels of protection throughout Europe.	A proper risk management can reduce/minimize the health impact of droughts. Degraded water quality and inadequate access to sanitation services promote the spread of water-borne infectious diseases such as cholera, dysentery and other diarrhoeal diseases. In certain situations, the droughts may cause dehydration and malnutrition with many subsequent health consequences or even death. Rural areas seem to be more vulnerable to drought-triggered health problems. Chronic stress and uncertainty, in combination with other corollaries increase the risk of developing mental disorders such as depression and anxiety (Sartore, Kelly et al. 2007). These disorders can manifest themselves through symptoms of psychosomatic illness such as migraine, back pain and irritable bowel syndrome.

Crime, Terrorism and Security	Selective implementation of drought risk management approach will lead to different levels of protection throughout Europe.	Driving by a host of factors, including drought, water security (i.e. capacity to ensure reliable access to potable water), is an issue of growing importance in Europe and elsewhere (see for example Bruins, 2010). As a consequence of climate change, the intensity and frequency of drought spells may increase; a fact that has to be taken into account when designing appropriate drought management schemes.
Access to and effects on social protection, health and educational systems	No impact beyond the what has been described under public health and safety, and security	No impact beyond the what has been described under public health and safety, and security
Culture	No impact	No impact
Social impacts in third countries	No impact	No impact

Environmental impacts[103]		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – New regulation or reform of the WFD**
The climate		Drought may locally or regionally exacerbate greenhouse gas (GHG) emissions in different ways. The permanent or temporarily loss of river vegetation and soil carbon leakages increase the emission of carbon dioxide, methane and other GHG. Drought exacerbated forest fire have similar effects. Tapping into groundwater for irrigation purposes during the droughts means higher energy use and indirectly higher GHG emissions. Low river flows reduce the potential for producing hydroelectricity. **A proper contingency based management of drought risk is able to reduce the risk drought poses to river ecology and variation of river flow, compared to drought emergency response without proper planning**. Few studies have documented the impact of drought on GHG emissions in Europe (e.g. Fenner and Freeman, 2011), whereas the impacts of large scale drought elsewhere are well documented (e.g. Lewis et al, 2011)

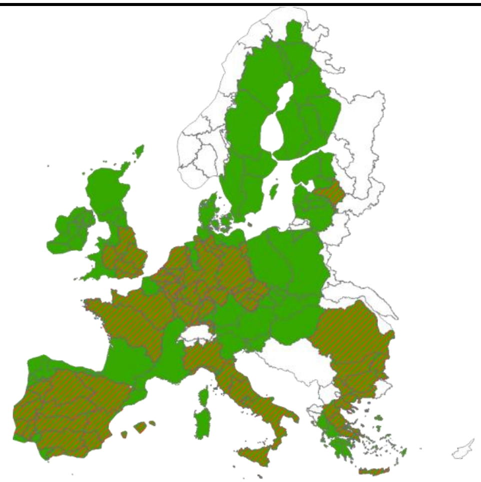
[103] An extensive account of the environmental impacts of drought is provided in Olsson et al (2010), as a result of a European research project Xerochore: An exercise to assess research needs and policy choices in areas of drought. Here we selectively highlight the benefits of a proper drought risk management approach.

Transport and the use of energy		Drought affects navigability of the major European rivers and leads to a greater energy use for water provision from groundwater. **Drought risk management can reduce these impacts to some extent**. Within the EU, considerable volumes of freight are transported on waterways: in the Netherlands 41,9 thousand mio tkm, Germany 64,7 thousand mio tkm, France 9,2 thousand mio tkm, Belgium 9,3 thousand mio tkm, Romania 8,2 thousand mio tkm and Austria 2,6 thousand mio tkm (EC 2009). Inland navigation and particularly freight transport is a competitive, safe and environmentally convenient alternative to road and rail transport: total external costs of inland navigation - due to accidents, congestion, noise emissions, air pollution and other environmental impacts - are seven times lower than those of road transport (EC 2009). During droughts, ships can be loaded with less freight volumes than other alternatives. The transport of the same freight volumes thus, has to be charged onto a greater number of vessels and the traffic increases. The latter leads to longer waiting and operating times in harbours and locks, contributing to higher additional costs. According to (RIZA 2005), the 1976 drought conditions in the Netherlands would have caused additional costs of some 417 million Euro in 2005.
Air quality		Droughts may compromise air quality, either directly by drought-exacerbated aerosolisation of spores in soil, or indirectly through air-born particulates released by forest fire, second order risk exacerbated by drought (Malcolm Gill 2005; Kalis, Miller et al. 2009). As a result of unsustainable agriculture practice in China and elsewhere (in the U.S. back in the 1930s), drought exacerbated soil erosion led to dust bowl, impacting the air quality.
Biodiversity, flora, fauna and landscapes		By maintain water levels and flow able to preserve the river ecosystems, a proper drought management can contribute achieving and/or preserving ecological status. The Water Framework Directive recognises (prolonged period of) drought as a condition under which the *temporary* deterioration in the status of water bodies in not in breach with the Directive's objective. At the same time, the Directive compels addition of all practicable steps to avoid further deterioration.
Water quality and resources		Drought leads to deterioration of water quality – greeter concentration of pollutants, higher temperature, salt intrusion in estuaries and harmful biological agents - leading to a higher treatment/water provision costs. Drought management can lessen these impacts to some extent.
Soil quality or resources		Soil quality may be compromised as a result of the inappropriate irrigation or salt intrusion in the aquifer exacerbated during the drought.
Land use		Prolonged drought period can foster transformation of land use and land abandonment.

Renewable or non-renewable resources		Drought compromise the production of hydroelectricity as a renewable energy source. The installed hydropower in Europe amounts to ca. 179,000 MW, the largest producing countries being France, Italy, Norway, and Spain. In Finland, the costs of replacing hydroelectricity by more expensive, predominantly fossil fuel generated electricity as a result of 2003 drought is estimated to 50 millions Euro. However, drought also compromise electricity production from conventional sources and nuclear energy.
The environmental consequences of firms and consumers		Reduced water consumption during the drought, steered by the well designed management responses to prolonged deficient precipitation, produce multiple environmental benefits .
Waste production / generation / recycling	No impact	No impact
The likelihood or scale of environmental risks		Drought risk management affects the vulnerability to, but not the probability of drought. As the drought intensity and frequency increases due to anthropogenic climate change, it become more critical to reduce the vulnerability to drought, in order not to compromise economic growth and social cohesion of European Communities.
Animal welfare	No impacts beyond biodiversity protection	No impacts beyond biodiversity protection
International environ-mental impacts	Voluntary implementation is more likely will require a bilateral	Some 40 out of 110 European river basins are international (EC, 2007), representing more than 60% of the Union territory. Water management provision related to drought include treaties and agreements for joint water management. The Programs of Measures (PoM) compelled by the Water Framework Directive and environmental requirements should be coordinated for the whole international river basin. Obligation to developed a shared drought risk management plan is an important driver for such agreements.

Strengthening the European Drought Emergency Response Capacity

Strengthening the European Drought Emergency Response Capacity	
Knowledge and awareness	**EU Financial instruments**



Indicator	Option 1 – Knowledge and Awareness raising	Option 2 – EU financial instruments
Spatial coverage (map)		
% of the EU territory potentially impacted by the policy option	46.1%	46.1%
% of the EU population potentially impacted by the policy option	57 .3 +/-5%	57 .3 +/-5%

Economic impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – EU financial instruments**
Policy option explained	The policy option consist of i) turning the European Drought Observatory (EDO) into a Pan European one-stop portal with modular architecture, interconnected with the regional/river basin monitoring in the participating Member States and with the Water Information System for Europe (WISE), providing multiple mobile services early alerting to drought conditions, and seasonal weather forecast; ii) reinforced European Disaster Risk Response capacity assisting all Member States with capacity (development) and material aid in cases of major drought emergencies, where necessary including temporary water transfers.	Policy option consist of i) and ii) as in the option 1 with the difference that all MS actively participate in the service provision and information sharing within the framework of the EDO; and iii) revised design of the European Solidarity Fund for the cases of major environmental hazard strikes.
Functioning of the internal market and competition	No direct or significant impacts identified	Low probability - high impact natural hazard strikes including large scale or prolonged drought spells can exceed the coping capacity of a single Member State. The financial aid provided under the framework of reformed Solidarity Fund can facilitate and speed the recovery, boosting the EU competitively and financial stability.
Competitiveness, trade and investment flows	No significant impact expected	Beneficiaries of the financial aid may take advantage of productivity gains through replaced capital. Overall these rebound effect are expected to have small impact the market competiveness.
Operating costs and conduct of business/Small and Medium Enterprises	No impact	No significant impact
Administrative burdens on businesses	No significant impact	No significant impact expected.
Public authorities	More efficient drought forecast and early warning system, thus better preparation and protection of the citizens and business. Participating countries will be required to align their monitoring systems and drought indicators to a common scheme. Information sharing and harmonized information access will initially lead to administrative burden and	As in the option 1 but including a higher administrative requirements for implementing an efficient and effective drought risk management, avoiding (or reducing to the minimum) the moral hazard associated with the provision of the financial aid from the European Solidarity Fund. Implementation of new or adaptation of existing risk sharing instruments.

	additional costs. On the other hand a shared monitoring network across the participating MS will reduce the data collection costs.	
Property rights	No impact	No impact identified
Innovation and research	Investment in ICT technology for collecting and transmitting information from the monitoring stations. Novel applications (apps) are possible developed on the basis of the information provided by EDO: these may include assisted irrigation guide for farmers, transmission of the drought alerts to citizens including the advise how to reduce water consumption, etc.	As in option 1 but of higher magnitude due to the participation of all Member States. Innovative financial, risk sharing instruments and public private partnership enabled.
Consumers and households	Consumers and household will benefit from a better information provision and sharing, including the apps developed, and a better risk preparation in participating countries. Additional benefits are provided with through the properly design drought risk management (plans), not addressed here but enabled by the enhanced capability of the EDO.	As in option 1 but benefiting also from a rapid recovery of critical public services including water supply in cases of major emergencies.
Specific regions or sectors	The impacts limited to participating countries on a voluntary basis.	All Member States may equally benefit but the Southern European countries exposed to more intense and frequent drought likely to benefit more at least initially. Financial assistance is provided to all Member States according to the revised rules of the EUSF.
Third countries and international relations	No impact	No impact
Macroeconomic environment	Anticipation of the drought spells, information sharing and transmission through the apps may yield discernable economic benefits.	As discussed extensively in the assessment of drought risk management policy area, droughts can inflict large economic damage and significantly affect some water intensive water sectors such as agriculture (with potentially significant repercussions on the rural communities highly depending on agriculture). This option will lead to greater macroeconomic stability and resilience, understood here as 'policy-encouraged ability of an economy to withstand or recover from exogenous shocks' (Briguglio et al., 2008). Similar to Cordona et al. (2008), economic resilience is associated with internal and external funds available to a government to face hazard losses.

Social impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – EU financial instruments**

Employment and labour markets	Discernable benefits from a better anticipation of, and preparedness to drought spells.	As in option 1 but additional benefits are provided by rapid disaster recovery.
Standards and rights related to job quality	No impact	No impact
Social inclusion and protection of particular groups	No impact	No impact
Gender equality, equality treatment and opportunities, non - discrimination	No impact	No impact
Individuals, private and family life, personal data	Discernable benefits from a better anticipation of, and preparedness to drought spells.	As in option 1 but additional benefits are provided by rapid disaster recovery.
Governance, participation, good administration, access to justice, media and ethics	Improved drought risk governance – particularly preparedness.	Improved drought risk governance – particularly preparedness, response and recovery.
Public health and safety	Improved protection against adverse impacts of drought (discussed in depth in the drought risk management sheet) though better preparedness.	Better protection and quick response to drought disaster strikes.
Crime, Terrorism and Security	Improved water security (discussed in depth in the drought risk management sheet) though better preparedness.	Significant improvement of water security through better preparedness, response and recovery.

Access to and effects on social protection, health and educational systems	No impact	No impact
Culture	No impact	No impact
Social impacts in third countries	No impact	No impact

Environmental impacts		
Issues	**Option 1 – Knowledge and Awareness raising**	**Option 2 – EU financial instruments**
The climate	No impact	No impact
Transport and the use of energy	Not impact beyond a better preparedness to drought spells.	Better preparedness to, and recovery from, drought spells significantly curbing the own energy production and temporarily reducing the energy autonomy.
Air quality	No direct impact	No direct impact
Biodiversity, flora, fauna and landscapes	Better preparedness to drought spells enabling to adopt necessary drought management measures to protect environment	Better preparedness to drought spells enabling to adopt necessary drought management measures to protect environment
Water quality and resources	Better preparedness to drought spells enabling to adopt necessary drought management measures	Better preparedness to drought spells enabling to adopt necessary drought management measures, including temporally water transfers.
Soil quality or resources	No impact	No impact
Land use	No direct impact	No direct impact. Water sensitive land management could be imposed as a part of preventive drought management measures.
Renewable or non-renewable resources	Better preparedness to drought spells enabling to adopt necessary drought management measures	Better preparedness to drought spells enabling to adopt necessary drought management measures

The environmental consequences of firms and consumers	No impact	No impact
Waste production / generation / recycling	No impact	No impact
The likelihood or scale of environmental risks	No impact	No impact
Animal welfare	No impact	No impact
International environ-mental impacts	Better preparedness to drought spells enabling to adopt necessary drought management measures	Environmental hazards including drought are trans-national and the European value in tackling them has been firmly recognized (not at least in the 2007 Communication on water scarcity and drought). This policy option will lead to a improved response capacity to large scale, cross boundary environmental hazard strikes.