BRIEFING

Water Scarcity

September 2011

Summary

Water scarcity has risen sharply up the EU policy agenda and will form a core focus for the Commission's **'Blueprint to Safeguard Europe's Waters'** in 2012. This briefing sets out key findings from research funded by the EU's Research Framework Programme related to water scarcity which can assist Parliamentarians in identifying important policy conclusions and so contribute to this debate.

Water scarcity occurs where there are **insufficient water resources available to satisfy long-term average requirements.** Population growth, more intensive agriculture, energy and manufacturing needs and tourism all contribute to increasing water use. In Europe significant water scarcity occurs in a number of regions and there is **concern that the problem is growing and that this may be exacerbated by climate change.**

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The **Water Framework Directive (WFD),** adopted in 2000, provided the first coherent legal tool at EU level to address water scarcity by requiring **long-term planning** of water resources and specific measures such as ensuring water abstraction is authorised. The strategic approach has since been taken forward with a 2007 Commission **Communication on water scarcity and droughts.** Also, the September 2012 Ministerial Meeting under the UNECE Environment for Europe process will focus on water scarcity. However, bringing together all of the actions needed to address water scarcity in a strategic approach is problematic and will, therefore, be a core focus for the 'Blueprint' in 2012.

Modelling is an important tool to examine future water resources within most water scarcity research, although it is always important to recognise the limitations of model outputs. Models show that climate change could **produce a net increase or decrease in water availability**, depending upon location.

Social and economic **scenarios also help researchers to imagine what might happen** over the next half a century and this can be an important method for flexible mid- and long-term planning. Scenarios provide alternative views of the future but they are not predictions nor should they be taken as the most likely of the numerous possible futures. Different scenarios result not only in different levels of water use, but can also vary in which users are most important. Thus the **social and economic choices we make may not simply affect water use, but may dramatically alter water outcomes.**

A wide range of water conditions affect the nature of the ecosystems they support. Over-abstraction today places **ecosystems** in a number of parts of Europe under severe pressure and with climate change **the vast majority of freshwater ecosystems in Europe will experience significant ecological change.**

Industry will likely be affected by future water scarcity due to lack of water for abstraction for manufacturing or as **cooling water.** However, a larger driver is projected to be increased water temperature as a result of climate change and lower flow levels, which reduces the ability of water to cool thermal processes.

Increasing water scarcity will affect **agriculture**, particularly that dependent upon irrigation. However, research on climate impacts has found that **socio-economic drivers, technological development and agricultural policies could be more important than climate change as factors influencing irrigation water withdrawals and water stress in the future.** Irrigation efficiency is the most important factor. Thus water stress for agriculture will increase in the Mediterranean region, but much of this can be compensated for by technology innovation. **Future water use may also be exacerbated by increased production of bioenergy crops.**

It is important to recognise the role of **improving the efficiency of water use by domestic users in addressing current and future water scarcity.** This can be stimulated by demand management incentives. Research shows wide variation in the efficiency of different appliances and, hence, overall household water consumption. Furthermore this varies between regions. Increasing incomes can both increase consumption (adding new appliances) and reduce it (buying more efficient appliances).

Research on the overall potential for saving water has been conducted for DG ENV. This concluded that in the Mediterranean, the potential for **water saving** would cover 45% of the predicted water demand in 2025 demand, which is significantly larger than the expected increase in demand over the same period. For Northern Mediterranean countries the largest water saving potential is in the irrigation sector (60%), followed by the industrial (25%) and domestic (15%) sectors. Thus **much can be achieved by improving what we do now.**

The WFD challenges Member State authorities to further address the issue of water scarcity. A far greater emphasis on appropriate measures to address water scarcity issues in implementing the WFD should be expected in the future. **Policy makers need to take seriously the WFD objective for minimum ecological flows** as a high priority driver for decisions on water allocation and planning.

The complexity of the legal and policy environment is a further challenge. While the WFD is central to EU policy, other **policies are piecemeal in their coverage of water scarcity issues and integration with sectoral policies such as agriculture is poor,** which results in agriculture not delivering its potential for water saving and not addressing illegal abstraction. There is, therefore, a gap between what is desired at EU level and what can be delivered at EU level. It is important that water scarcity issues are integrated into sectoral policies. The forthcoming revision of the Common Agricultural Policy is critical, such as **including some WFD obligations as cross-compliance requirements** under Pillar I to help discourage illegal abstraction.

The debates leading up to the EU 'Blueprint' next year are critically important. The decisions to be made need to be based on a sound knowledge base and it is important, therefore, for Parliamentarians also to draw on this knowledge in informing their views as they contribute to this critical policy process.

INTRODUCTION

This **briefing** sets out key findings from research projects funded through the EC Research Framework Programmes related to water scarcity. It has been written by Andrew Farmer of IEEP. It provides an introduction to the research and examines different possible future outcomes for water resources in Europe and the impacts these may have. It concludes by considering the policy implications of the findings. The briefing covers:

- The policy context for water scarcity issues at European level.
- Modelling of future water resources.
- Climate change impacts.
- Impacts of water scarcity on ecosystems, agriculture, industry and domestic users
- Socio-economic choices and their impacts on water resources.
- Priorities for water use.
- Policy implications.

This briefing is supported by two shorter additional briefings. One describes the **EU policy framework** that addresses water scarcity. The other provides background to the **Astana Environment for Europe Ministerial Conference.**

The pressures on water resources are increasing across the world. Water scarcity occurs where insufficient water resources are available to satisfy long-term average requirements. Population growth, more intensive agriculture, energy and manufacturing needs and tourism all contribute to increasing water use . In many regions water resources are already under threat and climate change will exacerbate this in many areas (Figure 1). Increasing pressures are also leading to concerns over the consequences for internal, transboundary and regional security implications as neighbouring countries compete for water resources.

Box1: Definitions

Water scarcity means that water demand exceeds the water resources exploitable under sustainable conditions.
Drought is a temporary decrease in water availability due for instance to a lack of sufficient rainfall.
An area experiences **water stress** when annual water supplies drop below 1,700 m3 per person. When annual water supplies drop below 1,000 m3 per person, the population faces **water scarcity**, and below 500 m3 per person **"absolute scarcity"** .

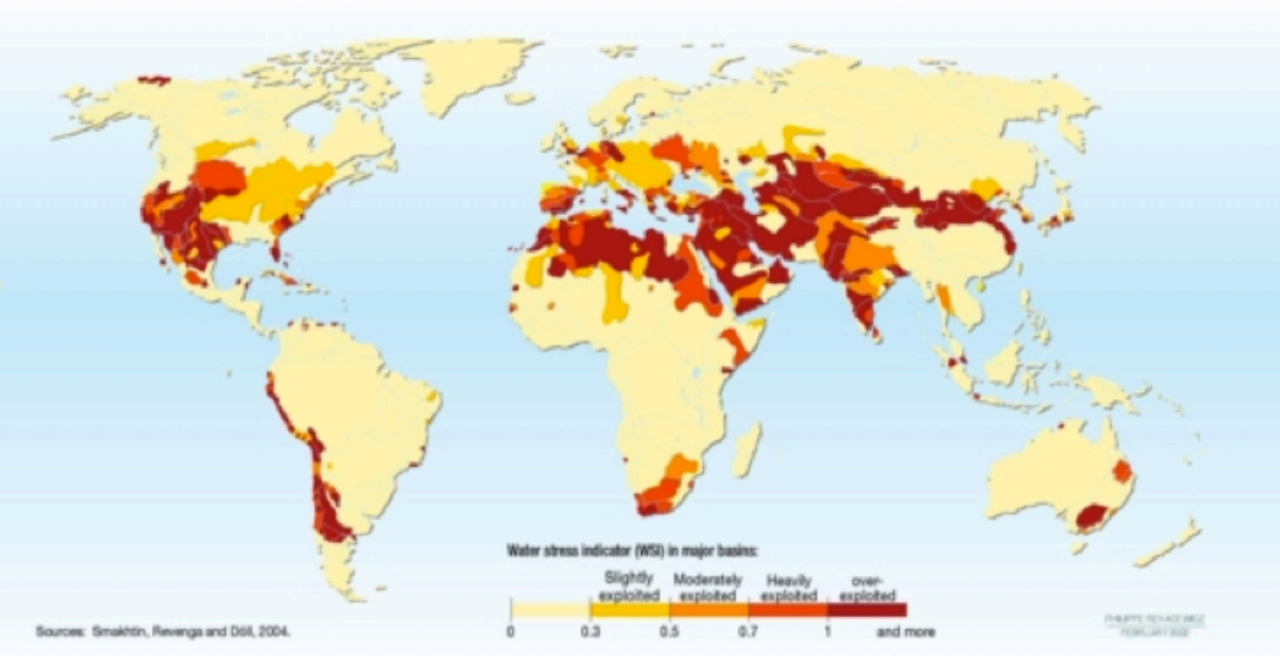


Figure 1. Water scarcity and stress across the world

In the EU: In Europe problems of water scarcity and droughts arise in many regions due to imbalances between abstraction and availability. Over the past thirty years droughts have increased in both intensity and frequency in the EU. The overall economic impact of these is estimated to be about €100 billion, without even including social and environmental costs. Total EU water abstraction is about 247,000 million m^3/year - 44% for energy production, 24% for agriculture, 17% for public water supply and 15% for industry , although these vary significantly across the EU. For countries in southern Europe, the agriculture sector accounts for more than 50% of abstraction (80% in some regions).

EU action and initiatives: EU water law has traditionally focused on water quality issues. However, the Water Framework Directive (WFD) 2000/60/EC provided the first coherent legal tool at EU level to address water scarcity by requiring long-term planning of water resources. The key tool to foster water efficiency introduced by the Directive is water pricing. The strategic approach of the EU has since been taken forward with a 2007 Commission Communication on water scarcity and droughts, which presented a set of policy options at EU, national and regional levels to address and mitigate water scarcity and drought. However, bringing together all of the actions needed to address water scarcity in a strategic approach is problematic as water affects a wide range of sectors. For example the need to overhaul the Common Agricultural Policy to protect water resources is currently the subject of vigorous debate. Globally, EU initiatives in other regions of the world are progressing, such as under the EU Water Initiative, but challenges remain in improving funding support for initiatives in these areas. In September 2011 the Ministerial Meeting of the UNECE Environment for Europe process will take place in Astana, Kazakhstan. One of its two main themes is water scarcity, illustrating its importance in a pan-European context.

EU RESEARCH PROJECTS ON WATER SCARCITY

Water scarcity has been a theme of studies funded through the EU Research Framework Programmes for many years. In many cases water scarcity is not the sole focus of the research, but is a major theme within wider research, such as on water management or climate change. Annex I provides a list of relevant FP6 and FP7 projects. Some FP7 projects are still in their early stages, and outputs are still forthcoming. However, links are provided to these projects for future reference. It is also important to note that DG ENV is closely linked to much of the FP research activity and, indeed, has established its own research specifically to compliment and draw upon FP research outcomes. Therefore, reference in this briefing is also made to this research activity. EU research funding under other programmes also contributes in taking forward action on water scarcity. Annex II provides further information on these with specific reference to LIFE+ and the Competitiveness and Innovation Framework Programme (CIP).

MODELLING WATER FUTURES: WATERGAP

A key way to examine possible future water resources in Europe and the pressures on them is through modelling. Modelling allows ideas to be explored – it is not the provider of definitive answers. The principal pan-European water model used within a number of FP projects and also supporting analysis for DG ENV is the WaterGAP (Water – Global Assessment and Prognosis) model. WaterGAP is a global water model developed at the Center for Environmental Systems Research, University of Kassel. WaterGAP computes both water availability and water use on a global grid and consists of two main components: a Global Hydrology Model to simulate the terrestrial water cycle and a Global Water Use Model to estimate water withdrawals and water consumption over different time periods. It can assess current water resources and uses, and the impacts of climate change and socio-economic drivers on changes in the water system and in water stress.

A large number of different driving forces are incorporated into WaterGAP. Each of these can be varied according to other model predictions, expert opinion, scenario analysis, etc., to assess the sensitivity of water outcomes to different drivers. The driving forces include:

- Population – driving domestic water use.
- Per capita income – water use tends to increase as a country becomes wealthier, but above a certain income, water use may level off and in some cases may even decline.
- Thermal electricity production – water needed for thermal power plants.
- Manufacturing value added - for water use in the manufacturing industry.
- Irrigated areas – as an important driving force of irrigation water use.
- Number of livestock – for water use by livestock.
- Technological changes – which tend to reduce water use in all water use sectors.

CLIMATE CHANGE IMPACTS

Climate change may affect water resources through changes in precipitation patterns, changes to water demand patterns, etc. EU research on climate change impacts on water resources has not sought to produce new models of future climate, such as those produced under the Intergovernmental Panel on Climate Change (IPCC). Rather, the outputs of existing climate models (precipitation, temperature, etc.) are used as drivers within water models to determine possible water resource outcomes (such as through WaterGap). It is important to note, however, that different

Box 2: How climate scenarios affect future outcomes: the Guadiana River, Spain and Portugal

The Guadiana River has a catchment area of about 67,500 km^2 and about 1.7 million people live in this water scarce region where irrigated agriculture is the highest user of water. Scenarios used by modellers are, however, very variable with regard to the river basin. For example the B2 scenario predicts a slight decrease in population in 2050 (1.5 million), while the A2 scenario predicts a slight increase (1.8 million). Other scenarios used are more extreme. With regard to water availability, the possible future range includes both a drastic reduction (ECHAM4 – A2 GCM) and a medium size increase (HadCM3 – B2). However (and perhaps surprisingly), the projected water withdrawals are very similar between the scenarios. The main reason for this seems to be a projected increase in irrigated land due to the combination of a warmer and drier future climate. Thus even though the projections for future water availability and water demand show a high range of possible developments, future water stress conditions in the Guadiana basin will remain severe.

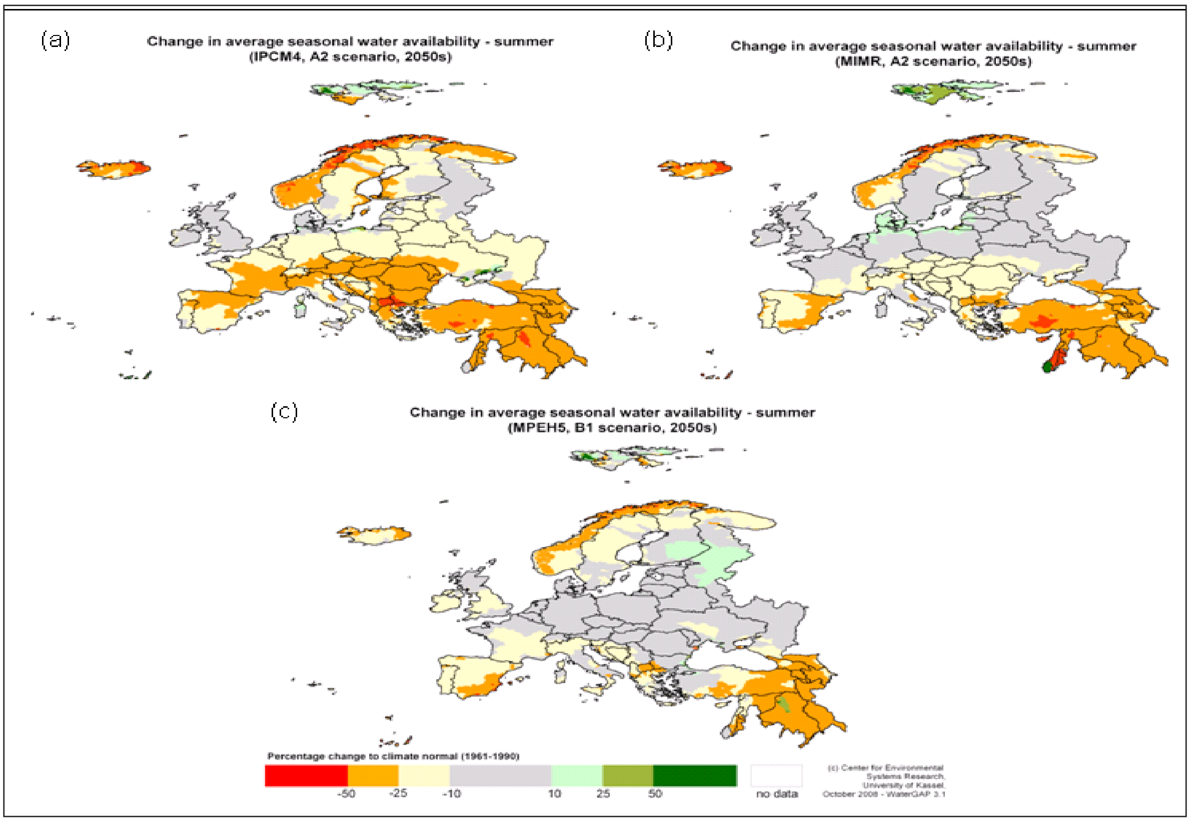
model assumptions result in different predictions of future climate. Climate modellers have used different scenarios to determine a range of potential climate outcomes and these different scenarios are used in water models.

Therefore, there is no single prediction for how future water resources will be affected by climate change. While this may, at first glance, add to the complexity of understanding future water resources, the range of model outputs allows one to understand how different future socio-economic choices may affect water outcomes. These outputs can help inform policy choices by helping to design policies which reduce pressures on future water resources as well as policies that adapt to situations where future water scarcity may be very difficult to avoid.

For example, two climate change scenarios usually used within water models are the IPCC A2 and B2 scenarios for the 2020s, 2050s and 2070s. Each describes a different demographic, politico-economic, societal and technological future, exploring global energy, industry and other developments and their implications for greenhouse gas emissions and other pollutants. The A2 scenario implies a differentiated world, with emphasis on regional cultural identities, family values and local traditions. This is accompanied by a continuous and high population growth and less concern for rapid economic development. The B2 scenario describes local solutions to economic, social and environmental sustainability. Box 1 illustrates the different results that may be obtained using different model inputs for a key Iberian river basin. These scenarios are input into Global Climate Models (GCMs) to produce different possible future climate outcomes.

Results of incorporating the outcomes of climate models into WaterGap show that while increasing precipitation over larger parts of the world could be expected to make more water available to society and ecosystems, the increase in air temperature intensifies evapotranspiration nearly everywhere, and hence reduces water availability. These two effects interact differently at different locations and can produce a net increase or decrease in water availability. Figure 3 shows this variability for different seasons, with some currently water rich areas having a decrease in water availability and, in particular, less available water across much of southern and central Europe. However, it is important to stress that all model outcomes should be examined closely, including the assumptions regarding their inputs.

Figure 2. Change in seasonal water availability under future climate conditions in 2050.



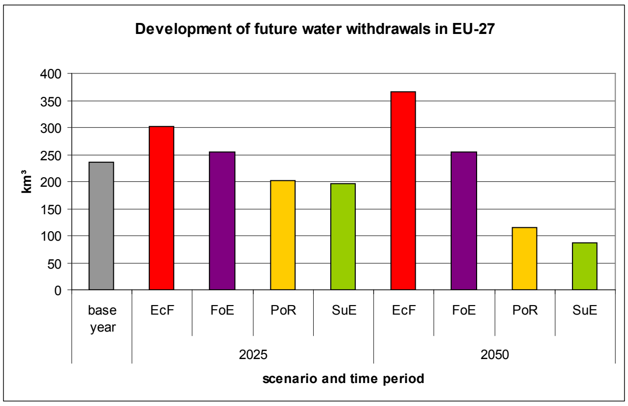
SOCIO-ECONOMIC SCENARIOS FOR WATER OUTCOMES

The EU's Adaptation White Paper (COM(2009)147) calls for adaptation actions to deal with unavoidable impacts of climate change. In order to identify possible adaptation measures regions and sectors vulnerable to climate change must be identified. Using scenarios helps to imagine what might happen over the next half a century and they are, therefore, an important tool in water resources research.

Scenarios provide alternative views of the future but they are not predictions nor should they be taken as the most likely of the numerous possible futures. By using scenarios, possible future developments can be explored and strategies to influence those potential developments can be tested. Although the use of scenarios has been embedded in the climate work of the IPCC, their use on an extensive scale for water issues in Europe is recent and principally addressed in the SCENES FP6 project where four scenarios were developed. These draw on the scenarios developed under UNEP's Global Environmental Outlook (GEO) developed for climate change analysis, but their final forms are significantly different to GEO scenarios in some cases. The four scenarios are:

- *Economy First (EcF):* A globalised and liberalised economy pushes the use of all available energy sources and an intensification of agriculture where profitable. The adoption of new technologies is low. Thus water use increases.
- *Fortress Europe (FoE):* A high number of crises (energy, financial, and climatic) result in an increasing instability and terrorist activities throughout the world, as well as in Europe. The WFD becomes the Water Security Framework Directive.
- *Policy Rules (PoR):* A stronger coordination of policies at EU level, but policies become slowly more ineffective. By 2050, Europe is at the forefront of a new socio-economic paradigm of public/ private partnerships.

Figure 3. Development in future water withdrawals for 2025 and 2050 as calculated for the SCENES scenarios. Aggregation on EU-27 level, base year 2005.



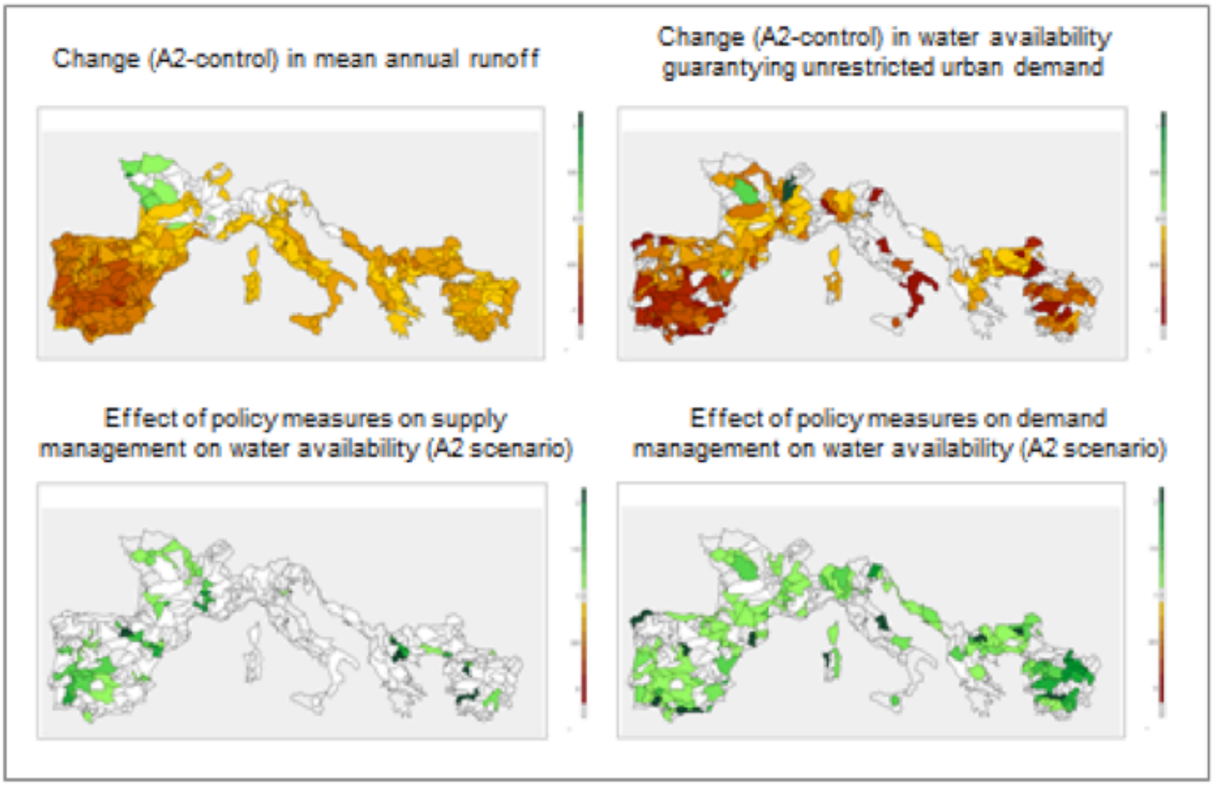
- *Sustainability Eventually (SuE):* This scenario sketches the transition from a globalising, market-oriented Europe to environmental sustainability, where local initiatives are leading and where the landscape becomes the basic unit of socio-economic planning.

Scenarios result not only in different levels of water use (Figure2), but also vary in the importance of different water users (Figure 3). For example, under EcF most water resources are used for industrial purposes followed by agricultural requirements which are located in the Mediterranean region. The FoE scenario shows only a slight increase in the number of river basins where most of the water is used by the agricultural sector. The SuE scenario reflects the trend in pushing back the industrial water uses in Europe. Here most of the water is likely to be used by the agricultural and domestic sectors. Manufacturing remains as the major water use sector in northern Europe.

DETERMINING THE IMPACT – PRIORITIES FOR WATER USE

Where there is insufficient water, different water users are potentially in competition. Laws and policies may be adopted to prioritise one user over another in cases of drought and long-term water scarcity planning. Understanding this is important not only for practical

Figure 4. The effect of different policy measures on water supply in Mediterranean countries of Europe.



management action, but also to interpret research outcomes. If there is 20% less water in a basin in the future, it is not reasonable to assume all sectors are equally affected – management decisions will be taken to protect some users. A research survey of countries across Europe provided an overall collation of use priorities set out in Table 1 below. It is important to note that the high priority for ecological objectives in EU law is not always adequately reflected in the laws and policies in Member States.

IMPACTS ON INDUSTRY AND ENERGY

Industry may be affected by future water scarcity due to lack of water for abstraction for manufacturing or as cooling water. This is, indeed, probable in some areas. However, a larger driver is likely to be the increased water temperature as a result of combined climate change and lower flow levels. Existing temperature sensitive industries may be forced to adopt new cooling technologies if river temperatures increase. Future electricity generation will increase cooling water requirements, however cooling water capacity will decline, consequently restraining the building of thermal power plants in river basins. Hydropower plants will also be at risk if river flows are reduced. This combination of potential impacts on energy production for thermal and hydropower production could result in concerns for energy security, depending on the importance of these sources for national power generation.

IMPACTS ON AGRICULTURE/FOOD SECURITY

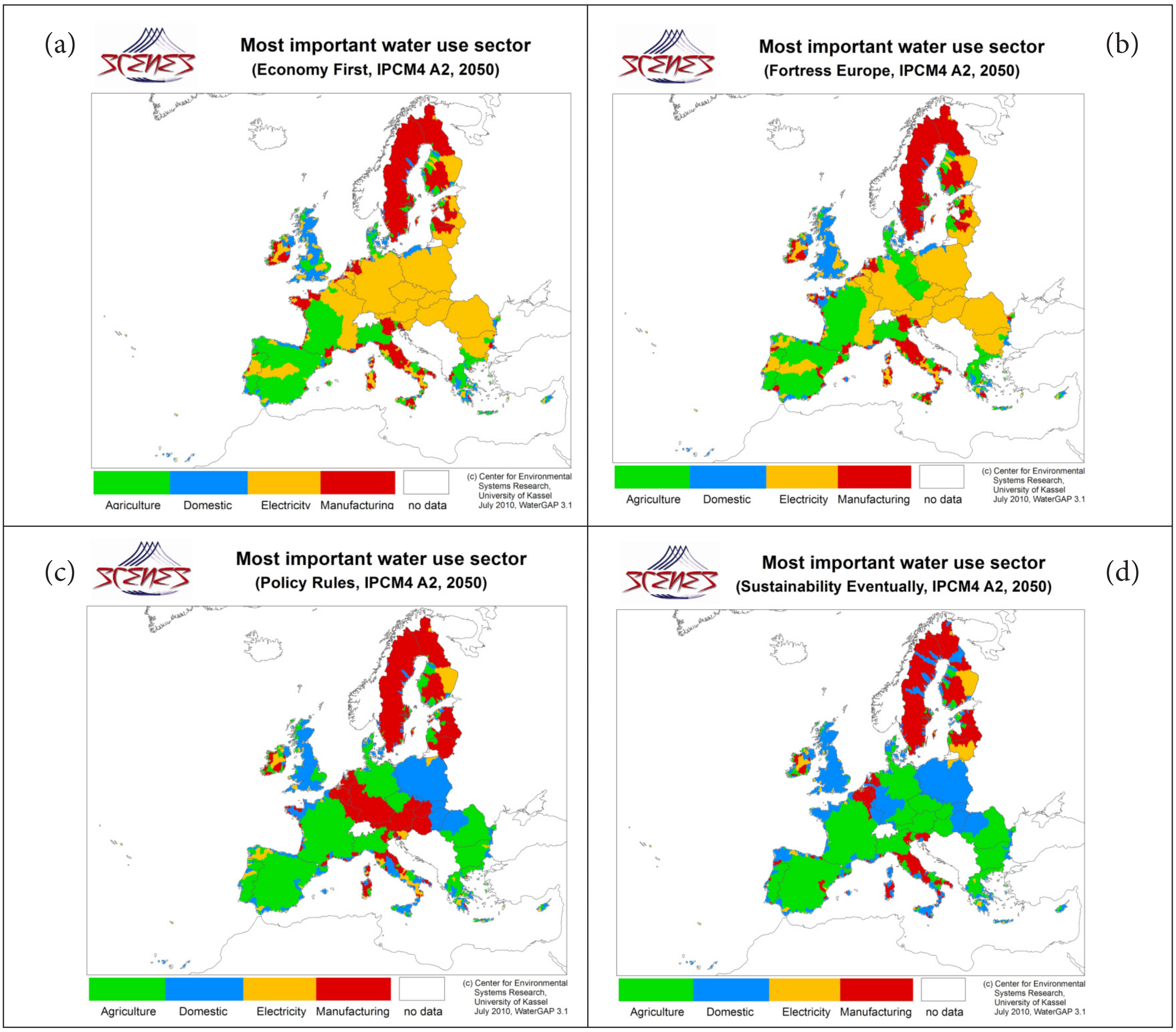
The PESETA project examined direct (CO^2 and temperature) climate change effects on agriculture (without water impacts). Crop suitability and productivity increases in Northern Europe are caused by lengthened growing season, decreasing cold effects on growth, and extension of the frost-free period. Crop productivity decreases in Southern Europe are caused by a shortening of the growing period.

However, research on climate impacts via water and different socio-economic futures has found that socio-economic drivers, technological development and agricultural policies are more important than climate

TABLE 1. Priorities water users when water is scarce

Priority	Water user	Comment
High priority	Domestic supply	To be maintained as far as possible to protect health and maintain supplies for fire fighting
High priority	Ecological objectives	To achieve WFD objectives and protection Natura 2000 sites are strong drivers in EU law
High-medium priority	Power sector	Of more importance than other industry, given those reliant on it
Medium priority	Industry	Employment and economic importance
Medium priority	Agriculture that is water efficient	Would be prioritised over less efficient agriculture (e.g. drip irrigation compared to spray irrigation)
Medium priority	Agriculture with high numbers of workers	Its position is due to social and economic concerns
Medium priority	Agriculture : permanent crops	Due to the potential for long-term damage.
Low priority	Other Agriculture	Such as water inefficient agriculture
Low priority	Navigation	If this is threatened, maintaining water levels would be extremely difficult to achieve
Low priority	Recreational water use	This includes measures to restrict non-essential use at home (e.g. car washing).

Figure 5. The most important water use sectors in 2050 under four socio-economic scenarios.



The effect of different policy options has been examined using the WAPAA model within the CIRCE project. These show the effect of demand and supply regulation and management in Mediterranean countries (Figure 5).

change as a factor influencing future irrigation water withdrawals and water stress. Irrigation efficiency is the most important factor. Thus water stress for agriculture will increase in the Mediterranean region and South Eastern Europe, but much of this can be compensated for by technology innovation.

Future water use may be exacerbated by increased production of bioenergy crops. For example, research found that many irrigated areas currently used for silage maize could be used for crop production for biogas, equivalent to 11% of EU renewable energy production in 2010. Such research is important not only to examine the implications of climate mitigation policies (i.e. renewable energy targets) on water resources, but also their competition with food production policies.

IMPACTS ON ECOSYSTEMS

A wide range of water conditions affect the nature of the ecosystems they support (both aquatic and terrestrial). These include the total volume of water, high and low water levels, timing of flooding and temperature. Many of these elements can be viewed under the overall heading of 'environmental flows' and minimum environmental flows can be considered an objective of the WFD.

Over-abstraction today places ecosystems in a number of parts of Europe under severe pressure. Under climate scenarios for the future, research indicates that the vast majority of freshwater ecosystems in Europe will experience significant ecological change , for both river ecosystems and wetland ecosystems, in particular due to changes to flow regimes.

While there are obvious impacts of reduced water levels on river ecosystems, it is important to note that reduced flooding regimes can also have significant ecosystem impacts. A study on floodplain inundation has found that three factors are important in determining the habitats of these areas: the overall flood volume, the duration of flooding and the time of year for flooding. Under different climate scenarios and models, the timing, volume and duration of flooding are all predicted to change across much of Europe. Lower precipitation levels in many areas will reduce duration and volume of flood waters. This reduction in available water is likely to lead to a decrease in formerly inundated floodplain forests and grasslands, which will be colonised by more terrestrial species or invaders. This situation will directly lead to a decline of habitat area for these vegetation types. Also a decrease of flood volume can lead to morphologically less active systems, especially in the upland areas, which lead to an initial increase in softwood forest establishment.

DOMESTIC SUPPLY AND THE ROLE OF TECHNOLOGICAL INNOVATION

Extreme water scarcity may impact on domestic supply and in extreme cases can lead to stand pipes in the street. However, as noted above, domestic use is generally protected during times of scarcity while agriculture and other users are restricted. Some uses may be banned (such as hosepipes or car washing). However, domestic users may have an important role in delivering improved efficiency in water use.

It is important to recognise the role of improving the efficiency of water use by domestic users in addressing current and future water scarcity. Improving the efficiency of different types of use (appliances, irrigation, etc.) benefits from private and public sector research and Annex II provides examples of EU funding in this area from other funding programmes. It is important to note that households can already improve efficiency. Research shows wide variation in the efficiency of different appliances and, hence, overall household water consumption (Table 2). Furthermore this varies between regions (Table 3). Increasing incomes can both increase consumption (adding new appliances) and reduce it (buying more efficient appliances).

Research on the overall potential for saving water has, however, been conducted for DG ENV. This concluded that in the Mediterranean, the water saving potential represents 45% of the 2025 demand (330 km^3/year)

TABLE 2. Efficiency of water use by appliances and total for households (l/cap/day)[13]

Appliance	Least efficient	Average	Most efficient
Shower	79.5	52.5	37.5
Toilet cistern	54.0	36.0	14.0
Washing machine	37.5	18.4	6.3
Dish washer	6.2	4.4	2.5
TOTAL (l/cap/day)	177.2	111.3	60.3

TABLE 3. Mean household water consumption per un region (l/cap/day) [14]

Region	E Europe	N Europe	S Europe	W Europe	N Africa	W Asia
Consumption	173.5	144.1	198.6	136.7	139.3	164.8

and is significantly larger than the expected increase in demand over the same period (+50km^3/year). For Northern Mediterranean countries the largest potential is in the irrigation sector (60%), followed by the industrial (25%) and domestic (15%) sectors.

These savings could be achieved by:

- Increasing the efficiency of water networks in irrigation (transport losses reduced to 10%, efficiency raised to 80%).
- Increasing efficiency in public water supply (loss reduced to 15%, user leaks reduced to 10%).
- Improving the use of water for industrial purposes (recycling generalized at 50%).

Thus, although research stresses the increasing water scarcity that will arise with climate change and some social and economic trends, there is much that can be done to address these pressures through improved efficiency and technological innovation.

CONCLUSIONS

Water scarcity is a serious and growing problem across many parts of Europe. Over abstraction, in particular, has been driven by changing agricultural patterns, changing household use (appliances, household size and behaviour), tourism and industrial activity. Water scarcity has, therefore, risen sharply up the EU's policy agenda.

Water scarcity problems will be exacerbated due to climate change, increasing the vulnerability of socio-ecological systems. The social and economic choices we make have to potential to increase or decrease our vulnerability to climate change risks. In order to understand appropriate responses to current and future water scarcity it is necessary to understand the vulnerability of the systems, sectors, populations, etc., that are at risk .

To respond to these vulnerabilities, a wide range of different measures are possible. The ClimWatAdapt project identified a range of different types of possible measures:

- **Technical measures** relate to technical infrastructure such as water supply systems.
- **Measures related to "green" infrastructure,** i.e. the interconnected network of open spaces and natural areas that naturally accommodates stormwater.
- **Measures changing management or practices:** such as changes in farming practice (such as water efficient crops) or changes in water management.
- **Risk prevention measures** that aim to reduce the risk of economic damage due to non technical action, such as early warning or risk maps.
- **Economic and financial measures,** i.e. incentives that change the behaviour of certain people or sectors, e.g. water pricing.
- **Awareness/information measures** making human society more aware of adaptation needs. Water footprint, product labelling.
- **Land use change and allocation measures:** which change how land is used, e.g. reallocation of buildings, afforestation of agricultural land.
- **Regulatory measures e**stablishing or changing laws and regulations.
- **Long-term contingency planning measures.**

While it is possible to see examples of all of these types of measures being used in practice, there are constraints in their application. For example, the Xerochore project identified a number of limitations regarding drought management in the EU which are also appropriate to water scarcity management, including lack of long-term planning, limited participation and failure of integration of water planning into other areas of policy development. The UNECE argued that efforts should aim to reduce vulnerability by reducing exposure and sensitivity (potential impacts) and increasing adaptive capacity and the CIRCE project concluded that policies for adaptation to climate change should institutionalise long-term planning. In particular, the importance of public involvement has been stressed by the CapHaz-Net project emphasised that the role of ensuring public awareness raising with regard to risks from hazards, including water scarcity, and how public action (such as on water efficiency) depends on the perception of risk.

How far countries are prepared to make the necessary decisions to address water scarcity will certainly vary. They may also find certain pressures or constraints arising from the EU level (such as with regard to bioenergy production) that interact with the adaptation responses. The SCENES project noted, therefore, that there is the potential for a range of conflicting and synergistic cross-scale governance outcomes. Understanding these, and managing them, should therefore be an important priority for policy makers at all governance scales.

POLICY IMPLICATIONS

The Water Framework Directive (WFD) is the main tool developed at EU level to address water scarcity, with its wide-ranging scope and ambitious objectives. Its specific measures also should deliver improved water management, such as ensuring water abstraction is authorised and so reducing illegal abstraction. The WFD should challenge Member State authorities to address the issue of water scarcity. However, there is concern over how ambitious Member States are in their implementation and this level of ambition will form a focus for future policy debate. A far greater emphasis on appropriate measures to address water scarcity issues in implementing the WFD should be expected in the future.

Future implementation of the WFD will need to take increasing account of climate change impacts. The Xerochore project has emphasised the need to include this in future periods of river basin planning. Furthermore, policy makers need to take seriously the WFD objective for minimum ecological flows as a high priority driver for decisions on water allocation and planning.

The complexity of the legal and policy environment is a further challenge. While the WFD is central to EU policy, other policies are piecemeal in their coverage of water scarcity issues and integration with sectoral policies such as agriculture is poor. There is, therefore, a gap between what is desired at EU level and what can be delivered at EU level. It is important that water scarcity issues are integrated into sectoral policies and that systems are put in place to monitor how this is progressing. A key integrating tool is water pricing, but this alone may not be sufficient to deliver water resource outcomes.

The agriculture sector needs particular attention. Pricing and regulatory controls are needed, alongside encouragement for investment and monitoring. The forthcoming revision of the Common Agricultural Policy will be critical. In this regard there is a specific opportunity to include some WFD obligations as cross-compliance requirements under Pillar I of the CAP, such as the need for abstraction to be authorised and, therefore, to help discourage illegal abstraction.

There are a number of further measures that can be taken at EU level, such as on efficiency of water using devices and use of EU funding. However, the complexity of the policy environment and the complexity of the dynamic social and economic interaction with hydrological systems present a major challenge for addressing water scarcity. Meeting this challenge, therefore, requires a partnership between EU, Member State and regional authorities as well as with the public and other stakeholders.

WHAT IS NEXT?

The debates within the Environment for Europe process and leading up to the development of the EU 'Blueprint' next year are critically important in establishing the framework for how we shall address water scarcity – the types of measures, role of the EU and Member States, etc. The decisions to be made need to be based on a sound knowledge base and the results of EU funded research can play a major role in ensuring decisions are robust. It is important, therefore, for Parliamentarians also to draw on this knowledge in informing their views as they contribute to this critical policy process.

ANNEX I

Projects (FP6 & 7 and others) relevant to this briefing

- The ACQWA Project: Investigating the vulnerability of water resources to climatic change in mountain regions: http://www.acqwa.ch/
- AquaStress: Mitigation of Water Stress through New Approaches to Integrating Management, Technical, Economic and Institutional Instruments: http://www.aquastress.net/
- CapHaz-Net: Social capacity building in the field of natural hazards and the role of risk communication: http://www.caphaz-net.org/
- CIRCE project: climate change and impact research in the Mediterranean:
- ClimWatAdapt: Climate: Adaptation – modelling water scenarios and sectoral impacts (DG ENV project): http://www.climwatadapt.eu/
- CLIWASEC – A cluster of FP7 research projects on climate change, water and security in Southern Europe and neighbouring regions: http://www.cliwasec.eu/home/home.php
- ENSEMBLES - Ensemble-based Predictions of Climate Changes and their Impacts: http://www.ensembles-eu.org/
- GENESIS, Groundwater and dependent ecosystems: New Scientific and Technical Basis for Assessing Climate Change and Land-use Impacts on Groundwater Systems: http://www.bioforsk.no/ikbViewer/page/prosjekt/hovedtema?p_dimension_id=16858&p_menu_id=16904&p_sub_id=16859&p_dim2=16860
- GRAPHIC (Groundwater Resources Assessment under the Pressures of Humanity and Climate Change): http://www.unesco.org/new/en/natural-sciences/environment/water/ihp/ihp-programmes/graphic/
- HighNoon: adaptation to changing water resources availability in northern India with Himalayan glacier retreat and changing monsoon: http://www.eu-highnoon.org/
- NeWater - New approaches to adaptive water management under uncertainty: http://www.usf.uni-osnabrueck.de/projects/newater/index.html
- PESETA - Projection of Economic impacts of climate change in Sectors of the European Union based on bottom-up Analysis: http://peseta.jrc.ec.europa.eu/
- REFRESH - Adaptive strategies to mitigate the impacts of climate change on European freshwater ecosystems: http://www.refresh.ucl.ac.uk/
- RESPONSES – European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation: http://www.responsesproject.eu/
- The SCARCE Consolider project on Iberian river basins: http://www.idaea.csic.es/scarceconsolider/publica/P000Main.php
- SCENES: Water Scenarios for Europe and for Neighbouring States: http://www.environment.fi/default.asp?contentid=379147&lan=EN
- SCENES webservice: http://www.1stcellmedia.de/customer/uni/cms/
- WATCH (Water and Global Change): http://www.eu-watch.org/
- Water2Adapt Project: http://www.feem-project.net/water2adapt/01_project.html
- WETwin: Integrating wetlands in river basin management: http://www.wetwin.net/about_introduction.html
- XEROCHORE – An Exercise to Assess Research Needs and Policy Choices in Areas of Drought: http://www.feem-project.net/xerochore/

ANNEX II

Research Relevant to Water Scarcity: LIFE+ and Competitiveness and Innovation Framework Programme

Research funded under the 6th and 7th FP form only part of the research funded by the European Commission relevant to water scarcity. Indeed, much of the research directly aimed either at changing water use behaviour or at technological innovation is funded through programmes such as LIFE+ and the Competitiveness and Innovation Framework Programme (CIP). It is not possible to review all of these projects here, but this Annex provides examples of the types of project funded so that the reader can explore these and others in more depth elsewhere if interested.

LIFE+ projects have included technological development projects to enhance water efficiency, methods to improve water use by different types of users and regional or municipal scale projects to integrate measures to improve water use.

Examples include:

- gEa project which developed "gEa", an interoperable irrigation management platform, in the El Vicario community in Guadiana, Spain, as an online system to support decision-making for farmers by offering the automated and real-time reading of meters, control of water quality, regulation of water consumption and detection of leaks.
- HAGAR, which aimed to demonstrate environmental benefits of self-management systems for water-related communities. The 'system for irrigating support', which reduces water demand and calculates real time plant water requirements, provided positive.
- Reuse filter backwash-water project. Many supplies of drinking water contain substances which must be removed in order to allow it to be used for human consumption. The frequently used filters, therefore, have to be washed out, resulting in backwashing, which is then disposed of as wastewater. The project showed that 99.85% of the backwash water could be recovered for drinking water.
- Zaragoza: water saving city. The aim of the project was to reduce household water consumption in Zaragoza by 1 million m3 in one year. This was to be achieved by changing consumption patterns and through the effective use of water saving technology. The project took the form of an awareness campaign setting concrete targets for the consumer. Before the campaign, only one third of households practised any kind of water-saving measure (a device or consumption habit). At the end of the project, this had doubled.

Competitiveness and Innovation Framework Programme (CIP) projects work with industry and have focused on improved technologies for water saving, including:

- RECOWATER - retort cooling water recycling. Retort food production uses steam to achieve commercial sterility. Reuse is sensitive due to possible re infection. Mars developed a recirculation system that allows 95% reduction of potable water used for cooling.
- AUTO-LEAK - up to 50% of water produced by operators is not paid for, much lost through leaks in the distribution network. The adoption of automatic meter readers integrated with other leakage control technologies, will identify the location of more leaks than is now possible.
- Cyprobell - grey water recycling plant. Potable water used in households and industry is normally taken directly from the drinking water system and discharged. This project in Cyprus is working to improve technology for grey water use.

ANNEX III

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SEVENTH FRAMEWORK PROGRAMME

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