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Current state and future challenges of Europe's Waters

STUDY

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Abstract

This study explains the current state of Europe's fresh waters and explores the challenges ahead. First, the state of water availability and quality are linked to climate change, energy, finance and nature protection. Then the current gaps and challenges are identified in terms of water efficiency, land-use, economic instruments, knowledge, governance, global aspects, and climate change.

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CONTENTS

LIST OF ABBREVIATIONS

CAP	Common Agricultural Policy
CC	Closed Cycle
CCS	Carbon Capture and Storage
CSP	Concentrated Solar Power
EAFRD	European Agricultural Fund for Rural Development
EIA	Environmental Impact Assessment
EPBD	Energy Performance of Buildings Directive
EQSD	Environmental Quality Standards Directive
ETC/W	European Topic Center on Water
EuPs	Energy use in Products
GWD	Groundwater Directive
IAS	Invasive Alien Species
ICPDR	International Commission for the Protection of the Danube River
IPCC	Intergovernmental Panel on Climate Change
ISPA	Instrument for Structural Policies for Pre-Accession
LCPD	Large Combustion Plant Directive
NOx	Nitrogen Oxides
OT	Once Through
PHARE	Poland and Hungary: Assistance for Restructuring their Economies
RBMP	River Basin Management Plans
SAPARD	Special Accession Programme for Agriculture and Rural Development
SEA	Strategic Environmental Assessment

SO2 Sulphur Dioxide

UWWD Urban Waste Water Directive

UWWT Urban Waste Water Treatment

UWWTD Urban Waste Water Treatment Directive

WEI Water Exploitation Index

WFD Water Framework Directive

WISE Water Information System for Europe

WuPs Water use in Products

WWT Waste Water Treatment

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EXECUTIVE SUMMARY

Background

This study has been requested by the Environment, Public Health and Food Safety Committee (ENVI) of the European Parliament in the context of the forthcoming Blueprint to safeguard Europe's waters.

Aim

The aim of this study is to provide an overview of the current situation in Member States regarding water availability and water quality. In this context the study provides the current status of the challenges facing the European water situation in regard to:

- water and climate change;
- water and energy;
- water and financing;
- water and nature protection;

Furthermore, the study provides an analysis of:

- Implementation, achievements, failures and gaps;
- Challenges for water availability (including the links with water demand, urbanisation, extreme weather events, water efficiency, etc.)
- Challenges for water quality (i.e. do national measure and/or measures within other relevant EU legislation achieve the objective of the Water Framework Directive for priority hazardous substances? Etc.)

The current situation of water in the EU

Key findings regarding water availability:

Water availability is mostly a local or regional issue – at EU-level it is a relatively minor problem but many regions in the dry South (Spain, Italy, Malta, Cyprus) and those with high population densities and/or concentrations of energy infrastructure or industry (Belgium, South East England, North East France, North Germany) face water scarcity issues.

The energy sector is the largest abstractor of water in most regions, with water used for cooling and in most cases returned quickly to surface water sources. Irrigation for agriculture is the next biggest user and the biggest user in Southern Europe. Households and industry remain important, but lesser, water users.

End-use water efficiency is improving as more efficient technologies (i.e. washing machines, dishwashers, toilets) are deployed, but demographic changes, i.e. smaller households with higher per-capita use and high leakage rates (up to 50%) in many Member States water supply networks, make overall water efficiency improvements harder to achieve.

Key findings regarding water quality:
Water quality in the EU is improving, but much work remains to be done to achieve the 'good' status targeted by WFD.

Wastewater treatment (WWT) in Europe is improving, with observable trends towards both higher percentages of the population being connected to treatment systems and moves towards better quality (tertiary) treatment.

Agriculture remains a major source of nutrients, such as nitrates and phosphorous, and this causes significant and continuing eutrophication problems in European waters, leading to lower ecological quality.

Acidification and other water pollution issues have shown positive trends - especially in the energy and industry sectors - as a result of technological advances and environmental, health and safety regulation.

Note on data
Data for water availability and quality is improving but remains highly variable by data point and member state. Essential data on abstraction and leakages remains weak and fragmented. The result at EU-level is that it is difficult to form a clear view on these important water issues.

The issue of sources, availability and collection, of data is further elaborated on in Chapter 3.

Challenges for European waters

European waters face a range of important challenges in the coming years, this section presents summary findings in the four areas identified for this study.

Water and climate change

Climate change is expected to have large impacts on the hydrological cycle. Altered precipitation patterns, evapo-transpiration and water temperature increase could lead to significant changes in water availability and quality, although the magnitude of the impacts is often uncertain due to lack of data and the complexity of ecosystems. Although at global level it can be stated with certainty that climate change-induced changes in both freshwater quality and quantity are expected to have large negative impacts which outweigh the benefits (Bates et al., 2008), on a European level it is more difficult to assess the time and scale of the potential damages. Some of the more certain impacts of climate change of water are:

- Changes in precipitation patterns, more water in the northern parts of Europe an less water in the southern parts;
- Changes in evapo-transpiration which could lead to prolonged droughts, salination of ground-waters, and ecosystem/biodiversity changes;
- Higher water temperatures and reduced ice covers;
- Increased run-off which results in augmented levels of nutrient loads;
- Increased costs for water management including waste water cleaning, flood control, irrigation and leakages; and,

- Changes in levels of pathogenic microbes which might have health implications.

In summary, water-stress is expected to increase due to climatic changes, and floods and droughts are expected to increase in frequency and intensity. However, adequate water management and climate change adaptation can help to substantially mitigate the negative impacts.

Water and energy

Water and energy are inter-related and also inter-dependent. This relationship is essential in providing the infrastructure through which our society functions. Climate change and other trends, such as increasing fuel costs, are leading to rapid change in the demands and pressures on both sectors. While investment in infrastructure, technological change and improved learning are improving the efficiency of water use in the energy sector, significant negative impacts on water availability and quality are still evident. Important challenges for water and energy include:

- The impact of hydropower on water courses vs. the low-carbon energy it generates, in the context of growth in pumped storage and micro-hydro;
- Changes in energy cooling systems leading to declining water abstraction but increasing water use by the sector;
- High water consumption in the production of biofuels;
- Continuing challenges from traditional energy-water pollution, i.e. heat pollution, acid rain and contamination. Potential new challenges e.g. shale gas.;
- Energy use of the water sector and an increasing need for efficiency. Potential for increase in energy from sewage sludge gas. Energy intensity of desalination;

For both water availability and quality it will be vital to understand how climate change and other mega-trends, such as electrification of transport, will change the demands and impacts on water and energy and what this means for management.

Water and financing

The need to replace old water-related infrastructures and to build new systems (especially for member states in Eastern Europe) requires large funds, not readily available within the sector. The principles for financing water services within the EU (full cost recovery) have been enshrined in the WFD, but many of the current financing systems still tend to ignore externalities and economic instruments focusing on efficiency in water supply are not widely used in Europe.

Innovative approaches to finance the required investments are needed at the same time as the challenges of policy integration need to be addressed. Given the (perceived) low returns on investment in the water sector, closing the financing gap exclusively with private funds will not be feasible and requires substantial efforts from public authorities to raise funds. In addition, public authorities will also have to pursue policies to improve the pricing system for water services). Policy integration (i.e. phasing out environmentally harmful subsidies and better coherence of water and other non-environmental policies) will be an essential element in this process.

Water and nature protection

Although EU nature protection policies date back to the 1970s, more explicit links to water only came relatively recently with the Natura 2000 programme, which covers a variety of freshwater habitats and ecosystems. This is part of the recognition that freshwater ecosystems play crucial roles in supporting biodiversity and provide valuable ecosystem services.

In respect of biodiversity it is clear that wetlands and other freshwater ecosystems are amongst the richest and most diverse ecosystems in the EU. In contrast freshwater ecosystems can also be vulnerable to invasive species, with associated economic and biodiversity costs. The services provided by freshwater ecosystems are also economically valuable providing food, natural filtration and purification of water, flood protection and leisure and tourism. The primary challenges in the area of water and nature protection include:

- Loss of wetlands and freshwater habitats to human development, with consequent losses in biodiversity and ecosystem services;
- Adapting flood protection measures as natural protections are reduced or lost;
- Managing water abstraction and ecosystem needs in times of drought, to ensure an 'ecological flow';
- Managing water quality to maintain the ecological good status of waters and ecosystems natural filtration functions while accommodating human activity and impacts on water.

Policy challenges in the area of water and nature protection stem partially from the fact that it is a relatively new policy area, but also that the policy objectives of the WFD and Natura 2000 differ. Whereas the WFD focusses more specifically on aquatic life and ecosystems, Natura 2000 takes a broader view and considers all life and ecosystems that rely on water.

EU water legislation: state of play

In 2000, the Water Framework Directive (WFD) marked a water-shed in European water policy. Whereas earlier policies such as the Nitrates Directive were geared towards stopping pollution, the WFD took a holistic and integrated perspective on water issues and solutions. It set out an ambitious agenda where Member States were required to submit River Basin Management Plans and designate competent authorities to make the decisions. The WFD pulled together the existing policies and was later complemented with a Flood Directive.

WFD was off to a slow start but today all Member States have transposed the legislation and delivered River Basin Management Plans. The evaluation is ongoing but the emerging picture is one of large differences in detail and ambition. It reflects a general observation which is that some river basins enjoy strong authorities with well functioning stakeholder participation, appropriate powers and resources, and as a result adequate and detailed management plans. On the other hand, some river basins are still heavily under pressure with no proper management due to a number of reasons. Reasons for low levels of ambitions are for example, insufficient levels of authority, resources and know-how, slow and badly managed stakeholder processes, and policy incoherence which leads to conflicting goals.

Whereas the WFD and much of European water policy are hailed by several stakeholders for its innovativeness, ambitions and integrated perspective, others point out the slow and uneven implementation of key measures in the Directives.

Challenges and gaps in European water policy

The general challenge for European water policy is the uneven level of implementation in Member States.

First, while European water policy has focused mainly on the abstraction, treatment, pollution control and flood prevention, there is an increasing urgency to also tackle demand. Water efficiency in buildings, supply infrastructure, irrigation and general use, need to be addressed with new types of policy initiatives and approaches. A good example is the employment of alternative treatments of water, including reuse and recyling. Several methods have been developed but needs be taken up more broadly. A key challenge is to promote new more water efficient technologies and curbing demand, while ensuring that water quality stays at acceptable levels. For water efficiencies in the supply systems some regions struggle with leakages and inefficient irrigation methods, which could be addressed by incorporating water issues into sectoral policies and instruments dealing with energy, agricutlure and buildings.

Second, the economic instruments and in particular pricing to reduce demand and distribute costs for pollution more evenly remains underdeveloped. Environmental taxes are the most frequently used instrument to influence the quantity and quality of water (and to raise funds), other tools such as tariffs and water markets remain underutilised. Better information based on solid evidence on how pricing can be used – and how and where it influences the water cycle - is needed. The results of this kind of evidence based evaluation should inform the political process and be communicated to the public to establish a more solid foundation for the further acceptance of these tools.

Third, the governance of water is key to ensure successful implementation. The WFD introduced several innovative ideas which have fostered cooperation across borders and regions. Designation of authorities for river basins have for example been generally successful and brought stakeholders together which otherwise would be more reluctant to cooperate. The ambitions and functioning however in terms of public participation, resources and power display several inadequacies. To increase political attention and get relevant authorities to address the challenges sufficiently remain problematic in some regions.

Fourth, policy coherence and integration is still under-developed. Flawless policy coherence is utopian to expect but conflicting goals should be removed. Recent examples are EU renewable energy goals that promote hydropower and bioenergy production, both of which already strain water quality and availability in some regions. The policy challenge may not imply new legislation but rather more cooperation and compromises across sectors and stakeholders. An effort should also be made to reduce the administrative burden on already often resource meagre authorities, companies and other stakeholders.

Fifth, land-use in forms of agriculture and urbanisation continues to represent one of the largest threats to both water quality and availability. By using ecosystem based approaches for spatial planning, water quality, flood protection and prevention, and nature conservation can be improved in cost-efficient ways.

Finally, the threat of climate has hightened the urgency for addressing both water quality, water scarcity and floods. Changes in precipitation patterns and the hydrological cycle in general will put increased pressure on existing systems. The role of adaptation to new circumstances is pivotal and needs to be better informed and further developed in both EU and national legislation and policy.

1. THE CURRENT SITUATION OF WATER IN THE EU

KEY FINDINGS

- Water availability is a local and regional issue – at EU-level it is a relatively minor problem but many regions in the South or with high population densities face water scarcity issues.
- The energy sector is the largest abstractor of water in most regions. Irrigation for agriculture is the next biggest user and the biggest user in Southern Europe. Households and industry remain important users.
- End-use water efficiency is improving as more efficient technologies are deployed, but demographic changes, i.e. smaller households with higher per-capita use; and high leakage rates (up to 50%) in many Member States water supply networks, make overall water efficiency improvements harder to achieve.
- Water quality in the EU is improving, but much work remains to be done to achieve the 'good' status targeted by the Water Framework Directive.
- Wastewater treatment (WWT) is improving with observable trends towards both higher percentages of the population being connected to treatment systems and moves towards better quality (tertiary) treatment.
- Agriculture remains a major source of nutrients, such as nitrates and phosphorous, this causes significant and continuing eutrophication problems across Europe.
- Acidification and other water pollution issues have shown positive trends.
- Data for water availability and quality is improving but remains highly variable by type and member state. Essential data on abstraction and leakages remains weak and fragmented.

'There is enough water, but not always in the right place, at the right time, in the right quantity or of the right quality'

This axiom neatly summarises the two key issues in water, availability and quality. Water, and especially clean water, has always been essential as we need it for many different purposes, in our households for drinking, washing, heating and sanitation; in our work and industry, with almost every product or material requiring water or water-based inputs; and we need it in our environment to produce food and to sustain our ecosystems and life.

EU-policy targets 'good' status of water quantitatively (availability), ecologically (availability and quality) and chemically (quality). This section summarises the current situation in the EU in respect of these key issues.

1.1. Water availability in the EU

The availability of water is understood through the lens of scarcity, is there enough to meet human and ecosystem needs? How do we use it? Are we using it sustainably?

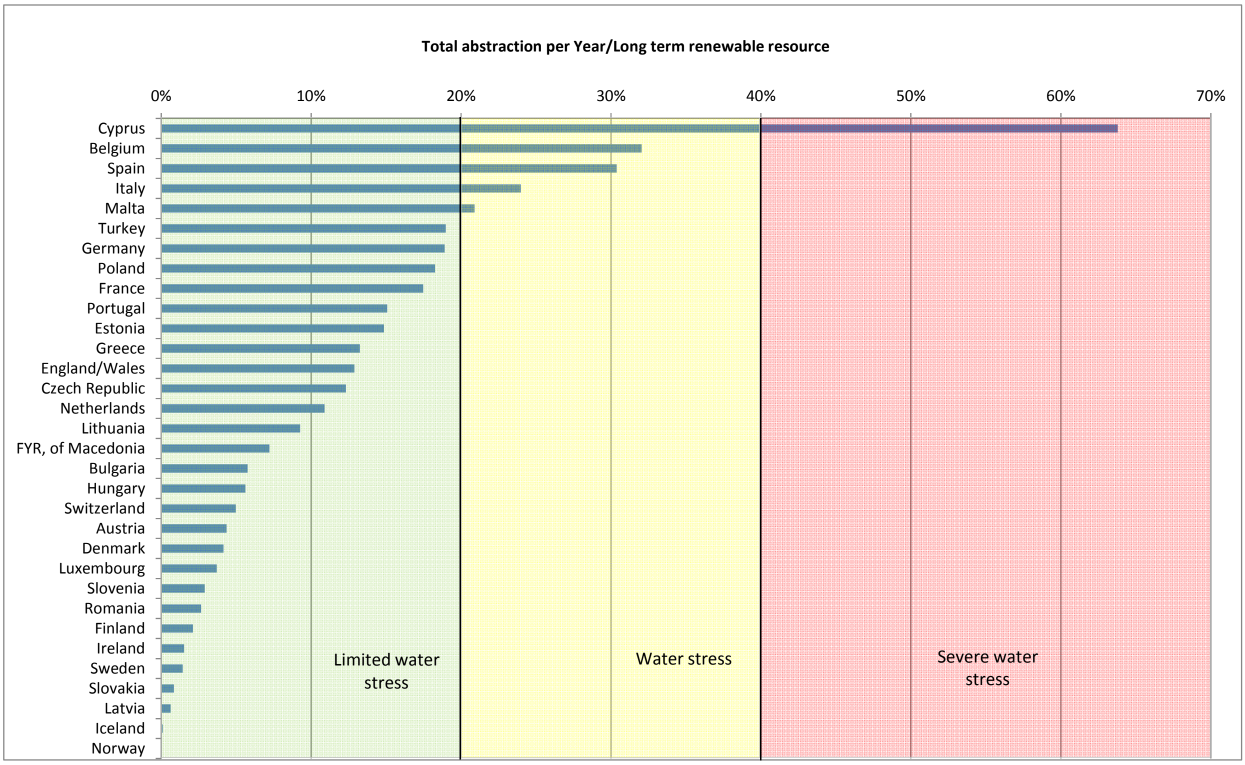
Europe as a whole is not significantly water stressed…

Europe is an area that, relatively speaking, has an abundance of water, for example abstracting only 13% of the total available resource; this makes water issues comparatively easy to manage. Yet looking down to national and regional levels, the picture can change significantly, with some regions, particularly in the Mediterranean South, facing severe mismatches between water supply and demand.

…but some nations, particularly in the Mediterranean South are…

At the national level, the Water Exploitation Index (WEI) offers a simple metric to understand water availability, dividing the total annual water abstraction by the size of the long term renewable water resource, with values over 20% demonstrating water stress and values over 40% severe and unsustainable water stress. As can be seen in Figure 1 most EU countries, at the national level, are not water stressed. The exceptions are Cyprus, which is severely water stressed, and Belgium, Spain, Italy and Malta which are stressed. With the exception of Belgium, which has high demand for water from its energy sector, these are all Mediterranean countries and this is a notable factor in water availability – countries with relatively low rainfall and high demand.

Figure 1 : Water exploitation index for European countries – latest year (2007)

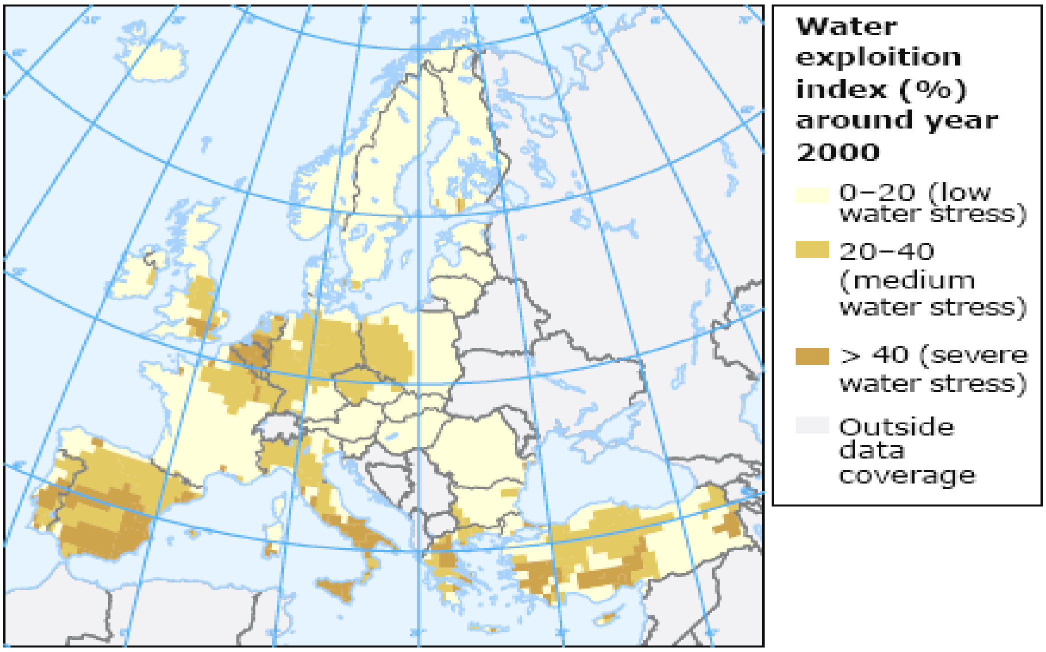


Source: EEA (2010)

...as are many regions of non-stressed countries

Yet this picture of water stress at the national level can be deceptive with significant regional and local water stress issues within countries. An analysis of this, from 2005, is presented in the figure below, which reflects the ratings in figure 1 but also highlights regional scarcity issues in countries that are not stressed overall, such as England (South East, Midlands and North), Ireland (Dublin area), Portugal (most non-coastal areas), France (North East), Germany (North and Central), Poland (West) and the Czech Republic (West). Stress in these regions is closely linked to urban population centres and the water requirements of energy and industry.

Figure 2: Geographic representation of water stress in Europe



Source: EEA (2005)

Availability is not just a long-term issue, floods and droughts are serious in the short-term

Availability is also subject to significant fluctuations due to floods and droughts; this can cause significant damage and create severe water stress. The figures below highlight the frequency of such events, with the damage to human life, property, the economy and eco-systems from these events running into billions of Euros each year, i.e. 6-9 billion EUR / year as estimated by the 5th World Water Forum (2009). It is understood that climate change will increase both the frequency and severity of these types of events; this is explored further in section 3.1.

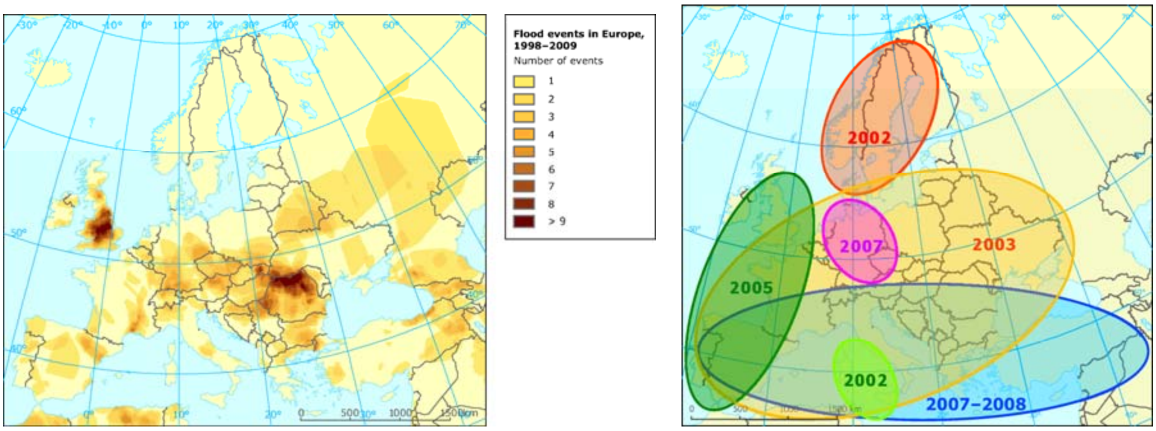
Flood damage in Romania and the UK

Between 1998 and 2009, 33 floods have occurred in Romania, causing the death of 261 people. In total, 233 114 people were affected and the economic damage was estimated at USD 1.8 billion.

Between 1998 and 2009, 17 floods have occurred in the United Kingdom, killing 31 people. In total, 381 468 people were affected and the economic damage was estimated at USD 15.5 billion.

Source: EM-DAT: The OFDA/CRED International Disaster Database – www.emdat.be, Université Catholique de Louvain, Brussels (Belgium)

Figure 3: Frequency of flood events in Europe 1998-2009 & Major droughts in Europe 2000-2009



Source: EEA (2010)

Water demand is declining, particularly from industry

Water availability is also a function of how we use water and in what quantities. This also varies somewhat by region and member state as shown in the table below. There is a clear trend in Europe as a whole for reduced water abstraction (use) since the 1990's and in every region, with a particularly large decline in Eastern Europe led by the reductions in abstraction for irrigation (-88%) and industry (-81%). The reductions in Eastern Europe were caused, at least in part, by the introduction of metering and increased water prices (EEA, 2009b). Energy is the single largest abstracting sector in Europe, accounting for around 45% of total abstraction, with water mainly used in cooling for thermal (coal, oil and gas) and nuclear power plants; hydroelectric power also plays a role. Only in Southern Europe is this different, where irrigation accounts for almost 48% of water abstraction and energy only 31%.

Table 1: Water abstraction by region and sector, early 1990s to latest 1998-2007 annual averages million m^3/year

Region		Energy	Industry	Irrigation	Public Water Supply	Total
Eastern Europe (BG, CZ, EE, HU, LT, LV, PL, RO, SK, SI)	Early 1990s	21 294	12 538	8 610	11 058	**53 500**
	1998-2007	20 562	2 276	1 060	6 555	**30 453**
	Change	-732	-10 261	-7 550	-4 503	**-23 047**
	Change as %	-3.4%	-81.8%	-87.7%	-40.7%	**-43.1%**
Western Europe (AT, BE, DK, FI, DE, IC, IE, LU, NL, NO, SE, CH, UK)	Early 1990s	44 820	17 307	2 002	21 343	**85 471**
	1998-2007	37 029	15 585	901	19 582	**73 096**
	Change	-7 791	-1 721	-1 101	-1 761	**-12 375**
	Change as %	-17.4%	-9.9%	-55.0%	-8.3%	**-14.5%**
Southern Europe (FR, EL, IT, PT, ES, MK)	Early 1990s	26 902	6 344	40 292	12 127	**85 665**
	1998-2007	25 698	3 821	39 417	13 592	**82 528**
	Change	-1 205	-2 523	-875	1 465	**-3 137**
	Change as %	-4.5%	-39.8%	-2.2%	12.1%	**-3.7%**
Europe Total	1990s	93 017	36 188	50 903	44 528	**224 636**
	1998-2007	83 289	21 683	41 377	39 728	**186 077**
	Change	-9 728	-14 506	-9 526	-4 799	**-38 559**
	Change as %	-10.5%	-40.1%	-18.7%	-10.8%	**-17.2%**

Source: Ecorys based on EEA (2010) CSI18 data[1]

Improved efficiency in water-use is a factor in reduced abstractions…

The efficiency of water use is a major factor in water availability and improvements in the water efficiency of technologies such as washing machines and dishwashers have contributed to the decline in public supply water use across Europe. Yet balanced against this is the trend in many Member States towards smaller households, which bring increased per capita use needs.

…but is undermined in many Member States by high leakage rates

The benefits from end-use water efficiency improvements can be undermined by leakage from water supply systems. This is water that is abstracted but is not used, as it is lost during transport or due to leakage; although this water may return to groundwater over time, the abstraction from source remains and the associated energy use is wasted: this is important from an overall resource efficiency perspective. The problem of leakage varies considerably across Europe. EU-level data on leakage is relatively weak, the data that is available is not very recent or complete, yet some figures do stand out, a handful of member states with very low leakage (DE, BE, NL) of less than 5%, others with leakage figures higher than 20% (IT, FR, UK, ES, IE, CZ, SK, RO, HU, SI) and the highest estimated at 50% in Bulgaria in 1996 (EEA, 2003; Eurostat). Reducing leakage rates could have highly significant benefits on water availability.

[1] There are inconsistencies within the dataset for water abstraction that mean the exact totals should be treated with caution. The data is clear on an overall trend towards less water use.

Low leakage rates in Germany
The low leakage levels in Germany can partly be explained by favourable soil conditions; however, there are various other important factors. The low leakage rate can be partly explained by the high financial budgets available for utilities, and the fact that the German tariff system allows full cost recovery for structural maintenance, without any significant problems of tariff collection (Rudolph, 2008). This has led to sustained levels of high investment in infrastructure and distribution networks: as a result, the infrastructure is in relatively good condition. Furthermore, preventative maintenance and leak detection are performed on a regular basis, repair mains can be accessed and exchanged easily and water is treated in order to reduce the damage it causes to infrastructure (Lallana, 2006; Riemberger, n.d.).

1.2. Water quality in the EU

Having established that water availability is a serious issue in Europe, it is important to look at water quality as this can also have serious implications for human and ecosystem health. Water quality is relevant through the Water Framework Directive (WFD) as measured by its ecological and chemical status and also through water pollution from point sources. The goal is to achieve 'Good ecological status' of all European waters by 2015.

1.2.1. Water quality and human health

European water quality has improved over the last 20 years but large challenges remain. There are many sources of water pollution such as landfills, mining, forestry, aquaculture and inadequate waste water treatment; however, there are two sources that dominate water pollution: agriculture and the urban environment. From agriculture the problems are mainly caused by nutrients such as nitrogen and phosphorus from fertilisers, pesticides, sediment, pathogenic micro-organisms produced by livestock and organic pollution from manure. In the urban environment the discharge is even more diffuse. Everything from personal hygiene products to friction from car tyres and industrial by-products can pollute water bodies. Wastewater collection and treatment is essential to limit the damages.

The pollution of waters from agriculture, the urban environment and other sources has several negative impacts on the environment such as eutrophication, ecosystem damages, and human health problems. Climate change is also expected to influence water quality and compound these negative impacts as changes in temperature and run-off, from increased floods and rainfall, influence water quality.

Water quality is shaped by wastewater treatment
Water quality is, to a large extent, shaped by the way in which we treat our wastewater, particularly around urban centres. Current technology defines three treatment levels, primary, secondary and tertiary, which represent increasing treatment of wastewater, with tertiary treatment the most advanced, removing more chemicals and microbes from wastewater.

Treatment has improved in every region of Europe since 1990

Waste Water Treatment (WWT) infrastructure has seen significant new investment in recent decades, and it will need continued investment into the future, for example an estimated EUR 90 billion in Western Europe in the next 5 years (Waterworld, 2011). As shown in the figure below the recent investment has resulted in improvements in the percentage of wastewater being treated and also the type of treatment.

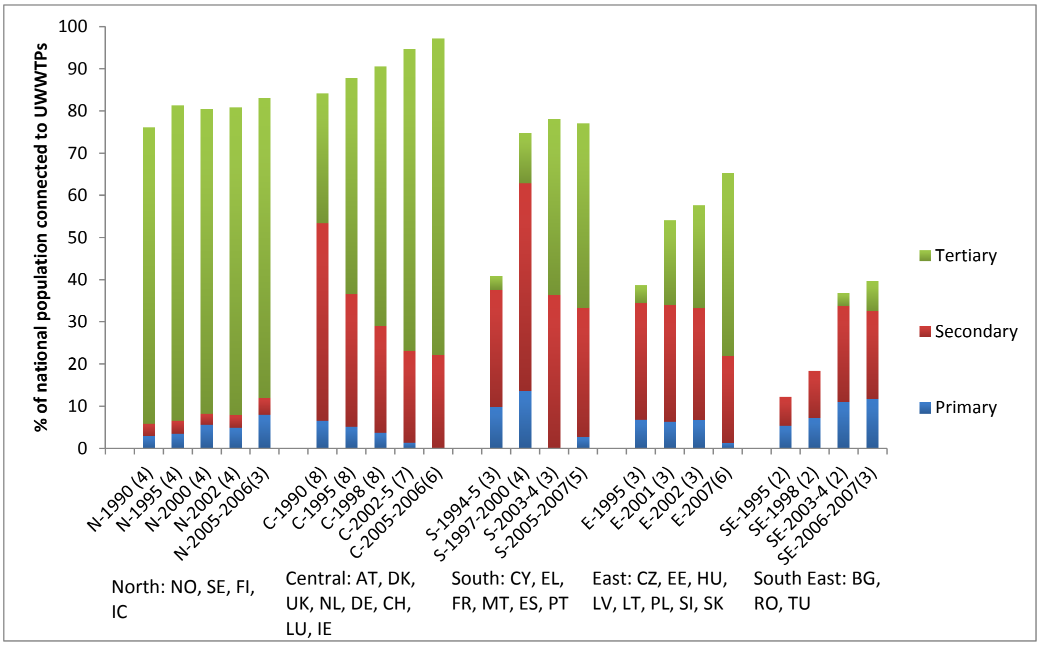
Tertiary WWT in Budapest, Hungary

In April 2011, the North Budapest Wastewater Treatment Plant was upgraded and commissioned to provide tertiary wastewater treatment. The annual reduction of nitrogen and phosphorous was targeted at 2 945 kg/year and 310 kg/year respectively. As a result of the project, the targets with respect to both Nitrogen and Phosphorous were met and exceeded, with results in June 2011 representing a 72% and 75% reduction in the two nutrients respectively. Other wastewater discharge parameters from the plant such as removal of Biochemical Oxygen Demand, Chemical Oxygen Demand, and Suspended Solids have also improved significantly (by 92 per cent)

These improvements are visible in every region with a clear trend for improvements to WWT capacity coming from new tertiary treatment plants, added either as additional new capacity or replacing primary or secondary treatment capacity.

In the central region over 97% of the population are connected to some form of WWT network, in the North this is 83%, the South 77%, with the East 65% and South East 40% lower, but rapidly improving. There are some limitations to further improvement in figures, with WWT infrastructure being less economic and practical in less populated areas. In these situations in particular, but also relevant overall, it is important to look at alternative treatment options, such as dry treatment systems

Figure 4: Regional variations in WWT between 1990 and 2007



Source: Based on EEA (2010) (CSI 24)

Note: number of reporting countries included in brackets (x).

Bathing water quality has improved

These trends are positive and will require continued investment to sustain. Improvement in treatment has also had some benefit to the quality of bathing waters, with bathing water ranked as 'good' or compliant increasing from 80% in 1990 to over 90% in more recent years, reaching 92.1% in 2010 (EEA, 2011).

There are also economic and environmental benefits from improved water quality

Benefits arising from improved treatment come not only to human health but also to the economy as they help people switch to mains supplied drinking water instead of more expensive bottled water. There are also environmental benefits as effluents are less polluted and have lower nutrient loads; this helps avoid damage to ecosystems (Corcoran et al. 2010).

1.2.2. Water quality and ecosystems

Water is a vital part of almost every ecosystem; human activities can therefore have significant effects on these ecosystems through things such as: building on wetlands, pollution incidents, eutrophication, acidification, changing the path and flow of watercourses and fishing. Measures of water quality in relation to ecosystems typically focus on eutrophication or acidification.

Eutrophication

Eutrophication is a state of water quality where an over-abundance of nutrients such as nitrogen and phosphate leads to rapid plant growth. In water this typically favours rapid growth of phytoplankton or algae. This has negative impacts on the wider ecosystem as the growth and decay of algae in 'blooms' crowds out other species: it does so as it blocks sunlight from reaching the bottom (it grows on the surface), reducing photosynthesis opportunities. In addition, when it dies it sinks to decay on the bottom, the decay process consumes oxygen, creating a situation of hypoxia (reduced oxygen), and this creates 'dead zones' where other species, such as fish, that need more oxygen cannot survive. This impacts not only lakes and rivers but also coastal ecosystems as the water is carried to the sea.

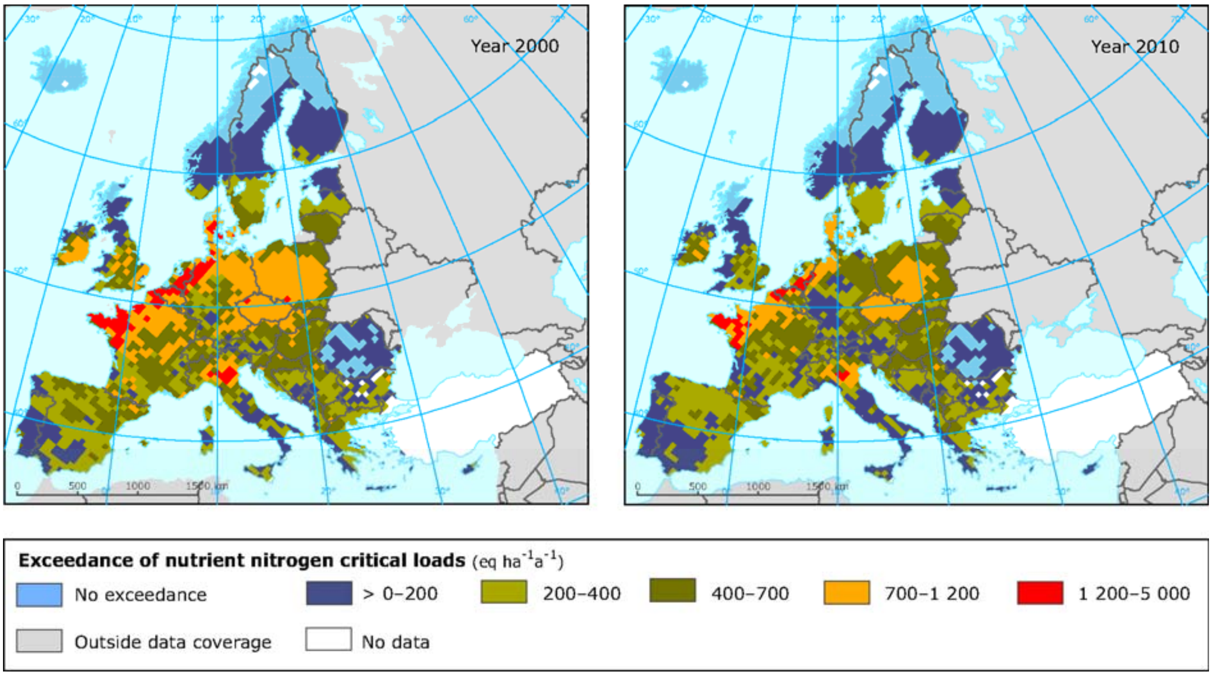
Agriculture and, to a lesser extent, municipal wastewater are the main sources

While eutrophication occurs naturally in some situations, it is in Europe much more closely related to the use of fertilizer nutrients, such as nitrates and phosphates, in agriculture (Ongley, 1996). Run-off from agricultural land carries concentrations of these to watercourses where they are a major cause of eutrophication. Municipal wastewater is another source of nutrients; this is part of the reason that WWT is important, and within WWT, moves to higher levels of treatment which remove more nutrients.

Although improving, there remains significant exceedance of eutrophication loads

The figure below presents a map of the eutrophication issue in Europe. This clearly shows how eutrophication loads are concentrated around major population and agricultural production centres, particularly in North West Europe, Poland, the Czech Republic and Northern Italy. The figure shows that there has been an improvement in loads comparing 2010 to 2000, but only a few regions in the North of Europe and Romania show no exceedance of critical loads. This demonstrates that there is still significant work to be done to reduce eutrophication.

Figure 5: Eutrophication in Europe – exceedance of nutrient nitrogen loads in surface water 2000 and 2010



Source: EEA - Coordination Centre for Effects (CCE), European Critical Loads Database 2008

Other ecosystem impacts are also relevant

Less data is available on some of the other water quality issues relevant to ecosystems. It is understood that acidification has decreased substantially in recent decades, driven by regulation and limits placed on the emissions of Sulphur Dioxide (SO2) since the 1970s, yet the EEA reports that 10% of natural ecosystems remain over their critical acid deposition load. Later sections will examine this and other water quality and ecosystem effects, such as reductions in wetland areas and disruption to watercourses by energy infrastructure (hydro-power), dams and weirs.

Note on data

The quantitative data presented and briefly summarised in this section is based on statistics collected and modelled by various agencies. A recent assessment of assessments (EEA, 2001c) has evaluated the quality and robustness of water data collection and measurement methodologies. It highlighted that although the number, frequency and quality of indicators have improved over the last 10 years significant gaps and weaknesses remain. This is evident through almost all of the data presented in this section, therefore while this represents the best information currently available it should also be interpreted cautiously.

The main source of information used for country level and EU aggregate data is the European Environment Agency (EEA). The EEA is a node in the so called Eionet and central player in the Water Information System for Europe (WISE). The data is normally provided by member states via reporting requirements in water legislation. EEA is therefore an outstanding source of information on water quality and water availability data in Europe. The issue of knowledge and gaps in data is further elaborated in chapter 3.3.4.

2. CHALLENGES FOR EUROPEAN WATERS

KEY FINDINGS

Water and climate change

- Climate change will have significant impacts on the hydrological cycle. Challenges will stem from these changes in terms of both water quality and availability and these will vary across regions;
- Climate change could lead to prolonged droughts, ground water salinisation, higher water temperatures, increased run-off and nutrient loads and changes in microbial pathogens;
- As a result, water stress could increase across Europe, with increasing need for active water management to mitigate and adapt to these changes.

Water and energy

- Are very closely interlinked and face significant changes in the next decades, policies in each area are not always coherent with each other;
- Energy generation challenges include hydropower disruptions to water. Disruptions are primarily related to micro-hydro and pumped storage, the water intensity of biofuels and trends for lower abstraction but also from increased use of cooling water in thermal plants. The traditional problems of acidification, heat pollution and contamination will remain;
- Energy use by the water sector is important, accounting for between 2-6% of all energy use. Efficiencies will need to improve and further potential for the sector to generate its own power exploited – i.e. through sewage sludge gas;

Water and financing

- Although extensive investments have been undertaken during the last few decades, significant new investment is still required to achieve 'good status' for the water environment;
- Differences between Member States on financing are significant and result from the differing needs and evolution of water supply systems.
- Pricing, taxes, subsidies, licensing and other market-based instruments can all help provide funding for the necessary investments in water infrastructure, political and consumer acceptance are often the determining factors.
- Estimates of a range of 0.35-1.2% of GDP annual investment in infrastructure illustrate the scale of the issue. There remains an important role for EU structural funds to assist Member States to meet WFD targets.

Water and nature protection

- Policy in this area is relatively recent and differences in focus between the WFD and Natura 2000 are evident, but both recognise the importance and value of freshwater biodiversity and ecosystem services;

- Human development of wetland habitats is a major challenge, not only for biodiversity and ecosystems, but also in terms of flood management and loss of other ecosystem services such as food, filtration, leisure and tourism.

2.1. Climate change

The availability of water is driven by climate variability and levels of demand. Climate change is likely to influence the climate variability and lead to more water in some regions and less water in others. The associated risks of both flooding and droughts are already taking heavy tolls on local economies and livelihoods. If demand stays high, climate change may exacerbate current stresses on European waters.

In a recently released report by the Intergovernmental Panel on Climate Change (IPCC) the impacts of climate change on weather events were elaborated. It confirms that it is very likely that the number of cold days and nights will decrease while warm days and nights will increase globally (IPCC, 2011). The character of the changes differs regionally and the impacts depend on the exposure and vulnerability of human settlements and ecosystems. Socioeconomic and demographic factors such as gender, income, governance and age determines play a role in determining the impacts. Where people decide to live is also important for the analysis as for example coastal and mountain communities, as well as small island states are more exposed to changes in weather patterns.

For each degree increase in the global temperature, the potential impacts of climate change on water grow large. The Stern report on the Economics of climate change (Stern, 2005) included the following table on the possible impacts of temperature increase on water:

1°	**2°**	**3°**	**4°**	**5°**
Small glaciers in the Andes disappear and threatens water supply for 50 million people	20 – 30 % decrease in water availability in vulnerable regions such as the Mediterranean region.	Extreme droughts occur once every 10 years with one to four million people experiencing droughts and one to five million experiencing floods	30 – 50 % decrease in water availability in vulnerable regions such as the Mediterranean region.	The glaciers in Himalaya disappear and threatens the water supply for China and millions of Indians.

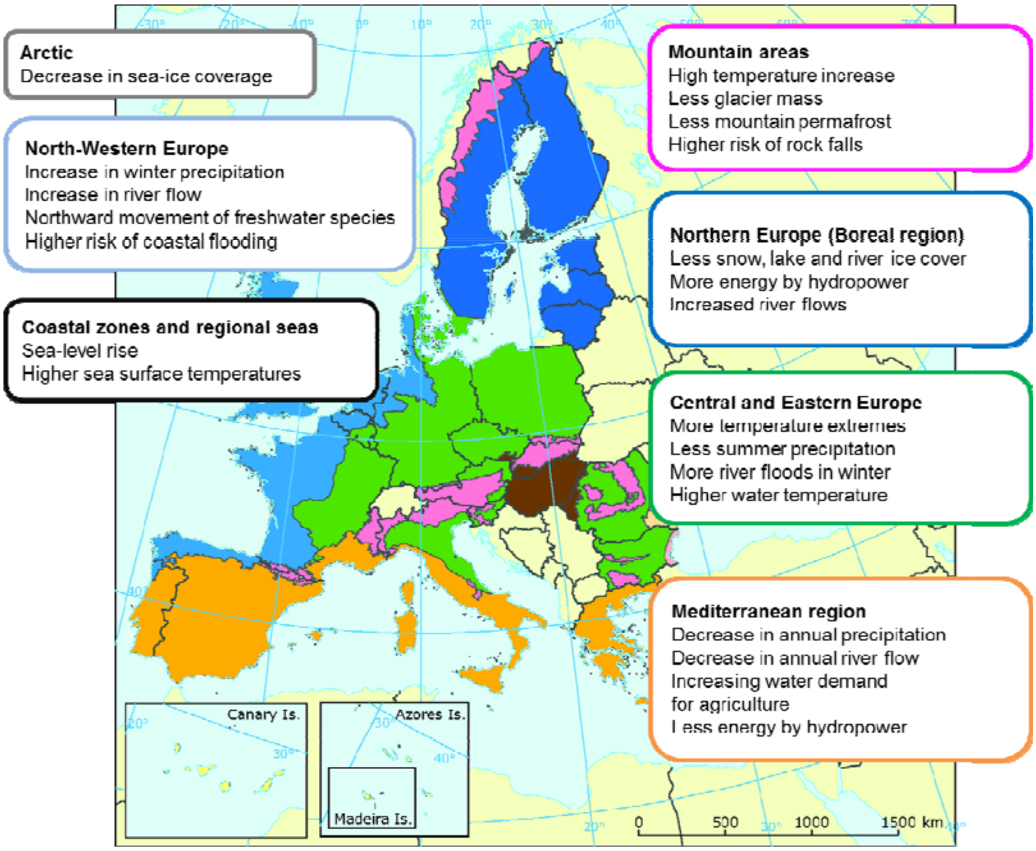
Source: Stern (2005)

It clearly shows that the risks of water related challenges due to climate change increases with the severity of temperature change. At five degrees increase for example, millions of people who depend on their water from the Himalayas would be affected.

Climate change is expected to affect both water availability and water quality. For water availability, the changes are likely to differ depending on latitudes and altitudes. In some regions of mainly the northern parts of Europe, fresh water becomes more abundant with increased precipitation and floods. For example, annual run-off in the northern parts of Europe is by some estimates likely to increase by 5 – 15 % by 2020 and 9 – 22 % in 2070 (Bates et al., 2008). In the southern and warmer regions, more droughts and desertification are likely to occur. Water run-off is here expected to decrease by 0 – 23 % by 2020 and 6 – 36 % by 2020 (Bates et al., 2008). Moreover, the refilling of groundwater reserves is likely to be reduced in Central and Eastern Europe in particular in valleys (Bates et al., 2008). Climate change is in general exacerbating current patterns in fresh-water availability with more extremes in droughts and floods.
Changes in water temperature and weather extremes also lead to (negative) impacts on water quality. Extreme rainfall for example can increase the amount of microbial loads in water reserves which heightens the risks for water related diseases (Bates et al., 2008).

The expected regional water-related impacts can be visualised as follows:

Figure 6: Regional climate change impacts



Source: Ecorys based on EEA (2010b) and EEA (2009)

Clearly there a large difference on where and how climate change will affect water. The following sections are divided into water availability which focus on floods and droughts, and water quality, where issues such as water borne diseases and food supply are discussed.

2.1.1. Impacts on water availability

Globally and regionally, water available has increased and decreased depending on where you look. In Europe, some regions experience an abundance of water which sometimes takes the shape of floods and high water levels, in other regions, natural replenishment is unable to keep up with demand which results in water stress and droughts.

The occurrence of droughts and floods is not likely to have increased in numbers or severity due to climate change. Costs for water related disasters on the other hand, have risen as societies become more vulnerable for disruptions. Climate change is expected to increase variability in precipitation patterns, the speed of evapo-transpiration, and increase sea-levels.

Again, the regional differences are expected to be large: rainfall, for example has increased in northern latitudes whereas it has decreased in tropical zones (10 degrees south to 30 degrees north) since 1970 (Bates et al., 2008).

The two extremes of water availability, floods and droughts, are discussed more in-depth below.

Floods

Floods are complex events and probably, along with storms, the most costly of disasters for Europe. Floods are complex since their causes and impacts depend on both hydrological and anthropogenic factors. If a flood for example occurs where no one lives, it might go unnoticed. If it however hits a densely populated area it could cause large damage in terms of lives, money and infrastructure.

Floods generally occur in four different ways:

1. When water tables are saturated during the wet season (normally winter in northern Europe and summer in south and Eastern Europe);
2. When the snow melt from mountains in spring;
3. After intense rain-fall (flash floods); and,
4. Coastal floods due to sea level rise and storms (Anderson et al., 2008).

Intuitively climate change should have impacts on precipitation, snow melt and sea level rise. Evidence point towards increased frequency and intensity of rain fall, faster snow melt and increase in sea level. Yet there is still insufficient evidence to prove a causal link and the statement that climate change exacerbates the occurrence of floods on a global scale is yet to be established scientifically. The IPCC recently argued that: "There is limited to medium evidence available to assess climate-driven observed changes in the magnitude and frequency of floods at regional scales because the available instrumental records of floods at gauge stations are limited in space and time, and because of confounding effects of changes in land use and engineering" (IPCC, 2011). The statement highlights the low amount of evidence available to establish a causal link but does not rule out that increases in precipitation will lead to more floods. Instead, the IPCC argues that due to changes in water and land management it could increase the exposure to floods.

Hence, there is currently no concrete evidence that climate change induces more flooding. The underlying (climatic) drivers of floods however are expected to be heavily influenced by climate change:

1. *Precipitation*
   a. Northern Europe will experience widespread increase in precipitation with 1 – 2 % per decade. Southern Europe will see smaller decrease with maximum 1 % and a few countries, France, Germany and Hungary, show ambiguous results.
   b. Winter and summer precipitation will change. Winters are expected to become 1 – 4 % wetter per average all over Europe. During summers on the other hand, the northern parts may experience a 2 % increase whereas the southern parts have a 5 % decrease.

2. *Mountain areas and ice-melt*
   a. Winter flows and summer flows of some floods such as the Rhine, the Volga and rivers of central, eastern and southern Europe are expected to change significantly. As temperature increases the winter flows may go up and summer flows as well as a result of melting glaciers.
   b. The weather conditions which sets off avalanches such as intense snow fall and possibly storms and temperature changes, are expected to increase with climate change. Accordingly the frequency of avalanches could increase (EEA, 2010a). Mountain regions are in general vulnerable to climate change and increase in temperature could lead to more floods
3. *Flash floods*
   a. The intensity and frequency of spring floods in North-Western Europe are likely to increase.
   b. Some argue that flash-flooding due to intense precipitation will be more frequent all over Europe already in the 2020s.
4. *Sea levels*
   a. Sea levels globally are expected to increase by 13 – 68 cm by the 2050s (Alcamo et al., 2007; EEA, 2010b).

In sum, the climatic drivers behind the different type of floods are expected to be enhanced by climate change.

Droughts and desertification

Europe is a relatively wet region and in general water is not a scarcity but rather a distribution problem. On average 13 % of our available water is abstracted annually (EEA, 2010a). Nevertheless, Europe is frequently hit by droughts with negative consequences for in particular the agricultural sector. Differences between regions are large and some southern countries are even in risk of desertification.

Droughts are natural events that occur due to climate variability, changes in land-use and excessive water abstraction. They strike all over Europe with variations in magnitude, causes and severity. In worst case a drought can lead to water stress and scarcity. In some countries of the north, drought lasts for a few months whereas in the south a drought can last for years.

There are three different kinds of droughts with different impacts[2].

1. A metrological drought is a longer period of reduced to none precipitation and creates a lack of available water.
2. A hydrological drought refers to a shortfall in precipitation and leads to lowered water availability in both surface and sub-surface sources.
3. An agricultural drought occurs when soils are becomes too dry to support crops or grass.

All three types of droughts are driven by climate variability, however hydrologial and agricultural droughts may be induced by sub-optimal water management and excessive demand.

To address droughts and water-stress more actively has become more pressing as seasonal and long term droughts seem to have become more frequent, in particular in southern Europe (IPCC, 2011). The economic incentives are clear: droughts cost Europe EUR 5.3 billion annually on average and only the large 2003 drought is estimated to have cost EUR 8.7 billion (JRC, 2011). Loss of lives, damage to infrastructure and reduced crops yields are some of the negative consequences.

The main culprit, however, has not been climate change but rather an increase in demand in regions where water is scarce. EEA lists four areas where water stress is imminent due to increase in demand (EEA, 2010a):

1. Agricultural sectors in southern parts of Europe have increased faster than water availability. Over the last 60 year, agricultural activity has grown significantly and has lead to excessive abstraction of water for irrigation.
2. Urbanization and growing cities that take their water from afar are vulnerable to shortages in demand. Local water sources are often polluted and unfit for drinking and water transportation is sometimes done over 100 – 200 km.
3. Islands such as Cyprus and Sicily are particularly vulnerable to water stress. They rely on rain fall and its seasonal variability.
4. Finally, some of the Mediterranean countries are huge tourist areas. France for example ranks first in the world according to arrivals globally and Spain second in terms of earnings (UNWTO, 2011). Tourism in these countries is generally water demanding with hotels, golf courses and swimming pools that needs to be maintained.

Climate change is however expected to exacerbate current shortages. As explained earlier precipitation patterns are likely to change. Reduced rain-fall in the southern parts of Europe will reduce the speed of natural replenishment of water reserves. This was recently confirmed by the IPCC that stated that there is (medium) confidence that droughts will intensify over the next 100 years due to less rain and more evapo-transpiration, in particular in the southern region of Europe, the Mediterranean region, and central Europe. Lack of data hinders a higher confidence level.

[2] We have limited the list to three types for reasons of clarity. Some authors use other categorizations and definitions. Metrological droughts are sometimes called climatological drought, and one can add for example river flow droughts to add specificity to the analysis.

2.1.2. Impacts on water quality

European water quality has improved over the last 20 years but large challenges remains. There is a large number of sources for pollution of waters such as landfills, mining, forestry, aquaculture and inadequate waste water treatment. There are two sources however that dominate the pollution: agriculture and the urban environment (EEA, 2010b). From agriculture it is mainly nutrients such as nitrogen and phosphorus from fertilisers, pesticides, sediment, pathogenic micro-organisms produced by livestock and organic pollution from manure which cause the problems. In the urban environment the discharge is even more diffuse. Everything from personal hygiene products to friction from car tyres and industrial by-products pollutes water bodies (EEA, 2010b). Waste water collection and treatment are essential to limit the damages.

The pollution of waters from mainly agriculture and the urban environment has several negative impacts on the environment such as eutrophication, ecosystem damages, and human health problems. With climate change the current state of water quality is expected to be influenced and compound negative impacts.

Changes in temperature and run-off influences water quality. Floods for example bring with them pollutants of organic matters, nutrients and hazardous materials. The impacts of climate change which are relevant for water quality can be divided into three categories (ETC Water, 2010):

1. Physical changes, such as:
   a. Increased water temperature;
   b. Reduced ice cover on rivers and lakes;
   c. More vertical stratification and reduced mix of water in deep-water lakes, and;
   d. Alterations in the discharge of water which can affect water levels and retention time.

2. Chemical changes, such as
   a. Increased nutrient concentration and water colour; and,
   b. Reduced oxygen content (ETC Water, 2010).

3. Biological change, such as
   a. Increase in pathogenic microbes.

Physical changes such as water temperature and larger/smaller water flows are clearly linked with chemical and biological changes. For agricultural discharge for example it is plausible to assume that more intense rainfalls and/or more precipitation would lead to more diffuse discharge of water from agriculture into water bodies. In this sense climate change catalyses already on-going processes.

Temperatures in surface water in some European lakes and rivers have increased with 1 – 3 degrees over the last century (ETC Water, 2010). Warmer waters have resulted in changes in the composition of species and ecosystems and their capacity to reproduce, produce and ability to resist and adapt to changes (Bates et al., 2008). Cases of prolonged stratification, meaning that water of different temperature divides into layers of depth, have also been found. Such states could lead to reduced nutrient concentration in surface layers and longer periods of reduces oxygen levels at deeper depths (Bates et al., 2008).

Warmer temperatures may also change the composition and functioning of ecosystems in water bodies.

In sum, changes in temperature, water flows, precipitation, eutrophication, prolonged stratification, erosion, and ecosystem alteration due to climate change have impact on the ecological status on waters. The impacts will generally be dependent on regional climate variability, type of water body and local context.

The European Topic Centre on Water (ETC/W) has made a useful overview of the different biological impacts depending on region and type of lake or river.

Table 2: Biological impacts of climate change on waters

Region	Lake or river type	Impact
North	Fast-flowing upland rivers	Reduction of cold water species, increased biomass of benthic algae.
	Slow-flowing lowland rivers	Reduction of cold water species.
	Shallow lowland lakes	Reduction of cold water species, increased biomass of phytoplankton, reduction of sensitive macrophyte.
	Deep lakes	Reduction of cold-water species, increased biomass of phytoplankton and more harmful algal blooms, and increase of alien invasive species.
Central	Fast-flowing upland rivers	Replacement of cool-water species with warmer water species. Increased biomass of benthic algae/ tolerant taxa and increase of alien invasive species.
	Slow-flowing lowland rivers	Loss of many fish species. Fish kills due to deoxygenation. Loss of sensitive benthic fauna species (deoxygenation), and increase of alien invasive species.
	Shallow lowland lakes	Greater, but less diverse plant growth, risk of summer fish kills, esp. piscivores. Dominance of cyprinid fish. Increase of alien invasive species.
	Deep lakes	Almost complete loss of salmonid and coregonid fish, total dominance of cyprinid fish, increased biomass of phytoplankton and more harmful algal bloom, and increase of alien invasive species.
South	Fast-flowing upland rivers	Major loss of biodiversity for all quality elements due to deoxygenation and salinisation, dominance by pollution-tolerant taxa and alien invasive species.
	Slow-flowing lowland rivers	Fish kills. Loss of biodiversity for most quality elements and increase of alien invasive species.
	Shallow lowland lakes	Loss of many species, more harmful algal blooms, major loss of endemic fish and amphibians
	Deep lakes	Loss of littoral zone due to severe water level drawdown in reservoirs, more intense and frequent algal blooms.

Source: ETC Water (2010)

In contrast to the foreseen impacts of climate change on floods and droughts, the confidence levels of changes in water quality are significantly higher. IPCC estimates with high confidence that higher temperatures and more weather extremes would lead to more water pollution and affect water quality (Bates et al., 2008).

The socioeconomic effects from deteriorating water quality due to climate change are wide ranging. The most significant changes are related to health problems and economic costs for waste water treatment. Worsening of bathing and drinking water quality has been associated with spread of water borne diseases, skin problems, stomach problems and risks to pets.

2.1.3. Summary

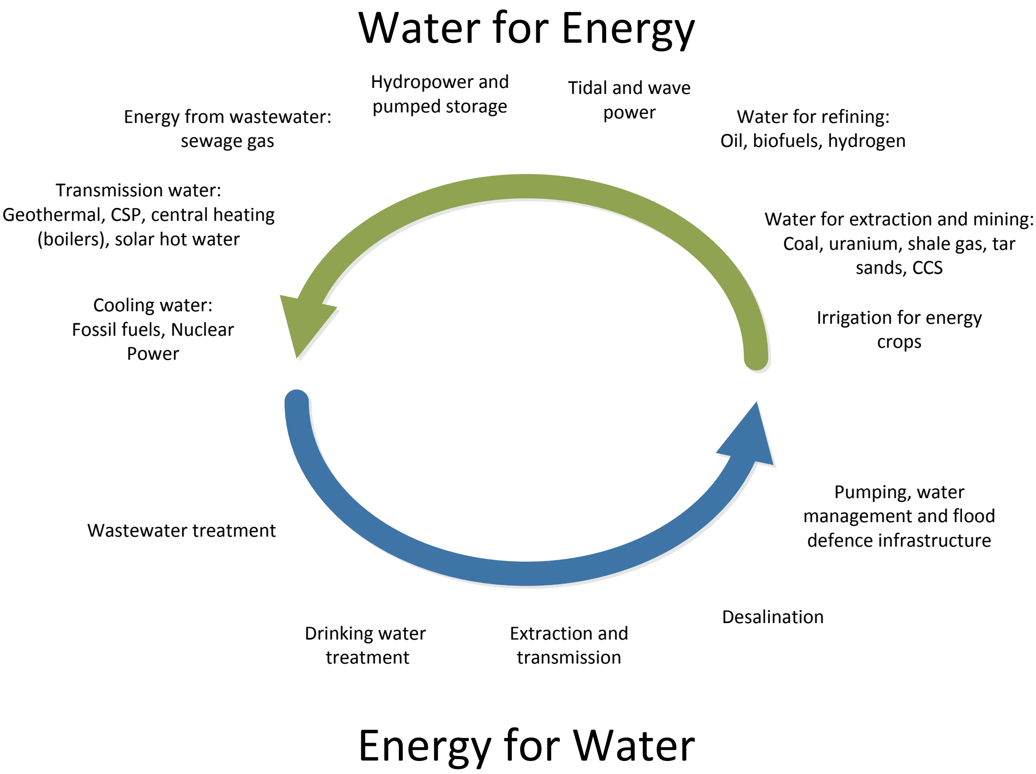
Climate change is expected to have large impacts on the hydrological cycle. Altered precipitation patterns, evapo-transpiration and water temperature could lead to significant changes in water availability and water quality. The magnitude of the impacts is often uncertain due to lack of data and complex systems. Although at global level it can be stated with certainty that climate change-induced changes in both freshwater quality and quantity are expected to have large negative impacts which outweigh the benefits (Bates et al., 2008), on a European level it is more difficult to assess the time and scale of the potential damages. Some of the more certain impacts of climate change of water are:

- Changes in precipitation patterns, more water in the northern parts of Europe an less water in the southern parts;
- Changes in evapo-transpiration which could lead to prolonged droughts, salination of ground-waters, and ecosystem/biodiversity changes;
- Higher water temperatures and reduced ice covers;
- Increased run-off which results in augmented levels of nutrient loads;
- Increased costs for water management including waste water cleaning, flood control, irrigation and leakages; and,
- Changes in levels of pathogenic microbes which might have health implications.

All in all water-stress is expected to increase due to climatic changes and floods and drought are expected to increase in frequency and intensity. Still adequate water management and climate change adaptation can mitigate the negative impacts substantially. These aspects are discussed in the next section of the study.

2.2. Water and energy

Water and energy is an area of increasing importance for policy and planning. While the past focus of research and policy has typically kept these two areas quite separate, as water scarcity becomes more acute and demand for energy increases the interaction between the two is crucial for the future and meeting sustainability goals for both. At a first glance the interaction between the two sectors seems somewhat limited beyond hydropower, but as demonstrated in the figure below, the two are very closely linked and meeting objectives in either will require understanding, co-ordination and co-operation between stakeholders and policy in both areas.



Source: Ecorys – adapted and added to from WBCSD (2009)

The energy sector is the biggest abstractor of water and is undergoing a transformation

The energy sector accounts for almost 45% of water abstracted in the EU. The sector is reliant on water availability and quality, the 2003 heat wave leading to a reduction in output of France's nuclear power plants as water levels were too low and too warm to provide sufficient cooling. The energy sector itself is undergoing a significant transformation process as it moves towards a low carbon future. This is seeing a decline in traditional fossil fuel plants and a move to lower carbon sources, often renewable. Some renewables such as wind and solar Photovoltaic's require very little water, but others such as Geothermal, Concentrated Solar Power (CSP) and Wave and Tidal energy have water as a critical component. Nuclear energy is a significant water user and its future is less clear following the Fukushima incident in Japan while some Member States are freezing their programmes or phasing it out, others continue to support it. Alongside programmes for energy efficiency to reduce total energy use, there is also expected to be a move away from energy fuels (oil) towards electrification, particularly of transport but also heating (IEA, 2008).

Energy is essential for our water supply, treatment and management

Energy is at the heart of the water use process it is needed for extraction, transmission and treatment. The treatment process itself can help generate energy – from sewage sludge. Desalination is an energy intensive process that may become increasingly important in Europe, particularly in the dry South. Water management for ground water levels and flood defence requires significant energy inputs for pumping, the requirements being particularly acute in countries with areas below sea level or prone to flooding such as the Netherlands, Belgium and the UK.

There is potential for conflict between the two in future

It is clear that water and energy are closely linked, and also that there is some danger of conflict rooted within this as the energy sector itself could demand more water, putting pressure on scarce resources, while the water sector may also demand more energy as treatment improves and desalination grows. There are worries that this will result in a 'power-struggle' over water (EurActiv, 2010). This section reviews the main areas of potential difficulty now and into the future.

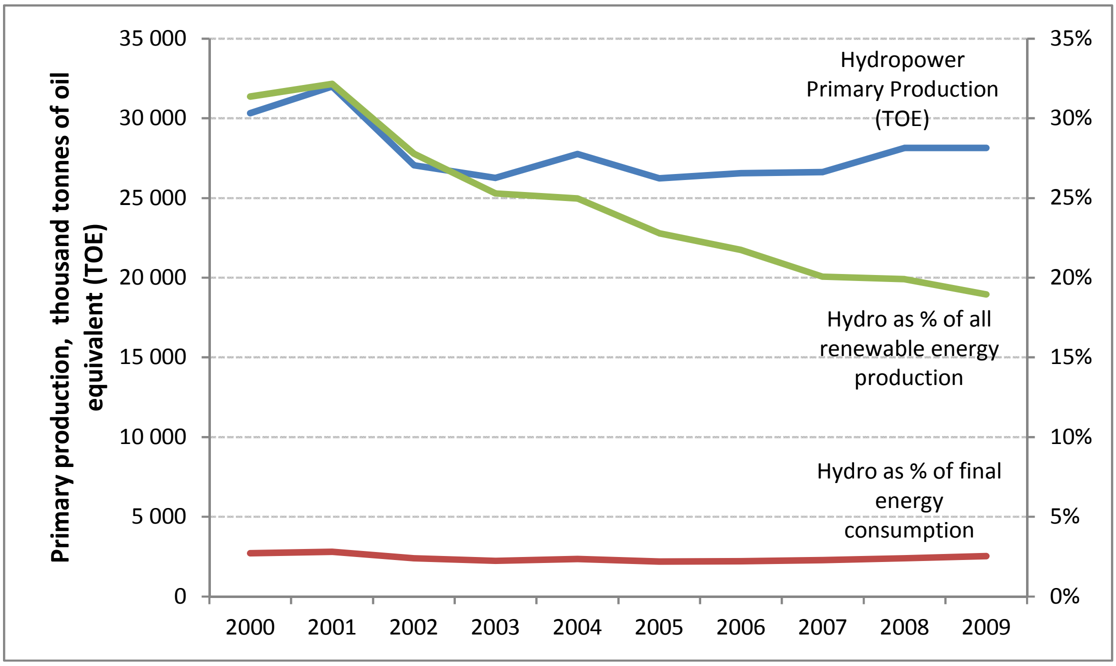
2.2.1. Impacts on water availability

Hydropower and other water based energy sources

Hydropower is a mature technology with most good opportunities for it already exploited

Hydropower is the classic link between energy and water. It is a mature energy technology that is widely deployed across Europe and, until the last decade, was the foremost renewable energy generation technology in use. As shown in the figure below the total amount of energy generated from hydropower has been relatively stable over time, this is in contrast to other renewable energy technologies, such as wind and solar, that have seen significant growth in the same period. This has resulted in the relative decline of hydropower within renewable energy production, although it has been relatively stable at of around 2.5% of all final energy consumption. This data demonstrates that most opportunities for hydropower have already been exploited, that only small opportunities, for micro-hydro, remain. The variation over time also demonstrates the effect of water availability, with production noticeably lower in drier years such as 2002 and 2003.

Figure 7: EU Primary production of hydropower and as % of final energy consumption, 2000-2009



Source: Ecorys – based on Eurostat data

The importance of hydropower varies significantly by Member State

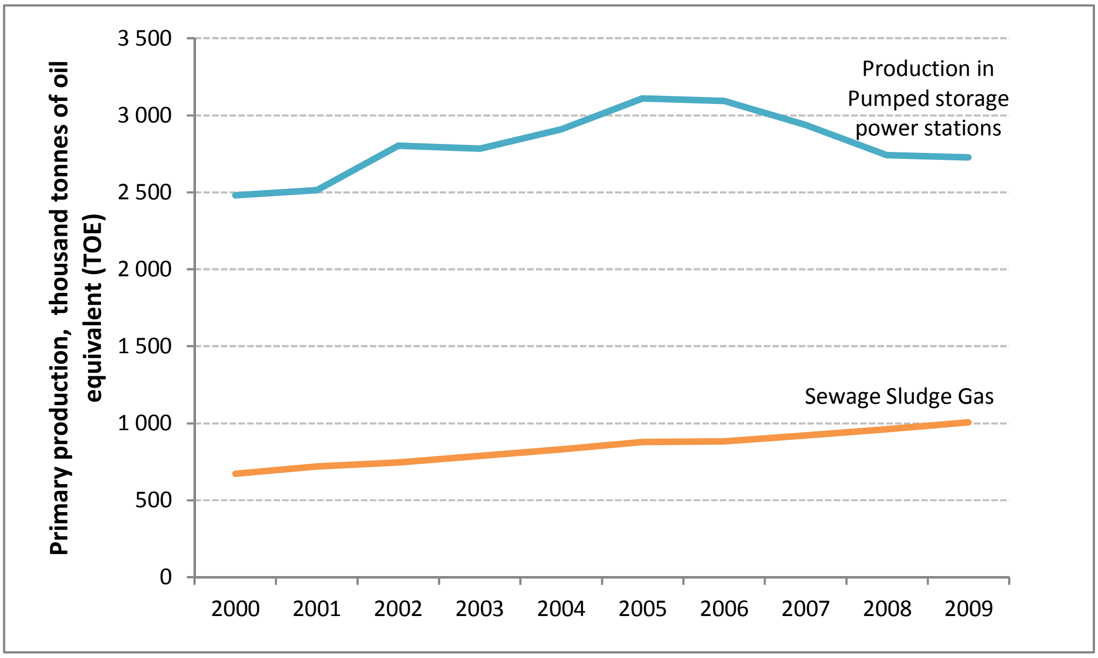
Although it is only 2.5% of all energy consumption, hydropower accounts for 12% of all electricity consumed in the EU. This proportion varies considerably by Member State, with some deriving significant proportions of their electricity from it, i.e. Austria (69.6%), Latvia (56.6%) and Sweden (53.4%), while others generate very little of their electricity from it, i.e. Malta and Cyprus (0%), Denmark and the Netherlands (0.1%) and Belgium (0.4%). France (25.3 GW), Italy (21.2GW) and Spain (18.5GW) have the highest hydropower capacities in the EU.

Pumped storage is growing and will be increasingly important in future to balance grids

Pumped storage is a type of hydropower that involves pumping water to a high reservoir, at times of low demand (and prices) to then release it to a lower reservoir, to generate power in times of high demand (and prices). This process uses more energy in pumping the water than it generates when the water is released. It becomes economic by taking advantage of the price differences in the energy it uses and the energy it generates.

Pumped storage serves an important function in the energy system, being able to provide energy at very short notice, which can be vital to balance the electricity network. It is also has excellent synergies with intermittent renewable energy, for example, being able to use excess energy generated by wind turbines in the night, to store power for use in the daytime. As shown in the figure below pumped storage has been demonstrating an upwards trend since 2000, but growth has flattened since 2006. Across the EU it accounted for approximately 1.2% of electricity use in 2009, and more than 5% of electricity in Austria (5.8%), Lithuania (8.5%) and Luxembourg (12%).

Figure 8: EU Primary production of other water related energy sources, 2000-2009



Source: Ecorys – based on Eurostat data

Wastewater treatment – sewage sludge gas – is also a growing energy source
Sewage sludge can be used to generate energy, the wastewater treatment process often employing an anaerobic digestion step to dry out and shrink organic matter in the sludge. The digestion by bacteria produces methane which can be captured and used as 'biogas' to generate heat or electricity. This is becoming increasingly common across Europe, see figure above, with the result that water utilities are becoming increasingly self-sufficient in their energy needs and also, in some cases, being able to export electricity or biogas to the grid. It is most widely used in Denmark, the UK, the Czech Republic, Germany and Sweden, with significant growth also in Poland and Austria.

Water use and consumption of energy generation technologies

Water is essential for steam and cooling in traditional power generation
Water is essential for traditional power generation: it is typically used as the medium to generate power, being used to make steam to drive turbines and then in the cooling process to condense steam back to water for re-use. This latter use is where the largest part of the demand for water arises. Freshwater and seawater, though the latter is more corrosive, can both be used for cooling and it is for this reason that most traditional power plants are located on the coast or near to a river or other major water source. There are two main systems for water cooling, with distinct differences in their impact on water availability:

- Once-through: cooling systems require a continual intake of cooling water; this is passed straight through the system. This leads to high water consumption (abstraction) but also swift return of the water to the environment with only low water loss (use).
- Closed-cycle: cooling systems use cooling towers to discharge heat through evaporation and recycle water within the power plant. This requires much less water than once-through systems though a higher proportion is lost (used) through evaporation.

Closed-cycle cooling abstracts less water, but uses more than once-through cooling
The greater expense of closed-cycle systems meant that they were less common than once-through systems; this is gradually changing, with closed-cycle systems now being used in around 75% of new plants (Tzimas, 2011). This has an impact on water availability, with the following table presenting a measure of the differences in water abstraction and consumption (use) for the various stages and energy technologies.

Table 3: Average water abstraction and use by energy technology and fuel, litres of water per MWh (OT=Once Through, CC=Closed Cycle)

Technology		Extraction / Growth	Refining	In transformation (Energy generation)	
		Water Consumption litres per MWh	Water Consumption litres per MWh	Water Abstraction litres per MWh	Water Consumption litres per MWh
Coal	OT	15	648	110 000	1 000
	CC	15	648	2 200	1 800
Gas	OT	370	25	45 000	500
	CC	370	25	900	700
Nuclear	OT	3 700	-	140 000	1 700
	CC	3 700	-	3 700	2 200
Hydro		Minimal	Minimal	Minimal	4
Solar PV		Minimal	Minimal	Minimal	Minimal
Solar Thermal		Minimal	Minimal	4 000	-
Wind		Minimal	Minimal	Minimal	Minimal
Geothermal		Minimal	Minimal	5 300	-
Biofuels	Ethanol	196 200	175	-	-
	Biodiesel	576 000	50	-	-
Oil	Standard	18	162	-	-
	Enhanced oil recovery	16 290	162	-	-
Unconven -tional fuels	Oil sands	3 366	162	-	-
	Shale gas	162	25	-	-

Source: Ecorys compiled from: Tzimas (2011); World Economic Forum (2009); World Energy Council (2009)

Note: The figures used are estimates compiled from various sources, each source reports uncertainty surrounding the estimates. Where a range of figures was given we have selected the mid-point value for simplicity, please refer to the original reports for further information.

Nuclear is the most water intensive of the major thermal energy types

The table clearly evidences the differences between once-through and closed-cycle thermal plants in water abstraction and use in energy generation, with abstraction significantly higher for once-through, but consumption higher for closed cycle. Nuclear power is clearly the most water intensive of the 3 (Coal, Gas, Nuclear) at the generation stage, and gas the least. The table also provides estimates of the water consumption in the extraction and refining processes of each fuel; this presents uranium extraction as a more water intensive process in comparison to coal and gas. It is notable that Carbon Capture and Storage (CCS), when applied to coal and gas plants, is estimated to significantly increase (x1.6-4) water abstraction and use.

Renewables typically require minimal water, although…

The table shows that most renewables use minimal water, except for solar thermal and geothermal and it is unclear how much of the water abstracted by these two technologies is actually consumed. Solar thermal, also referred to as Concentrated Solar Power (CSP), is typically located in dry, hot areas so water use could become an issue in future; at present only Spain has any substantial CSP capacity. At present, over 80% of EU Geothermal capacity is found in Italy. Hydropower is estimated to consume a small amount of water through evaporation from the reservoir lakes created behind the dams.

…biofuels are the most water intensive of all – water use in crop growth the major culprit

The fuels judged most water intensive of all are biofuels, with hundreds of thousands of litres of water required for each megawatt equivalent of energy. This is almost all required in growing the crops. Enhanced oil recovery and oil sands are also relatively high consumers of water in their extraction phases.

2.2.2. Impacts on water quality

The impact of the energy sector on water quality is more limited than its impact on water availability; its major impacts include the following:

Heat pollution from returned cooling water can damage aquatic life and ecosystems

The major direct impact of the energy sector on water quality comes through water temperature. Water that is abstracted is returned to water sources at a higher temperature than it was taken and is normal in the water source. This heat pollution can have a number of effects on water quality and ecosystems, including direct heat shock from hot discharges, which can kill organisms that cannot adapt to sudden changes in temperature. Oxygen depletion also becomes an issue, as cold water can hold more oxygen and hotter temperatures speed up decay processes, which also consume oxygen. Cooling towers, used in closed-cycle systems, can help minimise heat pollution by cooling to air, although water is then lost through evaporation. The temperature of water discharged by power plants is typically regulated to manage this problem.

Acid rain – the energy sector is a major cause…

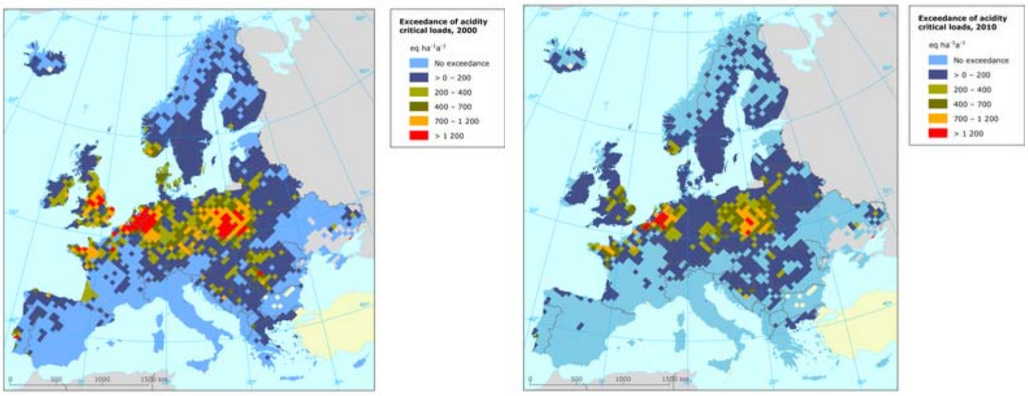
Acid rain has been a major impact of the energy sector on water quality and is caused by emissions of acidic Sulphur Dioxides (SO2) and Nitrogen Oxides (NOx) to the atmosphere from the combustion of coal and, to a lesser extent, natural gas. These particles become attached to water molecules, becoming acid rain as they fall (deposition). The run-off from this acid rain is absorbed into water courses and changes the pH balance; this is a particular problem in some lakes. Changes in pH levels, towards acidity, can have significant negative effects on water quality and ecosystems, with those in North West Europe and Scandinavia particularly susceptible to damage.

…but emissions have declined drastically since 1990, with benefits to the environment and water

In the EU, regulation of emissions from the energy sector as part of various legislation, including the Large Combustion Plant Directive (LCPD) has required power plants to fit various measures to plants to reduce emissions of acidifying substances.

These measures have contributed to a decline in SO2 emissions from the energy sector of 77.4% between 1990 and 2009, and a decline of 50.9% in NOx emissions over the same period, though these declines have slowed in more recent years. This is significant as the energy sector is responsible for between 55-65% of all EU SO2 emissions and 15-25% of all NOx emissions. As the figure below shows, the results of this decline in emissions have been positive, with a significant reduction in the exceedance of acidity critical loads between 2000 and 2010. This demonstrates an improvement in water quality in much of Northern and Central Europe, though 'hot-spots' in and around the Netherlands and Poland remain. Solutions to acidic waters include the application of lime to increase pH levels.

Figure 9: Exceedance of acidity critical loads in the environment, 2000 and 2010



Source: EEA (2011) European critical loads database 2008

Biofuels and contamination from agriculture could be an issue in future

The use of water in the growth of energy crops is another area of potential impact on water quality, as it is possible for it to become a carrier of agricultural contaminants. This could be important if growing demand for biofuels is met by increased European production, but could also be labelled a general agriculture and water quality issue. This is an area that requires further research.

Direct contamination from energy generation and extraction remains a risk

A final area of impact on water quality is contamination from energy sources, with run-off from coal heaps, radioactive discharges to water and groundwater contamination from gas and oil extraction among the major sources.

Nuclear energy can contaminate water with radioactivity

Nuclear energy has the potential to contaminate water with radioactivity, with water an important part of plant operation and fuel cooling. Two nuclear fuel reprocessing plants in Europe, one in the UK and one in France, discharge radioactive wastewater to the sea. This is believed to be at low levels so that little environmental damage is caused, but is an area of concern for neighbouring countries. The 2011 Fukushima disaster highlighted the potential for natural disasters to cause widespread damage to nuclear, or other, energy facilities and the resulting need for the use of water to manage the situation, which then becomes contaminated. It is understood that the risks of such a tsunami incident are lower in Europe, but flooding could have similar effects if not adequately managed.

Coal contains a variety of contaminants that are emitted to water directly or indirectly

Coal typically contains a range of other elements which can be released as coal is 'washed' prior to use or as it is burned for power. This can emit a variety of harmful substances to the environment, including pollutants such as mercury, cadmium and benzoapyrene. Emissions to air, and subsequently to water, of many of these contaminants has been reduced in Europe as power plants have been required to improve the filtering of emissions to capture these and other substances, such as SO2 and NOx as highlighted previously. Similar issues are posed in oil and gas extraction and refining, though much of this is located at sea or in coastal areas, with lower freshwater impacts.

Shale gas poses risks to groundwater, though these are not yet fully understood or quantified

Shale gas extraction is a relatively new energy source; it has been extensively developed in the US in the last few years and there is potential to also develop this in Europe. Given Europe's reliance on gas imports and gas being a lower carbon alternative to coal, there is pressure to explore and exploit this resource. The shale gas extraction technique, by injecting water and chemicals at high pressure into underground formations holding gas, has the potential to pollute groundwater, through both the chemicals used in the process and the potential to 'wash-out' natural contaminants contained underground. Cases of flammable tap water in the US highlighted the potential risks of this. As a relatively new technique and one that has, to date, been mainly developed under relatively lax US environmental protection and extraction laws, it is unclear what the long-term effects on water quality would be if shale gas is developed in Europe. Further research is ongoing.

2.2.3. Other impacts

Ecosystem disruption from hydropower

The development of hydropower and the water infrastructure in general has significantly changed the free flow of water across Europe; this has had important implications for ecosystems, with dams, weirs, locks and other barriers blocking migration routes, reducing water flows downstream and flooding areas behind the dam. This can impact a variety of aquatic species, particularly those that migrate upstream to reproduce, such as salmon. It also reduces the connectivity of ecosystems, and therefore their resilience to change and diversity. Some mitigation measures can be built in, such as fish-ladders, and careful consideration of siting and flow diversions. Although few major hydropower developments are foreseen in Europe in the future, there is growth in micro-hydro power; this is bringing new disruption to ecosystems at a smaller and lower level. There is an argument to be made that the energy gains from micro-hydro plants do not compensate for the ecosystem disruption and damage caused.

Water and energy infrastructure disruption

The events at Fukushima in Japan present perhaps the furthest extreme of how water can disrupt energy infrastructure and cause significant human, economic, social and environmental damage. A step back from this unlikely extreme are floods and droughts, which are much more common across Europe, and also have significant potential to disrupt energy infrastructure and cause similar damage. The knock on effect of damage to the energy infrastructure is also likely to be felt by water infrastructure with reduced or no energy available to power water supply and treatment.

Droughts

As noted in the introduction, droughts in the heat wave of 2003 forced energy firms to reduce production of electricity in France as there was not enough cooling water available in total or at the right temperature. Drought can also have a major impact on hydro-electric power, reducing the amount of water available to generate electricity and also leading to demands for water to be released from reservoirs for ecological, rather than energy, reasons. These types of conditions were affecting South East Europe in autumn 2011, causing disruption to production which led to increasing energy prices and cancellation of energy export contracts (Mitev-Shantek, 2011).

Floods

Flooding can be highly damaging for energy infrastructure, and with climate change projections anticipating an increase in the severity and frequency of flooding this could be an increasing problem. Problems of this type have already been experienced; in Romania in 2006 flooding shut down power supplies and flooding in England in 2007 left tens of thousands of homes without power.

Energy use by the water sector – is significant…

A final point on the relatedness of energy and water can be made on the energy used in the supply and treatment of water. The table below provides a summary of the average energy use of different steps in the water supply and treatment process based on the extraction source or method. This shows that surface water requires least energy to extract, treat and deliver to consumers, while desalination of seawater requires the most energy, over 8 times as much as surface water. Wastewater treatment also requires significant energy.

Table 4: Average estimated energy use of water sector – KWh of energy per cubic metre of water

Water type	Extraction	Treatment	Delivery	Total Average
Surface	0.20	0.03	0.29	**0.52**
Ground	0.29	0.03	0.29	**0.60**
Wastewater Treatment	-	0.66	-	**0.66**
Desalination Brackish Groundwater	-	0.85	0.29	**1.14**
Desalination Seawater	-	4.05	0.29	**4.34**

Source: World Economic Forum (2009)
Note: Energy use in the water sector varies significantly based on the distance it travels, the elevation it is pumped to, the quality of the water and intensity of treatment. These values represent the midpoints of the ranges in the source document, and surface water on average requires 30% less energy than groundwater to extract.

…using between 2-6% of all electricity in the EU

In total the water supply and treatment sector has been estimated to consume a significant share of energy; in the US this has been estimated at 138 TWh or 3.5% of total US electricity consumption in 2005 (EPRI, 2000). Similar data is lacking for Europe, but making a few simple assumptions[3], an estimate of approximately 200 TWh of electricity, or 6% of electricity supply is reached, with around half of all energy use in water treatment.

[3] Taking total average EU water abstraction of 186 077 million m3, assuming 80% is surface water, 19.73% is groundwater, 0.07% is desalination of brackish water, 0.2% is desalination of seawater, and that 80% of all water abstracted is treated. Then multiplying these volumes by the estimated energy uses in table 2. These assumptions are based on latest data from Eurostat.

This is a highly rough estimate, but it remains likely that the water sector in Europe accounts for somewhere between 2-6% of all electricity use.

Sludge gas meets an estimated 6% of these energy needs, with significant growth potential

As noted previously, using sewage sludge gas provides synergies between energy use and water supply and treatment. Combining the rough estimate above with known energy generation from sewage sludge gas, then this generates enough energy to meet approximately 5.9% of the energy needs of the water supply and treatment sector. If all Member States generated a similar proportion of sludge gas energy as Denmark, proportionally the EUs highest performer[4], then the energy generated from sludge gas could increase six-fold to meet over 35% of the sectors energy needs.

Similarly there may be synergies between solar power and desalination in hot, sunny countries. These are yet to be exploited on any scale.

2.2.4. Summary

This section has set out how water and energy are inter-related and also inter-dependent. This relationship is essential in providing the infrastructure through which our society functions. Climate change and other trends, such as increasing fuels costs, are leading to rapid change in the demands and pressures on both sectors. The energy sector is being required to switch to a low carbon future to meet emissions reduction commitments and mitigate future temperature increases, while the water sector has to adapt to growing scarcity, with part of the response requiring further infrastructure and consequently energy needs.

Investment in infrastructure, technological change and improved learning are improving the efficiency of water use in the energy sector but significant impacts on water availability and quality are still evident. Hydropower still significantly affects the water bodies it is located on, but it also provides a large amount of low-carbon electricity. Micro-hydro and pumped storage are likely to continue to grow in the future. Other changes in the energy sector, including the switch to renewables and growing use of closed-cycle cooling systems are likely to drastically reduce the amount of water abstracted from surface water in the EU, but at the same time, may increase the amount of water consumed in the process. The future expansion of Carbon Capture and Storage (CCS) has significant potential to increase water use, though many uncertainties remain.

Impacts on water quality have been present from the earliest power plants and issues such as heat pollution, acid rain and contamination of water sources from energy generation activity will remain. These issues will also develop and change, as on the one hand, new ways to reduce emissions and contaminants are found, and on the other hand, new uses and emissions and contamination potentials emerge, as in the case of shale gas.

The water sector itself is a significant energy user and will need to play a part in reaching EU energy goals in 2020 and beyond. There are opportunities to do this, for example in increasing the use and efficiency of sewage gas schemes, and reducing energy needs by improving whole system efficiencies.

[4] Based on sludge gas energy production per million cubic meters of water abstracted.

Necessary development of energy intensive water infrastructure, such as desalination, may contradict energy goals, therefore it will be important to consider how to accommodate this.

These various developments pose a range of management challenges for the EU, River-basin management committees, Member State governments, regional and local government, and stakeholders throughout the water and energy industries. It will be increasingly important to consider the water use implications of new energy infrastructure, whether supply and demand is sufficient, and also the energy use of new water infrastructure. It will also be important to continue to consider and manage the impacts on water quality from existing and new developments. For both water availability and quality it will be vital to understand how climate change and other mega-trends, such as electrification of transport, will change the demands and impacts on water and energy and what this means for management.

2.3. Water and finance

Introduction

It is generally agreed that water management and achieving good ecological status as specified by the WFD is costly and with many countries facing the challenge to reduce pressures from agriculture and to improve river morphology, financing has become a clear priority for member states. The financial burden imposed by the WFD implementation is even higher for new European member states, as they have to implement several (older) EU directives at the same time.

Up to a few years ago, financing water management usually referred to funding the development and maintenance of (hard) infrastructure and the operations of organisations involved in the water sector. However, more recently it has been recognised that ecosystem processes are an important aspect of sustainable water management and can contribute to the reduction of the 'whole life' costs of delivering sustainable water stewardship. Examples in the area of flood management include i) restoration of river/wetland systems; ii) run-off control in urban areas through improving soakaways and providing on-site storage facilities; providing floodways that allow excess rainwater or snowmelt to pass safely and offer recreational and communal benefits at other times.

Heavy investments are needed

Water services are characterised by heavy investments: treating and distributing drinking water and collecting / treating wastewater is very capital intensive. In many parts of the EU, annual capital investment is more than EUR 200 per household and exceeds total operational costs.

Although extensive investments have been undertaken during the last few decades, significant new investment is still required to achieve „good status" for the water environment; moreover, investment needs are likely to go on increasing as the environment changes continuously. Some of the most significant reasons for this continuing investment need are:

- Infrastructure in the water sector is long term based and it is a precondition for a sustainable service to have continued reinvestments over time. Large infrastructure investment, renewal and maintenance operations require that the costs are distributed among the generations that benefit from these investments.

- There are always changes in the field where water utilities operate which could or will influence future infrastructure investment. Examples of drivers of change are: i) changes in population densities (people moving from rural to urban areas); ii) increasing demands on water quality (e.g. water hardness) by customers; iii) ongoing technical progress and the necessity to adapt infrastructure to the state of the art; iv) new agricultural business fields (such as bio-fuels) can lead to intensified agricultural production and increased usage of fertilizers and pesticides with negative impacts on raw water quality; and v) improvements in technical measurement methods may lead to more ingredients becoming traceable (e.g. hormones, new kinds of pesticides, etc.).
- The consequences of climate change for the water sector could be manifold like droughts, floods and heavy rainfall; e.g. sewers would have to cope with more intensive rainfall and drinking water reserves could come under pressure because of droughts. Additional investments will be needed for adapting the existing infrastructure and developing new ones as well.
- The Water Framework Directive (WFD) entered into force in 2000 and aims to maintain and improve the aquatic environment. New strategies concerning demand management and efficient use of water resources will have to be developed. Member States need to take measurable steps towards achieving the WFD environmental objectives by 2015 and justify delaying certain measures until later. Obviously, WFD together with the implementation of the Directive on Urban Wastewater and the revised Directive on Drinking Water into national law, together with requirements to address water scarcity and drought risk through leakage reduction and other means, will possibly require large investments in the next few years resulting in an increase of water prices.

Divergent approaches by Member States

The Communication from the European Commission to the European Council, the European Parliament and the Economic and Social Committee on "Pricing policies for enhancing the sustainability of water resources" (EC, 2000b) makes clear that charges for water and waste water services should include the recovery of depreciation on the assets invested in the provision of these services and the costs of ensuring that this infrastructure is renewed and maintained. This Communication also identifies financial costs – alongside resource costs and environmental costs – which must be recovered by water customer payments. Furthermore, the WFD cost recovery principle also provides that water users and water service users should contribute to this cost recovery.

In spite of the agreement among Member States on the principles of pricing water services, Member States apply different "financial models" to their water sector. Many of them include explicit subsidies but policies vary between countries. On the one end of the spectrum, in the UK, water (and sanitation) assets have been privatised and there are no overt public subsidies. In Finland, on the other hand, water companies are public and the surpluses they generate contribute to local government spending on other programmes. In the Netherlands, surface water management is the responsibility of Water Boards, sewerage and wastewater falls to municipalities and drinking water is supplied by publicly-owned limited companies. Each of these bodies levies charges or tariffs, and the Dutch Water Bank provides long term loan capital for the development of infrastructure. The policy in France requires the municipalities to collect tariff revenues from users.

These tariffs include abstraction and pollution charges that are transferred to the six River Basin Agencies. These authorities in turn subsidise municipalities to enable them to finance water and wastewater infrastructure. Elsewhere in Europe, the Czech Republic aims at full cost recovery for water and wastewater infrastructure, and in Spain, the basin authorities charge municipalities for the cost of providing large water infrastructure, while new wastewater treatment plants are to be subsidised partly from the EU and partly from central government.

Whereas the differences between member states in their financing models lead to differences in price levels between countries charged by water producers, there are also important differences within countries between the various economic sectors. In many countries farmers can rely on low (read subsidised) water tariffs, often leading to overexploitation of local resources.

Over the years, member states have developed a variety of approaches and solutions with regards to water pricing. These reflect the diversity of local scarcity and pollution conditions as well as the legal, administrative and socio-economic set-ups. Below we provide examples of the principles on which water prices (and discharge fees) are set in various European countries (EEA, 2001).

Austria	Fees on volumetric basis. The charges reflect the full capital and operational cost to the municipality of providing the water services. There is no nationally uniform method that occurs before charges (i.e. Salzburg charges are related to the area of the dwelling, hotels are charged per bed, restaurants per seat).
Finland	The wastewater fee is directly connected to the water use even if the fee is a separate one.
France	Pollution levies are based on measured or estimated quantity of substances discharged (decided by the Basin Committee). Revenues are redistributed to industries, regional authorities and farmers. Withdrawal levies are based on On net and raw volume withdrawn (decided by water agencies) and taxes are based on water used (decided by the State).
Germany	Groundwater abstraction charge (federal states or Länder) on a volumetric basis. There are big differences between charges in the federal states. Some states have not introduced these charges. A high amount of the charges is used for water protection measures. For wastewater, charges are also levied by the federal states (Länder) and the charge is based on the concentration of certain pollutants and on toxic units.
Greece	Wastewater charges with sanitation fee by local water and sewerage company. The fees are based on volume in big properties or contractual price. However, these are often insufficient to finance wastewater treatment.
Italy	Waste water taxes through local water companies are based on volume and water quality, which partially finance the compensation of environmental damages.

The special position of agriculture (both as a provider of basic societal necessities as well as often detrimental to the water environment), is mirrored in water pricing policies and in water extraction usage. Across the EU, most water fees for agricultural use do not reflect (full) cost recovery principles and area-based charges represent a commonly used pricing structure in agriculture[5]. However, as prices do not rise proportionally to the amount of water used, these tariffs are generally considered to be unsuitable for giving incentives and promoting a more sustainable use of water resources. On the other hand, area based charges could serve as a starting point to calculate block tariffs and to reduce opposition and impacts. To fulfil cost recovery and incentive functions, however, any area-based charge would need to increase in price or be combined with a decreasing quota to have any future effect on water consumption (Intervies and Gorlach, 2011).

In October 2010 a workshop[6] was organized in th context of the Common Implementation Strategy of WFD to discuss current experiences in addressing economic issues within the implementation of the WFD and future possible developments. With regard to current implementation it was noted that:

- A variety of methodologies and approaches have been developed and applied in Member States for the implementation of the different aspects of Article 9 of the WFD ("Recovery of costs for water services"), including on cost recovery for water services; definition, estimation and internalisation of environmental and resource costs ; the application of the flexibility associated with Article 9 implementation; the application of the polluter pays principle; the adequate contribution of water uses to the recovery of costs of water services and the evaluation of water pricing policies with regards to the provision of incentives for efficient water use in order to reach the environmental objectives of the Directive.
- Most Member States had a clear idea of cost recovery regarding financial costs of water supply and sewerage services. However, this was not the case for environmental and resource costs. Therefore, there has been the use of proxies, particularly in relation to the estimation and internalisation of environmental and resource costs.
- Data gathering is a common challenge for Article 9 implementation, including issues of data availability, format, ownership, collection and processing of different data formats and the related costs. The main data/information gaps in relation to cost recovery estimation were for the agricultural sector.
- On cost recovery it was reaffirmed by the workshop that a 100 % cost recovery is not required by the WFD in all circumstances, but it is important to explain the current cost recovery rates in order to improve transparency.
- Most Member States reported to have incentive pricing policies in place, some already for some time, others recently implemented.
- While incentive pricing policies should contribute to reaching the WFD objectives, a common understanding of the role of incentive pricing and its contribution to achieving the objectives is an area of uncertainty. The low price elasticity of demand for water was highlighted, thus other incentive instruments beyond pricing need to be considered.

[5] 100% cost recovery of operation and maintenance and capital costs is applied only in Austria, Denmark, Finland, Sweden, and the United Kingdom. A 100% cost recovery of operation and maintenance costs, but less than 100% recovery of capital costs is found in France, whereas less than 100% cost recovery of operation and maintenance and capital costs is common in Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, and Spain.

[6] Workshop: CIS-Workshop on WFD-economics – Taking stock and looking ahead - 19-20 October 2010

Another important outcome of the workshop was that the environmental dimension (of water) was still not on equal footing with the economic and social dimension when it comes to priority-setting for funding to achieve greater territorial cohesion. In this respect it was noted that Cohesion Policy focuses on economic growth and social development and has less attention for inter-linkages between project related impacts, such as increased water and air pollution and their link to protected and natural areas (EEA, 2010e). Significant shortcomings in streamlining environmental concerns, continued bureaucratic rigidities as well as problems with co-financing rates remain serious points of criticism (WWF, 2011).

In short, experiences with financing systems in the water sector are varied and issues vary:

- Service levels have evolved gradually, and vary greatly between EU countries.
- In some cases, infrastructure is privately owned and operated, in others publicly or communally owned and operated.
- Although ownership affects the funding of capital investment, the sector taps three basic sources of revenue - tariffs and other user contributions, tax-based subsidies and transfers such as those from Structural Funds.
- Many systems contain hidden subsidies and under-funded costs, especially under-investment that has major future funding implications.
- There is no single "financial model" common to all countries.

Sources of finance

Both reducing costs and/or increasing revenues contribute to closing the financing gap. Reducing costs includes measures such as improving operational efficiency and selecting cost-effective interventions. To increase the revenues, a clear financing (and regulatory) framework is needed, as this might help to attract private investors which can temporarily "bridge" the financing gap. As the water and sanitation sector is perceived as a sector with high risks and low returns, different options for "blending" private and public funds, accessing bond markets and attracting private funds can help to bridge the financing gap temporarily.

However, building a financing structure on a more sustainable basis entails the establishment of institutions at the national level for channelling funds (both public and private) into the sector in order to finance relatively small projects (rather than focusing on a few large transactions at the international level).

Although financing water management is often taken for granted, more attention should be paid to justifying the benefits (direct and indirect) of financing water management, in particular with regard to "soft" costs related to monitoring, public participation and governance. Although the costs of these "soft" water management tasks are often mentioned as constraints for their implementation, the most important factor for their successful implementation remains political will. In the context of the preparation of the RBMPs, economic instruments that have been considered include prices and taxes, licensing of reallocation instruments (environmental standards/ norms, trading/voluntary agreements) and subsidies.

However, most Member States' efforts have been limited to studies and assessments. Despite the progress made in using economics in support of the development of river basin management plans, only a few Member States have considered adapting economic instruments or implementing new instruments for the implementation of the WFD.

Examples include: the new permit-fee system for pollution control proposed and currently tested in Sweden; environmental charges implemented by the Water Agency of Catalonia in response to the requirements of the WFD; new financing instruments to support hydro-morphological improvements proposed in Austria in response to the new challenges of the WFD. The main reasons behind this limited consideration of economic instruments by Member States remain, however, unclear.

The scale of funding …

There are various estimates that inform us of the required annual expenditures in the water and wastewater sector. One study, quoted by the OECD study Infrastructure to 2030 (OECD, 2007), estimates the needed annual expenditures to finance infrastructure, maintenance and services at 0.35 to 1.2% of GDP. In the table below, the estimates for a number of EU countries have been extracted from this study.

Table 5: Projected expenditures on water and wastewater services. Average annual investment (in USD billions)

Country	By 2015	By 2025
Austria	2.59	3.91
Belgium	2.75	4.38
Czech Republic	3.12	2.83
Denmark	1.82	2.74
Finland	1.35	2.15
France	16.86	25.84
Germany	23.38	35.84
Greece	2.17	3.34
Hungary	2.02	2.79
Iceland	0.09	0.14
Ireland	1.35	2.15
Italy	16.83	25.23
Luxembourg	0.24	0.39
Netherlands	5.43	7.88
Poland	7.93	7.18
Portugal	1.96	2.97
Slovak Republic	1.35	1.22
Spain	10.97	15.96
Sweden	2.26	3.6
United Kingdom	19.14	27.96

Source: OECD, (2007)

What funds…

To close the gap between the need for funds and the finances available from within the water sector, considerable EU funding has been made available. In particular the EU cohesion policy and the second pillar of CAP provide considerable financial support to respectively investments in urban waste water treatment plants and investments at the level of farms (in particular through the so-called agri-environment measures). Also other EU funds, though to a lesser extent, have provided financial support to certain aspects of water policies at national level. It is foreseen that funding needs in relation to the implementation of the WFD and other water Directives will remain big in the coming years, and substantial EU funding will be needed from the EU cohesion policy and rural developments funds, especially for infrastructure investment in the new Member States. But also in the realms of climate change adaptation, the financing needs will be substantial, as climate change impacts will exacerbate water-related problems and challenges (e.g. floods, water scarcity and droughts). In relation to the latter, the Fitness Check (EC, 2011) notes that the uptake of cohesion policy funds made available for investments in 'risk prevention' (flooding, forest fires, storms, etc.) is lagging behind compared to investments in waste water treatment.

Two examples

To illustrate the various funding sources we look at the situation in Romania (depending mostly on structural funding) and Germany (where Länder receive funds from various sources).

The situation in Romania

In Romania, only 52 per cent of the population is connected both to water and sewage services and more than 71% of the wastewater is either untreated or insufficiently treated (Boer, 2008). With its accession to the EU in 2007, Romania needs to comply with the European Directive 98/83/EC on drinking water quality by 2015 and the Directive 91/271/EC on urban wastewater treatment by the end of 2018. The former requires construction of new urban waste water treatment plants; up-grading of the existing urban waste water treatment plants, also in the agro-food industry; rehabilitation of the existing urban sewerage collecting systems; as well as construction and/or extension of urban sewerage collecting systems. Total investments are estimated to amount to EUR 9,5 bn. (EUR 5,7 bn. for water treatment plants and EUR 3,8 bn. for water sewerage systems). Operating costs, for a transition period of 12 years, are estimated at about EUR 3,4 bn. These investments will be covered from multilateral grants, loans for public service and infrastructure investments with governmental or local guaranties, stimulation of private funds and public-private partnerships. In addition, the pre-accession instruments (ISPA, SAPARD, PHARE) are also used to finance the works in the field of waste water sewage and treatment. Furthermore, the International Bank for Reconstruction and Development, the European Bank for Investments and the European Bank for Reconstruction and Development provide financial support. Overall, the main financing sources are: approx. 40% from EU funds; 30% from national and local budget, 20% credits and public-private partnerships, 3% Environment Fund and 7% population.

The allocation of financial support during the last few years looks as follows:

Table 6: EU Funds in Romania for WWTP (Million Euros)

Year	State & local budgets	EU funds	Other sources	Total
2008	180	150	75	**405**
2009	2000	250	100	**550**
2010	276	395	230	**901**
2011	256	395	250	**901**

Source: Government of Romania

In order to comply with the quality parameters of drinking water as defined in the Drinking Water Directive, investments of EUR 5,6 bn. need to be made. These investments will be financed by state and local budgets, external financial assistance and public-private partnerships (Government of Romania, 2004b). An overview of the main financing sources during the transition period is provided below:

Table 7: EU Funds in Romania for drinking water (Million Euros)

Year	State & local budgets	EU funds	Other sources	Total
2008	86	260	74	**420**
2009	942	270	78	**440**
2010	120	410	110	**640**
2011	127	495	106	**728**

Source: Government of Romania (2009)

… and in Baden-Württemberg (Germany)

In Germany, the implementation of the Water Framework Directive is the responsibility of the Länder. While each Land has to develop its own strategy for mobilizing the necessary financial resources, Germany follows the principle of cost recovery of water services by water users, i.e. measures have to be financed by those responsible for their implementation. Under certain conditions (i.e. if foreseen by law or if incentives for a rapid, voluntary implementation of measures seem appropriate) the federal state will provide additional financial aid. Additionally, the following financial instruments have been identified:

- European and German national funds: European Regional Development Fund, European Agricultural Fund for Rural Development, German Joint Task for the Improvement of Agrarian Structures and Coast Protection
- Cross compliance under the Common Agricultural Policy
- Municipal financial equalisation
- Compensation measures under German law / trading with ecological points
- Effluent charges
- Fishing charges
- General budget funds

To provide an example, total investment costs in Baden-Württemberg have been estimated at EUR 780 mio. and annual running costs at EUR 1,67mio. (Mattheiß et al., 2010). The cost-structure and the potential financing sources are illustrated below:

Table 8: EU Funds in Baden-Württemberg

Type of pressure	Type of financing sources	Amount of funding
Point sources	- Sewage charges, - Support through the subsidy guidelines for water management, - Municipal Environmental Fund	EUR 40 m/year
Agriculture	Existing programmes are used for financing agricultural measures, complemented by specific advice	EUR 97 m/year
Hydro morphology (structure, continuity, minimal flow)	- Structural funds: EAFRD, EFF (European Fisheries Fund), Municipal Environmental Fund, lottery funds, Ecological accounts - Continuity of hydropower plants: Application of the Renewable Energy Law - Federal water ways - The rest will depend on negotiations between national ministries and the Land.	EUR 8 million/year EUR 10 million

Source: Source: Mattheiß et al. (2010)

2.3.1. Summary

The water sector in the EU is faced with major challenges as a result of demographic developments, urbanization, economic progress, social changes and climate change. The need to replace old infrastructures and to build new systems (especially for member states in Eastern Europe), requires large funds, not readily available within the sector. The principles for financing water services within the EU have been enshrined in the WFD, although many of the current systems still tend to ignore externalities and economic instruments focusing on efficiency in water supply are not widely used in Europe and remain controversially discussed, particularly within the agriculture sector.

Innovative approaches to finance the required investments are needed at the same time as the challenges of policy integration need to be addressed. Given the (perceived) low returns on investment in the water sector, closing the financing gap with private funds will not be possible. This requires efforts from the public authorities to raise funds and to improve the pricing system for water services (i.e. by including all externalities). Policy integration (i.e. phasing out environmentally harmful subsidies and better coherence of water and other non-environmental policies) will be an essential element in this process.

2.4. Water and Nature protection

Europe's nature protection policy dates back to the 70's…

Recognising that nature does not respect national borders, the first EU-wide nature protection policies came into force 30 years ago with the adoption of the Birds Directive in 1979. Extension came with the Habitats Directive in 1992. Those two directives form the legal backbone of the Natura 2000 network which is an EU-wide network of nature protection areas, incorporating the areas created under the earlier Birds Directive, and a strict system of species protection on the other hand (EEA, 2010a).

Natura 2000 is not a system of strict nature reserves where all human activities are excluded. Whereas the network will certainly include nature reserves most of the land is likely to continue to be privately owned and the emphasis will be on ensuring that future management is sustainable, both ecologically and economically (EC, 2011).

In Natura 2000 fresh water is one of the protected areas…

Key ecosystem types in Natura 2000 are: agro-ecosystems, forest, grassland, heath and scrubs, wetlands, river and lakes and coastal ecosystem. Freshwater ecosystems cover about 15 percent of Natura 2000. "Fresh water systems are created by water that enters the terrestrial environment as precipitation, and flows both above and below ground toward the sea" (EEA, 2010a). These systems encompass a wide range of habitats, including wetlands, and lake and rivers. Although all ecosystem are to a certain extent affected by droughts and/or floods (water availability) and water quality, this chapter will focus on the water related ecosystems since these ecosystems heavily depend on both water and nature protection policy.

Wetlands cover 11 percent of the surface of Natura 2000 (EEA, 2010a) hold an important part of Europe's biodiversity and provide ideal conditions for a vast diversity of habitats and species. Natural habitats of large bogs, marshes, and small or shallow lakes are the home of a large number of species including bird, amphibian, invertebrate and plant species during key stages in their life-cycle (LIFE, 2007). They are often key areas during the breeding season and provide spawning grounds for fish and feeding and breeding areas for birds (Smith, 2011; LIFE, 2007). They also supply us with drinking water and recycle our groundwater (Vandewalle, et al., 2010). They are a buffer against flooding and are vital carbon sinks. Wetlands are of relevance for biodiversity, agriculture, fresh water and tourism and there is a clear overlap between wetland systems and other ecosystems such as agro-ecosystems, lakes and forests (EEA, 2010a; VandeWalle, et al., 2010).

Lake and river ecosystems cover at least 4 percent of the surface of the Natura 2000 (EEA, 2010a) and play an important role in the water supply services and in water purification. Rivers provide, regulate and support also other related ecosystems by the continuous inflow of fresh water provide food for inhabitants and are an important source for energy production. Lakes and rivers are intensively used for recreational activities (fishing, bathing, rafting, etc.), while particular species (fish and birds) are of economic importance for the tourism sector in some places. Since the water from lakes and rivers is of a great importance for human health, the monitoring of these ecosystems will take place regularly in most countries (Vandewalle, et al., 2010).

But nature protection is relatively new in water policy…

Although the nature protection policies date back to the 80's, ecosystem health is a relatively new objective for European Water policy. Previous legislation focused on cleaning up chemical pollution, rather then recognising that water should also be able to support healthy ecosystems (WISE, 2008; EP, 2000). In the Water Framework Directive there are a number of objectives in which the quality of water is protected and in which the protection of aquatic ecology and valuable habitats are ensured (EP, 2000). The focus on the ecological status of water bodies implies that traditional water protection and management approaches have to be complemented by methods and approaches from nature conservation (Bär & Choudhurry, 2001).

There are both overlaps and differences between WFD and Natura 2000…

The WFD and Natura 2000 aim at healthy aquatic ecosystems for the future, while at the same time ensuring a balance between economic sustainable use and nature protection (EC, 2010). The WFD has clear linkages to nature conservation/biodiversity. Improving the status of water bodies (cleaner water, more natural parts of rivers, river continuity, sustainable water use etc.) means better habitats for aquatic organisms and for other water depending species.

In the WFD the water quality assessment is about the aquatic biology (and not only physic-chemical elements). Ecological status assessment focuses on selected indicator groups of aquatic plants and animals to determine the overall structure and functioning of the aquatic ecosystem. However, some aquatic organisms and species depending on water but living outside the water are not included in the WFD ecological status assessment. Natura 2000 targets specific habitats and species and sets the basic requirements of assessment of the health of ecosystems: they include the species that are not living in the water (EC, 2010). Contrary to the aim of Natura 2000, the aim of the WFD is not to protect individual species but rather to use them as indicators of the ecological status of the aquatic ecosystem (EC, 2010).

The water-dependent Natura 2000 sites are listed under the WFD as well as under Natura 2000 (Table 9). For those areas the objectives of Natura 2000 and WFD apply and special attention and coordination is needed where these directives are implemented in the same areas (EC, 2010).

Table 9: Examples of habitats listed in Annex I of the Habitats Directive

Examples of habitats listed in Annex I of the Habitats Directive	Relevant WFD category
3. Freshwater habitats	
31. Standing waters	
3160 - Natural dystrophic lakes and ponds	Lakes
32. Running water - sections of water courses with natural or semi-natural dynamics (minor, average and major beds) where the water quality shows no significant deterioration	
3210 - Fennoscandian natural rivers	Rivers
3220 - Alpine rivers and the herbaceous vegetation along their banks	Rivers
3250 - Constantly flowing Mediterranean rivers with Glaucium flavum	Rivers
3260 - Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation	Rivers

2.4.1. Impacts on water availability

Impacts of aquatic ecosystems on flooding and vice versa

Wetlands

Until recently several initiatives took place to drain wetlands and place dikes and dams to protect urban settlements from flooding and to purify water (Smith, 2011). These activities mean a loss of wetland (in the US, more than 1,200 square kilometres of wetlands disappeared between 1990 and 2006, a change of 5 percent of the country's total surface), while wetlands are one of the best natural protections against flooding (EEA, 2010a). Wetlands are integral to flooding both in terms of the influence of wetlands on floods, and the influence of floods on wetlands (Baker & Eijk, 2006). Wetlands can play a crucial role in mitigating floods via their natural 'sponge' function (Baker & Eijk, 2006). Wetlands can store, slow down and release flood waters, while they also rely on flooding to keep the ecosystem healthy. It depends on the type of wetland, what the capacity of flood mitigation is (Baker & Eijk, 2006). Although wetlands can help to protect urban and agricultural land for floods, decision makers, tend to prefer investing in water-related infrastructure, rather than improving the capacity of water-related ecosystems (UN ECfC, 2005).

Lakes and rivers
Most of the rivers in the European Union have undergone modification over time to guard against flooding, or for navigation, agriculture or hydro-electricity purposes. These modifications have resulted in a significant loss of biodiversity and have also disrupted rivers' ability to provide vital services such as floodwater retention or water purification. The EU Biodiversity Action Plan calls on Member States to protect fertile soils and to restore valuable rivers so that they can help alleviate potential floods. Flood plain restoration increases the water storage capacity of a floodplain and help controlling flooding. Furthermore the restoration contributes to nature conservation.

Impacts of aquatic ecosystems on droughts/water scarcity and vice versa

Wetlands
Wetlands can regulate the frequency of drought periods (IPCC, 2001). During periods with no rainfall some wetland types can continue to supply small tributaries with water and keep them from falling dry (Baker & Eijk, 2006). But droughts can also affect the wetlands. Some plants and animals shall not survive dry periods and breeding places could disappear (Lake, 2011).

Lakes and rivers
As lakes and rivers fall dry some invertebrates may become trapped and die (for example mussels), some adapt and migrate deeper into the moist sediment or fly to remaining pools (Scott et al., 2011). Fish living in the river congregate in the remaining deep waterholes along a river channel and are easy targets for fishing (Scot et al, 2011). But there is always a dynamic process taking place. Although there is a reduction in aquatic habitat, there is a corresponding increase in the area of semi-aquatic and terrestrial habitat in which new plants and animals can feed, live and breed (Scott et al., 2011).

2.4.2. Impacts on water quality

Impacts of wetlands on water quality and vice versa
Wetlands absorb and serve as a natural chemical filter for urban run-offs and contaminants and they play a distinct role in the natural process of self purification of rivers and streams (Baker & Eijk, 2006; LIFE, 2007; Smith, 2011). They can also provide important services to framing system such as pollination and the harbouring of natural predators of agricultural pests (VandeWalle et al., 2010). However, heavy modification and pollution of wetlands are two of the main threats to the biodiversity of these ecosystems (EEA, 2010a). Untreated runoff from agricultural land, urban areas, and other sources is a leading cause of water quality impairment. Siltation; pollutants; excess nutrients; and increased turbidity, are responsible for most of the impacts to wetlands from runoff.

Other pollutants, mainly from urban run-offs are not or only partly treated before they are discharged into a water body. They include water that is released from vehicles, or deposited from atmosphere and could contain heavy metals and other chemicals (EEA, 2011). In some countries of Europe the urban storm water is also transported to the waste water treatment plant. However, when the system exceeds its maximum capacity during heavy rainfall the water is discharged untreated into the surface water (EEA, 2011). Other sources of urban pollution are broken sewer, leaking septic tanks and leaking landfills (especially the older ones) and contaminated land (EEA, 2011).

The WFD sets out clear objectives to prevent further deterioration of European aquatic systems and to reach a good ecological status for all types of surface water by 2015 (EP, 2000; LIFE, 2009).

2.4.3. Other impacts

Invasive Alien Species

Europe's rivers are widely used for transportation by ships. A negative side effect of shipping is passive transportation of Invasive Alien Species (IAS). "Invasive alien species (IAS) are non-native species whose introduction and/or spread outside their natural past or present ranges pose a threat to biodiversity (EEA, 2010b)". Only a small part (10-15 per cent) is indicated to have a negative effect on the ecology. Most alien fish and invertebrates are introduced into the ecosystems mainly for supporting extensive fish culture and sport fishing and intensive aquaculture and by passive transportation by ships (DAISIE, 2009). Although alien species are a threat to the species of origin, in Europe loss of habitat and pollution are more threatening (EEA, 2010b).

2.4.4. Summary

Although EU nature protection policies date back to the 1970s, more explicit links to water only came relatively recently with the Natura 2000 programme, which covers a variety of freshwater habitats and ecosystems. This is part of the recognition that freshwater ecosystems play crucial roles in supporting biodiversity and provide valuable ecosystem services.

In respect of biodiversity it is clear that wetlands and other freshwater ecosystems are amongst the richest and most diverse ecosystems in the EU. In contrast freshwater ecosystems can also be vulnerable to invasive species, with associated economic and biodiversity costs. The services provided by freshwater ecosystems are also economically valuable providing food, natural filtration and purification of water, flood protection and leisure and tourism.

Policy challenges in the area of water and nature protection stem partially from the fact that it is a relatively new policy area, but also that the policy objectives of the WFD and Natura 2000 differ. Whereas the WFD focusses more specifically on aquatic life and ecosystems, Natura 2000 takes a broader view and considers all life and ecosystems that rely on water.

In terms of water availability and nature protection the biggest challenges revolve around the loss of wetland ecosystems and habitats, over 5% by area lost in the last two decades. This is increasingly a problem in terms of both nature protection and also the loss of ecosystem services, with flood protection a particularly acute issue as building on floodplains reduces flood protection function while also exposing more buildings to flooding. Droughts can also be problematic as abstraction increases and flow from rivers and lakes decreases: ensuring an 'ecological flow' is vital for these ecosystems.

In terms of water quality, nature protection relates back to the function of ecosystems as natural receptacles and filters of waste. They are able to provide some services for free, but challenges arise when these functions are overwhelmed by human impacts, which can damage and destroy ecosystems.

3. EU WATER LEGISLATION: STATE-OF-PLAY

KEY FINDINGS

- The WFD and much of European water policy is hailed for being innovative, ambitious and take an integrated perspective, implementation however has been slow and uneven.
- Directives targeting pollution have been fairly successful, the remaining problems are mainly in; water efficiencies and curbing demand; diffuse sources of pollution; policy integration between policy areas such as water and energy; the economic instruments; and, unevenness in implementation among Member States.
- For water efficiencies there are alternative approaches for treatment and reducing demand which might be more cost-efficient than traditional approaches.
- Land-use is emerging as a major challenge, especially agriculture and urbanization, EU legislation and policy initiatives however lack the incentives to apply more ecosystem based approaches and use infrastructure for pollution control, water retention and flood prevention/protection.
- Economic instruments have been applied to varying degrees, but evidence based evaluation should inform policy makes and public on the value of these tools.
- The WFD has spurred a huge amount of data to be collected but major gaps remain.
- Water problems are global in nature which brings with it both business opportunities and challenges for policy-makers. EU water legislation is still not perfectly in line with some of the major UN conventions, and the impact of trade on water access in other countries is not perfectly understood.
- Climate change has heightened the urgency for policy action and is expected to put more pressure on water availability and quality, especially in terms of increased in floods.

The water sector is of particular importance to the European Community's environmental policy. Not only was it one of the first sectors of environmental concern to which the European Community directed its attention, it has become the sector with the most comprehensive coverage in EU environmental regulation (Kallis and Nijkamp, 1999). European water policy started to develop in the early 1970s. At the time, policy measures were mainly concerned with protecting the quality of water used for human activities. As of the late 1980s, the scope was extended to include limitations of emissions of pollutants (Aubin and Varone, 2004). Early legislation focused mainly on specific environmental problems and evolved in a piecemeal fashion. The fragmentation of the policy landscape called for concerted efforts and a more integrated and strategic approach to sustainable water management, leading to the adoption of the Water Framework Directive (WFD) in 2000 (Kallis and Nijkamp, 1999; Lanz and Scheurer, 2001). It has become a fairly unique piece of legislation which ties together a broad range of policies to tackle a series of complex and interlinked water problems.

3.1. The legislative framework

The WFD establishes a framework for the protection of all European water bodies. It states that all water bodies must at least meet the standard of 'good status'[7] by the end of 2015 (EC, 2011e). It is complemented by two more operational daughter directives: the Groundwater Directive (GWD) of 2006 and the Environmental Quality Standards Directive (EQSD) of 2008.

- The GWD requires groundwater quality standards to be established by the end of 2008 and introduces measures to prevent or limit groundwater pollution (EC, 2011d).
- The EQSD sets limits on concentrations in surface waters of 33 priority substances and eight other pollutants with the aim of achieving good surface water chemical status (EC, 2008). Several other directives are closely related to and form an integral part of the WFD (EC, 2010).

The GWD and the EQSD are directly linked to the WFD with the purpose of operationalise and clarify specific parts of the framework. Two other pieces of legislation that are linked to the WFD but not fully integrated are the Urban Waste Water Treatment Directive and the Nitrates Directive. They formed the basis of pre-WFD EU water management and are key to 'the pollution control' approach.

- The Urban Wastewater Directive (1991) aims to protect the environment from the adverse effects of urban and industrial waste water discharges by regulating the collection, treatment and discharge of such waters (EC, 2011f).
- The Nitrates Directive (1991) aims to reduce and prevent water pollution by nitrate originating from agricultural sources. It requires Member States to monitor waters, designate 'nitrate vulnerable zones' and adopt and implement action programs and codes of good agricultural practices with the aim of improving fertiliser management and reducing nitrate leaching towards waters (EC, 2011e).

The Floods Directive of 2007 is also linked with the WFD and requires Member States to coordinate their action plans for flood management and river basin management. All Member States are to assess if all water courses and coast lines are at risk from flooding by 2011, to map the flood extent and assets and humans at risk in these areas by 2013, and to take adequate and coordinated measures to reduce this flood risk by 2013 (EC, 2011a).

Further to the WFD, the Bathing Water Directive and the Drinking Water Directive have been developed to address specific usages of water with impact on human health.

- The objective of the new Bathing Water Directive of 2006 is to reduce and prevent the pollution of bathing water as well as to inform European citizens of the degree of pollution, for example by the introduction of logos (Europa, 2011).
- The Drinking Water Directive (1998) sets standards for the most common substances to be found in drinking water to make sure drinking water everywhere in the EU is healthy, clean and tasty (EC, 2011c).

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[7] 'Good status' means that "the values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions" (EC, 2000).

Besides freshwater policy the EU has adopted legislation for the marine environment with goals linked to the WFD.

- The Marine Strategy Framework Directive (2008) provides that all marine waters must meet the standard of "good environmental status" by 2020. To this end, Member States must draw up the necessary programmes of measures by 2015 (EC, 2011e).

Finally, the EU has yet to address a few key issues with legislative action, in particular for climate change adaptation, and water scarcity and droughts. However, (only) two non-legislative acts have been adopted:

- The White Paper on Adaptation to Climate Change (2009) presents the framework for adaptation measures and policies to reduce the European Union's vulnerability to the impacts of climate change. In order to cope with the challenges created or aggravated by climate change, it calls for an integrated approach to both water management and the management of marine and coastal areas. In this context, several references are made to the WFD and the directives related to it (see above) and recommendations to climate-proof these policies are presented (Deloitte and IEEP, 2011; EC, 2011b).
- The Communication on Water Scarcity and Droughts sets out options for reducing the impacts of droughts and planning for water scarcity. These include
  - Putting the right price tag on water
  - Allocating water and water-related funding more efficiently
  - Improving drought risk management
  - Considering additional water supply infrastructures
  - Fostering water efficient technologies and practices
  - Fostering the emergence of a water-saving culture in Europe
  - Improving knowledge and data collection (EC, 2011g).

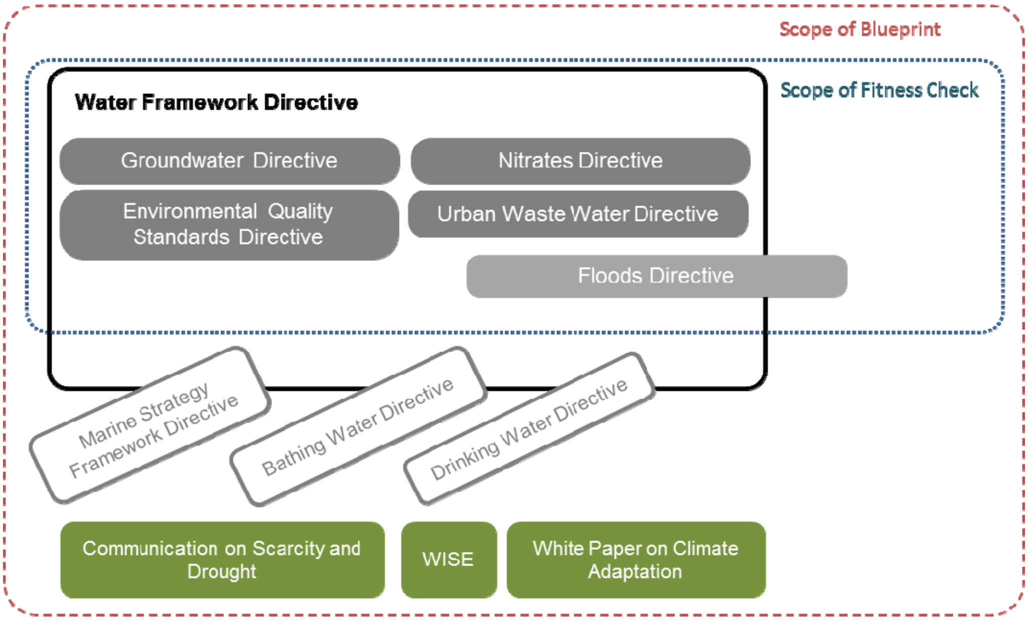
For 2012 a Policy Review on Water Scarcity & Droughts is planned which aims to reveal important knowledge gaps which still exists. The review process has recently started and the insights derived from it will inform the Blueprint to Safeguard European Waters (EC, 2011g).

Finally, water management on a European level has long suffered from lack of comparable and robust data. With the introduction of WISE (Water Information System for Europe) in 2007, the European Commission (DG Environment, Joint-Research Centre and Eurostat) together with the European Environment Agency (EEA) the gap was somewhat bridged. WISE provides an interactive Internet tool which also aims to inform Europe’s citizens and experts about water quality and EU water policy (EEA, 2007).

Through the Water Framework Directive, the EU has created a comprehensive and coherent policy framework to address the full range of challenges to water availability and quality. The purpose of the Blueprint to Safeguard European Waters (2012) is to assess the implementation and achievements of the current policy, in particular the WFD. It should identify gaps and shortcomings as well as look forward at the evolving vulnerability of the water environment to identify measures and tools for long-term sustainable water management. The Blueprint is meant to synthesise policy recommendations building on (1) the assessment of the River Basin Management Plans delivered by the Member States under the Water Framework Directive, (2) the review of the policy on Water Scarcity and Droughts and (3) the assessment of the vulnerability of water resources to climate change and other man made pressures (EC, 2011e).

A stylized visual overview of the European water policy framework is provided below:

Figure 10: Overview of the European water policy framework covered by the Blueprint



Source: Ecorys

The next section of this study introduces the (currently known) policy gaps, challenges, opportunities and successes in European water legislation.

3.2. Current levels of implementation

The next section aims to take stock and assess implementation gaps and successes in European water policy. It also looks ahead to where the main policy challenges remain. The first more general part of the assessment relies mainly on the recently released Support to Fitness Check Water Policy (Deloitte and IEEP, 2011). The official Fitness Check from the Commission is due sometime during 2012 and covers the WFD and its daughter directives as well as the UWWD, the Nitrates Directive and the Flood Directive.

3.2.1. Implementation of the WFD and other European water regulation: an overview

The introduction of the WFD in 2000 was a game changer in the water policy framework of Europe. It tried to address water from a holistic perspective by streamlining previous legislation while introducing new regulation where gaps existed. It therefore makes sense to begin the analysis with the WFD.

The transposition[8] of the WFD into national laws has been completed despite some initial delays. In the first steps, besides overall transposition of the WFD, the Member States needed to identify River Basin Districts, designate competence authorities, analyse and report the state of the river basins, and set-up monitoring programmes. In the second step, Member States were obliged to start public consultations on the River Basin Management Plans (RBMP) and thereafter draft and submit RBMPs to the Commission. Finally, by 2010, the Member States should have put pricing policies in place together with an economic analysis of the so-called cost recovery of water services (described in-depth in chapter 3).

The implementation of the WFD contains both success stories and more problematic areas. For instance, the set-up of monitoring programmes has been a large success. Hering et al. (2011) argue that a "huge amount of monitoring data is now being generated for WFD purposes" (p.1). For RBMP more than one third of the Member States have finalized and submitted their plans. Yet, in spring 2011 the Commission started infringement cases against Belgium, Greece, Denmark and Portugal for failure to not act in time. The implementation of pricing policies remains to be evaluated and an official evaluation of the submitted RBMPs are undergoing.

Despite full transposition of the WFD, levels of implementation and quality of assessments/monitoring show large differences between Member States. There are considerable gaps to be filled by some whereas others have put large effort into their water management policies. There are also no clear trends in regions that have been more successful in implementation than others. To deem the low level of ambition in some Member States a failure is however premature. In Germany for example there are cases where the WFD has fostered dialogue between previously unconnected stakeholders and the mere agreement on a River Basin Management Plan should be considered a success.[9]

With regards to other directives and policies, besides the WFD, the following table sketches the main achievement and failures of the main water legislation in Europe:

8 There is a clear difference between evaluating transposition (output) of EU legislation and the impact (outcome/impact) of the policy. The former is in general easier to asses but might tell less about the 'real' impact of the legislation. Whereas transposition appears to be successful in all Member States, the implementation gives more mixed results.

9 Personal communication with German NGO Grüneliga.

Table 10: Achievements and failures in selected European water legislation.

Legislation / Policy	Successes	Failures
Urban Waste Water Treatment Directive	• Waste water treatment improved substantially over the last two decades	• Large parts of Eastern Europe, South-Eastern and Southern Europe yet to be connected to waste water treatment facilities. • Large challenges remains for implementation in EU-12
Nitrates Directive	• Some success in decreasing release of Nitrates and Phosphorus from agriculture. • Designation of sensitive areas has improved. • Manure management has improved	• Large number of infringement cases due to problems with implementation. • Difficulties to implement in countries with large agricultural sector
Water Scarcity and Droughts	• Eight MS have introduced water tariffs, five are in the process of doing so. • Coordination among MS in the area is improving.	• Lack of comparable data.
Climate Adaptation	• Acknowledged and required in the second period RBMPs.	• Lack of clear indicators, guidelines and reliable assessments.

Source: Deloitte and IEEP (2011), Deloitte and IEEP (2011) contend that it would be premature to evaluate the EQSD, the Floods Directive and Groundwater Directive due to their relative short period of existence.

The general reasons for gaps in implementation are also investigated by Deloitte and IEEP (2011, p.127). Budget and time constraint came out as the two most important problems which may be linked to the third in line, namely lack of political will to address the issue.

After the general overview of implementation and gaps in water legislation, the next sections zoom in on specific thematic challenges that remain for both legislation and Member States.

3.3. Challenges and gaps in European water policy

3.3.1. Water efficiency

Climate change and continued unsustainable abstraction of water in some regions will put large pressure on future water availability. Several regions already suffer from water stress in particular southern Member States such as Spain, Cyprus and Greece. To increase water efficiency has become a key policy goal for the Europe. The Commission has launched several studies which investigated the magnitude of the problem and possible solutions. A public consultation is also carried out with regards to water efficiencies in buildings.

Water efficiency is both a supply and demand side challenge...

On the supply side, leakage in distribution system has increasingly become an area of interest in water policy. Data from Hungary (from 1996) suggest that 50 % of the abstracted water is lost in urban distribution system (OECD, 1996). In Germany, however, the number is only 3 – 5 % (from 1999) (EEA, 2010). Leakage is clearly a problem confined to a few European regions and barely a problem in others. There is also a severe lack of information where data is over 15 years old and of bad quality. To solve the problem of leakage is however important. The situation is a result of years of under-investment in infrastructure and maintenance. Distribution systems are old and both under- and over-dimensioned. In regions with urbanization and net immigration, the water supply system is often not adequately upgraded. Moreover, in some regions, such as East Germany, there is a net migration of inhabitants from cities, which leads to over-dimensioned supply systems and inefficiencies. Investments in upgrading infrastructure are in most cases considered extremely high and in some regions have adopted alternative techniques, such as water pressure management, to extend the life-time of a system. Inadequate supply systems are clearly a problem for efficiencies in terms of water availability but could also have negative impacts on water quality and human health.

Water efficiency in buildings has also become an area for discussion. An average European uses roughly 160 litres of water per day (BIO-IS, 2011). In some Member States the levels are reduced to 140 – 150 litres, which indicate that efficiency gains can be made. Residential buildings make up for about 73 % of the water-use and non-residential 27 %. The largest share of water is used for flushing toilets, showers, bath and other personal hygiene (BIO-IS, 2011). To target these areas would clearly be the most effective.

European-wide legislation to address inefficiencies is limited...

On the demand side some countries are actively trying to curb their citizens' water use. The key problem has been low levels of awareness of water as a scarce resource. Water is in many countries seen as an abundant resource. Users are in general unaware of the associated energy use for pumping, heating, cleaning, etc, and the negative environmental impacts on river basins and ground water levels.

EU level policy to address water use in buildings is currently limited. Local and voluntary initiatives mainly consist of water saving campaigns, metering, and building codes. To address problems with leakages and in-efficient water use in buildings, the Energy Performance of Buildings Directive (EPBD) is sometimes mentioned as it has provided a strong incentive to reduce energy use in building. For water-using of the products, the Energy use in Products guidelines (EuPs) under the Ecodesign Directive has been taken as a role-model and ideas on regulation for Water use in Products (WuPs) are currently being floated. Finally, to provide incentives for users to better monitor their water usage some initiatives on smart metering for water are being tested. [10]

[10] For more information on policy options for water efficiencies in buildings, see: BIO-IS (2011)

Alternative techniques to increase recycling and reuse of water are held back...

To upgrade conventional supply systems thereby preventing leakage is estimated to be associated with extremely large costs and long pay-back times (McKinsey, 2009). To avoid the large costs, the use of alternative techniques which includes recycling and reuse of greywater is envisaged.[11] Greywater is easier to treat than blackwater and techniques are available for direct reuse and recycling in households if it is clearly separated. A decentralisation of greywater treatment could be beneficial both for energy-use and water availability. For such things as flushing and car-washing the potable water could be used. Experiments in Denmark show up to 43 % potable water savings with decentralised greywater treatment (Revitt, Eriksson, and Donner, 2010).

Alternative techniques to treat, reuse and recycle greywater suffer from two major regulatory gaps: (1) European legislation is not dealing with water reuse and recycling techniques, and (2) there are potential legal dilemmas between the alternative techniques and water quality legislations dealing with health concerns. Waste waters from the urban environment are dealt with in the Urban Waste Water Treatment Directive (UWWTD). It takes a traditional approach to pollution abatement and even if it refers to reuse of water where appropriate, a legal void remains on a European level for reuse and recycling of greywater.

There is no lack of alternative treatment or reuse project in Member States. A study estimates that there were over 700 reuse projects in 2006, with a slight dominance of projects in Southern European Member States (Marecos do Monte, 2007). However, projects are sometimes hindered by water quality standards based on traditional supply chains.

Innovative alternatives are available but health concerns can be a barrier

Innovation is targeted at a variety of water issues, particularly to improve efficiencies in its extraction, distribution and use. Among the main innovative solutions proposed are moves towards greater re-use and recycling of water, for example using greywater or rainwater for some household or industrial purposes, i.e. toilet flushing, water for gardens or processes. This has the potential to provide a significant reduction in demand for treated freshwater, reducing the amount of water that needs to be abstracted and treated. The use of untreated water in this way is problematic under the current WFD with health and safety concerns related to hygiene and human contact or consumption of untreated water.

Other innovations include alternative water treatment systems that do not involve connection to UWWT plants, such as dry toilets. These alternatives could be particularly relevant in areas of low population density where UWWT infrastructure is not economic. At present it is felt there is little flexibility within the WFD to accommodate these alternatives, with health and safety once more cited as an issue. Australia was put forward by an interviewee as an example of legislation that is better adapted for flexibility on these matters.

[11] Greywater is water that comes from household use such as laundry, dishwashers, baths, and showers. Greywater is distinguished from 'blackwater' which contains human excrements.

Improved public-private co-operation and funding is important for better and faster innovation

Improving the speed and effectiveness of innovation in the water sector is a challenge that will require efforts from both public and private stakeholders. From public policymakers there is the need to continue to fund, and if possible, increase funding for water innovation. Beyond funding, there is an important role for policy as an enabler for the private sector, not just utilities, by setting out a legislative framework that accommodates innovation, by making issues such as efficiency and sustainability relevant to suppliers, i.e. by making green procurement a reality, with tangible benefits for innovative firms. Policy also needs to be clear and coherent in its objectives and legislation, for example, on water re-use, use of sludge nutrients and biofuels, to create the space for innovation and reduce the uncertainty and risk associated with it.

3.3.2. Land-use

Agriculture and forestry are increasingly understood as important for ecosystem-based water management. Agriculture causes one of the largest pressures on water availability and is a main source of many water pollutants. It uses about 24 % of all freshwater abstraction and often much more in already water stressed regions in southern Europe (EEA, 2009b). Compared to other large users of water, such as energy production, most water used in agriculture disappears in production process and through evaporation, which means that only 30 % is returned on average. At the same time, agriculture is heavily dependent on clean water to function and access should be a mutual benefit.

Agriculture puts large pressure on water availability and quality but is also dependent on clean water...

Agriculture and irrigation for crops have increased dramatically over the last 50 – 60 years in mainly southern Member States. It has put increased pressure on some already water stressed regions. On the other hand, the discharge of Nitrates and other pollutants have seen a more positive development with declining levels of nutrients reaching waters from agriculture. Nevertheless, improvements could be made in stopping more diffuse pollution. Such things as better manure storage, buffer strips between water and used land, and rebuilding of wetlands, lack clear policy incentives.

A key challenge for the near future, to ensure that current positive trends in agriculture are maintained, is to integrate policy instruments with water policy directive, primarily the Common Agricultural Policy (CAP), which is currently in a reform process expected to be ready in 2013. Numerous propositions have been made to tie cross-compliance rules and rural development support to water quality and efficiency standard.

Ecosystem-based water management approaches are often low-cost measures with several benefits...

There are different types of measures to reduce the threats of flooding, groundwater and surface water pollution, drought and water scarcity. Working with nature's capacity to absorb measures is increasingly seen as a way to use the power of ecosystem services to tackle some of our water issues. These so called 'green' or ecosystem based measures benefit water quality, water availability and nature. The basic premise is that healthy ecosystems are excellent water purifiers, erosion stoppers, and flood protection in themselves. Conservation of nature and ecosystems adjacent to water therefore serves multiple purposes and is often very low-cost compared to infrastructure, water treatment, and post-disaster recovery.

A good example of ecosystem based measures is to use natural water retention measures in rural and urban areas. It could include restoration of floodplains, natural flood defence measures, sustainable urban drainage systems, natural water retention in upstream parts of river basins by reforestation, wetland restoration or soil management, etc.

Wetlands and agriculture: mutual benefits from an interlinked system?

Wetlands are another good example of how a preserved ecosystem can support agriculture through the maintenance of water tables and nutrient retention in floodplains (LIFE, 2007). They also support framing systems such as pollination and the harbouring of natural predators of agricultural pests (VandeWalle et al., 2010). They also allow for production of crop such as rice, peat, game and berries grow. By doing so the wetlands are of economic importance in some Member States (LIFE, 2007). Such a wetlands project in Europe is the Lower Danube Green Corridor project. It aims to create a 'green corridor' along the whole part of Lower Danube. The instruments are protection of wild-life and nature along the flood plains and restoration of wetlands, which have created increased flood protection, water retention, water security and recreation potentials. Each hectare saved is expected to generate EUR 500 of various benefits (ICPDR, 2010).

The key challenge to the ecosystem based approaches is the design and implementation of often complex measures using a mix of techniques benefiting water quality, availability and ecosystems. The current policy framework is particularly weak on this area.

Green infrastructure is key to low-cost water management...

Costs of floods, droughts, erosion, and water treatment are high and expected to rise with climate change. Moreover, much of our built environment is built in areas in risk of flooding such as flood plains and by coast-lines. Protection from floods and coastal erosions is often considered in terms of infrastructure such as dikes, concrete wall, dams and canals. Water quality has mainly been an issue for water treatment plants. More innovative approaches however are not adequately promoted in EU legislation. These can be captured in the concept of green infrastructure.

Green infrastructure in spatial planning is the key concept to reap low-cost solutions to water related issues. The idea is that engineering systems can be combined with the natural environment to create smarter solutions. For example, to invest in water efficiency instead of dams, and to restore flood plains instead of building dikes and levies. The US is currently more advanced in adopting green infrastructure solutions but also the UK and other European countries have been active in trying to formulate policy.

The main challenges that remain are how to find efficient policy measures to support the development and green infrastructure, in particular for agricultural policy and the integration with spatial planning as well as the Nature Directives.

3.3.3. Economic instruments

The application of economic instruments in the field of environment and in particular water management has been advocated by many as an effective means of promoting the protection of the environment[12]. Water pricing – in accordance with the user pays principle - is thereby of central significance, as well as the use of other economic instruments, such as taxes and charges. In theory these instruments encourage the adequate consumption of waters and can internalise the external costs water pollution entail. The latter is in line with the requirements of the polluter pays principle – the foundation of all European environment policies, i.e. a requirement that the external costs of water pollution are borne not by the public but by the polluter.

The most commonly used economic instruments that can be distinguished in the context of water policy are tariffs (or prices), and taxes and charges. Other instruments are subsidies and the market for environmental goods. Each of these is briefly discussed below.

Water pricing

In the context of the FWD, water-pricing policies have to ensure the "polluter pays" and "user pays" principles by providing adequate incentives for water use. As an outcome of these and other activities, Member States needed to ensure that by 2010 water pricing policies provided adequate incentives of water use and that different users make an appropriate contribution to the costs of water services. Requirements for cost recovery and incentive pricing may thus be tailored to the individual national needs, including other priorities of sustainable human development. However, as was seen above, few member states used this instrument.

Pricing water (setting the tariff) is seen as one of the most effective economic instruments for quantitative water management. However, their level and structure is widely varying between countries and regions, leading to different effectiveness in providing incentives for sustainable water use and different levels of cost recovery.

Water related taxes and charges

Taxes and charges on water abstraction are widely applied, their level being differentiated by water source (groundwater or surface water) and/or by the type of user depending on countries. They are also an important means to collect taxes. There has been a shift in the taxation system across Europe from other taxes towards environmental taxes and charges which is generally referred to as 'greening of the tax system'. This approach was first proposed to the Member States in the Commission White paper 'Growth, Competitiveness, and Employment' (EU, 1993). Under the heading of taxes and charges, two instruments can be mentioned:

- Water tariffs: to collect financial resources for the functioning of a given water service such as tariffs for drinking water and sewage, and tariffs for irrigation water. These are a vital instrument in the context of water quantities.

[12] In Europe, the Treaty on the Functioning of the European Union states the polluter pays principle (PPP) as a foundation of all European environmental policies (Article 191.2), economic instruments being considered as one way to implement this principle and providing the general framework for internalising environmental externalities – and thus being an effective means of achieving environmental policy objectives.

- Environmental taxes or charges: designed to internalise negative environmental impacts and influence behaviour, and – not unimportant - to collect financial resources for the central budget. Examples include taxes on pollution discharge or abstraction, and taxes on polluting input (such as taxes on pesticide use). However, the tax levels are often too low to provide incentives effectively, thus limiting their role to revenue collection.

Other instruments

Although not commonly used in the EU, tradable water rights systems constitute an example of an innovative economic instrument which is increasingly being discussed in various policy forums in Europe. However, the establishment of such a market is a rather complex undertaking which is not free from certain risks. Additional instruments include the allocation of subsidies for building alternative storage and reduce water abstraction.

As a next step in the use of economic instruments, policy makers should be better informed on the value of these tools based on solid evidence. It should tell them how pricing can be used – and how and where it influences the water cycle. In addition, the results of this kind of evidence based evaluation should also be communicated to the public to establish a more solid foundation for the further acceptance of these tools.

3.3.4. Knowledge base

It is essential for management and policy to be based on science and robust information. It is also crucial for the broad knowledge on water to be communicated to the public and other users, to influence their perceptions and behaviour in relation to water. There are various challenges and, as can be expected, gaps in the European water knowledge base.

The WFD has helped improve data gathering but significant deficiencies remain

European level data and monitoring on water has significantly improved over the last 20 years (EEA, 2011b), from a base where data on water tended to be rather fragmented and missing. Yet this progress varies: in some areas, for example, the monitoring of water chemical status, there is an established network for monitoring and reporting with detailed data available per chemical, per monitoring station and on a regular and timely basis. This has a history in both national and EU legislation, with the WFD seen as an important factor in improving monitoring scope, frequency and coverage (Hering et al, 2011).

Yet significant gaps and fragmentation remain for water data in general, the example in the table below highly illustrative of the gaps that exist at European level for the most basic data on abstraction and leakage. The table clearly shows that some Member States report little or no data, some report on a less than annual basis and a few report on a timely basis up to 2009. The data on leakage is particularly illustrative in terms of an issue that is perceived, and anecdotally known, to be a major issue for water policy yet there is very little data for policymakers to work with, as barely a quarter of countries provide any data. It is common to see a figure of 50% leakages referred to as an extreme example of the problem, yet this is based on an OECD report on Bulgaria from 1996, which is now significantly out-of-date, yet these numbers are widely used in the debate. These issues and gaps are repeated across the broad spectrum of water indicators collected by Eurostat and other agencies, and cross into many different water policy areas including climate change (IPCC, 2007), water and energy and droughts and scarcity (EC, 2011g).

In some cases detailed data of this type is produced, by the water utilities and national and regional agencies, but is not disseminated more widely at a European level.

Table 11: Eurostat water abstraction and leakage data 2000-2009, million m³

Title	Total abstraction of freshwater, million m³			Losses by leakage, million m³		
	2000	2005	2009	2000	2005	2009
Belgium	7 536	6 389	:	87	91	100
Bulgaria	6 132	6 036	6 121	:	:	:
Czech Republic	1 918	1 949	1 947	:	:	:
Denmark	723	:	:	:	:	:
Germany	:	:	:	:	:	:
Estonia	1 471	1 304	1 056	:	:	0
Ireland	:	799	:	:	:	:
Greece	9 924	9 654	:	:	:	:
Spain	36 689	35 565	:	:	:	:
France	32 715	33 872	:	:	:	:
Italy	:	:	:	:	:	:
Cyprus	196	235	184	0	3	1
Latvia	283	238	:	37	29	:
Lithuania	3 578	2 365	2 412	:	:	30
Luxembourg	:	:	:	:	:	:
Hungary	18 878	19 053	:	:	126	128
Malta	37	33	31	12	7	4
Netherlands	:	11 453	:	:	45	:
Austria	:	:	:	:	:	:
Poland	11 994	11 522	11 517	:	:	:
Portugal	:	1 086	:	:	:	:
Romania	7 967	5 301	:	:	:	:
Slovenia	:	924	943	:	43	45
Slovakia	1 171	907	:	:	:	:
Finland	:	:	:	:	:	:
Sweden	2 688	2 630	:	:	153	:

Title	Total abstraction of freshwater, million m^3			Losses by leakage, million m^3		
	2000	2005	2009	2000	2005	2009
United Kingdom	14 568	10 323	:	1 456	:	:
England and Wales	14 568	10 323	:	1 456	:	:
Northern Ireland (UK)	:	:	:	:	47	:
No Data	**10**	**7**	**21**	**23**	**20**	**22**
% of countries with no data	**34.5%**	**24.1%**	**72.4%**	**79.3%**	**69.0%**	**75.9%**

Source: Eurostat – extracted 23-1-2012
Note: : = not available

WISE and associated work is an important step in the right direction
The work being carried out under the Water Information System for Europe (WISE) partnership, between DG Environment, EEA, JRC and Eurostat, is helping to slowly improve the situation. The work under WISE is drawing together relevant data sources, to become a hub for data in this area, linking to models such as the FATE models produced by JRC. These new models are providing interesting, interactive geographic data tools for nutrient loads, chemical pollution, droughts, floods and other water policy issues, expanding accessibility to useful information.

Continuing development of an information hub of this type will encounter further issues in expanding the knowledge base including how to best disseminate to sector professionals and the wider public and how to best link to scientific knowledge, particularly in the area of costs, benefits and valuation of water. Another issue that is likely to come to the fore is policy relevance and analysis, with these being marked as weak points of existing assessments and data (EEA, 2011b).

Consumer awareness, understanding and accessibility to information is an issue
Gaps in the data and knowledge available to scientists and policymakers also permeate to the information that is available to the public and firms, leading to weak understanding of the issues affecting water and why further investment is needed. This is important as costs of infrastructure improvements to address water availability and quality are passed onto these consumers. As their water bills rise consumers are increasingly asking why, raising concerns about the affordability of such an essential service. All stakeholders interviewed in preparing this research raised this as an issue and stressed that more needs to be done to provide better and more accessible information to consumers – particularly explaining what needs to be done, why and what the benefits are - so that improvements to water supply and treatment can continue with general consent.

The next step from this is related to water efficiency, for campaigns to successfully achieve behavioural change in water users then information has to be accessible and at the right level.

Government at all levels could better consider their communication strategies for water efficiency, particularly in linking messages on water efficiency to the win-win of cost savings to consumers and energy and climate change benefits.

3.3.5. Global aspects

While water is primarily a local or regional issue there are significant connections with the international economy and global issues such as climate change. This presents challenges for the EU and individual Member States in water use and management.

Water and the international green economy

The green economy is a rapidly growing sector with water efficiency and wastewater treatment offering major market opportunities, as countries continue to develop demand for water supply and WWT infrastructure and services will increase. The EU market was estimated at more than EUR 97 billion annually in 2008 (Ecorys, 2009) and the global market even larger, estimated at more than EUR 300 billion annually (Innovas, 2010; S-NET, 2011) and set to grow rapidly in the coming years. European firms have a strong position in these markets accounting for approximately 30% of existing markets (Ecorys, 2009). The scale of the economic opportunity in these markets is significant but also poses a challenge for European firms as competition increases. Policy should continue to support and promote free trade and EU products and services, while also providing a stable domestic market which drives innovation to maintain global competitiveness.

Border issues remain a challenge for implementation

Moves under the WFD towards RBMP have introduced transnational management for water bodies. In many places this is the first time this has been the case. Almost all stakeholders agree that this is a positive move which will reduce the potential for conflict over water and support moves towards more sustainable water management. Feedback suggests that to date, these bodies have only limited funding and power, that they are little more than talking shops with actual decisions and implementation still resting with national and regional authorities. The challenge remains to better integrate and support them to effectively deal with cross-border issues.

EU influence and participation in international legislation is important…

Water is related to a variety of global issues such as climate change, biodiversity, security, food supply, trade and energy. European participation and leadership in the international efforts and agreements in these areas is a crucial element of European and Member State foreign policy and being responsible global partners. Engagements with UN processes related to water, such as the RIO +20 event and UNFCCC process, represent important opportunities and challenges for the EU. In addition the legislative developments from the UN through UNECE, including the Water and Health Protocol and the UN Water Convention are important. These could help add to EU legislation, e.g. in the area of conflict resolution.

…and is also related to the EU's significant water footprint / virtual water imports

Looking at a nation's water-related impact in terms of how it abstracts and treats water within its own borders can be said to ignore the full impacts of its water consumption. Water is embodied in all the products and services we consume and as a result water is effectively imported and exported in all traded products and services. Attempts have been made to quantify this water footprint, through the use of the concept of 'virtual water' in international trade. Analysis in this area (Chapagain & Hoekstra, 2008; Mekonnen & Hoekstra, 2011) shows clearly that Europe as a whole and almost every individual member state is a major importer of water, based on what is embodied in trade.

As growing understanding of this emerges a challenge may emerge for Europe to reduce its global footprint and/or its import of 'water' from water-stressed countries.

3.3.6. Climate change

The main policy challenge is well stated in the White Paper on Adaptation from 2009: "The challenge for policy-makers is to understand these climate change impacts and to develop and implement policies to ensure an optimal level of adaptation." Ecosystem based solutions and expansion of green infrastructure are expected to be more efficient than infrastructure approaches in some cases. Focus on water retention in soils, erosion preventions, and natural flooding of flood-plains for example could turn out cost-efficient and effective measures. However, to plan and implement such plans demand a different approach to water management moving from a traditional pollution reduction focused policy framework to more integrated regulation.

That climate change poses a range of challenges for future water management became clear in chapter 3. It changes the very problem structure of water issues in Europe by amplifying already existing processes and thereby increasing the need for policy implementation.

The first impact is plainly the increased intensity and frequency of current water problems. If water levels rise and sink, and floods and droughts become more severe, both mitigation and adaptation efforts need to be intensified.

Water policies needs to be 'climate change proofed'...

To address changes expected in the climate over the next decades, EU water policies needs to become climate proof. Taking the range of scenarios for change as a start, water bodies, rivers, marine and aquatic ecosystems must be made resilient enough to withstand both increased and decreased water levels. Currently neither water policies nor other relevant pieces of legislations such as the regional development frameworks are sufficiently 'climate proofed'.

The White Paper on Climate Change Adaptation from 2009 is the centrepiece of the policy efforts. In terms of water management however it only high-lights the importance to consider climate change when developing RBMPs and other planning documents

The most urgent policy, however, may be implementation of the Floods Directive. Droughts and water scarcity are also expected to be influenced by climate change but the impacts could be mitigated by demand management, improved supply systems, and smart greywater use and reuse. These issues are addressed in other policies.

The Floods Directive is a key piece of legislation for climate change adaptation...

If one accepts that climate change will increase the number of floods in Europe then the policy implications are considerable. In 2007 a new Floods Directive entered into force and brought with it a number of aspects similar to the WFD. It requires Member States to assess the vulnerability of water courses and coast lines to flooding. The identified areas then need to be mapped in terms of floods risks, and in a final stage there needs to be risk management plans for prevention, protection and preparedness by 2015. The new Floods Directive also echoes the WFD in that it supports knowledge sharing and dissemination, and public participation and consultation. The planning of flood risk and management plans is aligned with the planning cycles of the WFD.

The implementation of the Floods Directive has just begun. Public consultation processes are only expected to begin in 2012, the first hazard and risk, and management plans to be delivered during 2013 and 2015, and the end of the first flood risk management cycle only by 2021. It is therefore premature to make statements about the process on floods management.

3.3.7. Governance

One of the main successes of the WFD has been the improved dialogue and cooperation among stakeholders. Water has the peculiar attribute that it moves across borders, sometimes crossing half of Europe. It means that down-stream regions are heavily dependent on what goes on up-stream. Pollution, irrigation, dams, urbanisation and energy-production all affects the availability and quality of the water that reaches the cities.

Whether decisions should be taken on European, national, or regional level remains a challenge…

It is clear that users and stakeholders in a river-basin must engage in dialogue and that decision-making on appropriate levels is pivotal. Designation of appropriate jurisdictions, authority, and powers however remain a policy-challenge for the foreseeable future. Power is of particular importance since there are several instances where the competent authority lacks the power to take the necessary decisions.

The move towards river-basin level management has ameliorated problems of overlaps and conflicts in authority. Like in most areas of water policy in Europe, the challenges and successes differ greatly across regions. In the Elbe river-basin for example the WFD has spurred a unique dialogue and stakeholder participation. A RBMP has been written and submitted to the Commission. Final authority however is still divided between the German navigation authority on a federal level, and the environmental authorities on a state level.[13] The split between authority of navigation routes and the eco-system could create hurdles when more holistic policy-instruments, such as climate change adaptation, need to be taken. The problem of several authorities responsible for one river-basin has been observed in particular in federal countries.

(International) cooperation was identified by the Support to the Fitness Check as one of the most serious short-comings in implementation of European water policy (IEEP and Deloitte, 2011). Nevertheless, in some river basin commissions such as the International Commission for the Protection of the Danube River (ICDPR), the WFD seem to have catalysed action.

Participation has increased in decision-making but could improve…

The nature of river-basin management requires a broad set of stakeholders to participate in the policy formation. Agriculture, navigation, power-generation, industry, nature, and drinking-water, are a few of the main abstraction purposes which all are dependent on available water. In many cases water quality is also of large importance. To ensure an 'integrated approach' to river basin management all interests should be accommodated which demands international cooperation and public participation.

[13] Personal communication with German NGO Grüneliga.

The WFD has improved the environment for cooperation and in many Member States and river-basins the stakeholder dialogues have developed well. In for example the Scheldt river, Elbe, Danube, the Meuse and the Rhine, there are multilateral environmental agreements and river basin commissions with highly formalised and well-functioning decision-making processes. It should be noted however that many of these existed before the introduction of the WFD. From interviews, some regions such as Baden-Württemberg in Germany and Cataluña in Spain were high-lighted as examples of best-practices.

There are however many barriers which remain to improve participatory processes. Public Water Authorities mention for example different institutional arrangements, human and financial resources, and language, as main hurdles (IEEP and Deloitte, 2011).

There is a need to improve integration between policies…

Coherence between environmental policies is never going to be flawless but major conflicts between goals and measures should be avoided. Furthermore, even if the original set-up of the policy framework is coherent it does not imply that implementation will follow suit. Coherence is important for many reasons including efficiency and effectiveness, and to lower administrative burdens on authorities and private actors.

The level of coherence is perceived differently by stakeholders and our interviews show how opinions are divided.[14] Integration of policies would alleviate the problem of coherence and is identified as essential. Across the different water related policies there are a number of integrative procedures such as public participation, management plans, data collection, designation of areas for protection, and integration of economic and environmental considerations (Frederiksen, Mäenpää, Hansen, 2007). Whereas the first categories are part of several pieces of legislation, for example; designation of special protected areas are part of the Nature Directives and the WFD; public consultation is part of the IPPC, EIA and SEA Directives, and the WFD; the last category of economic and environmental integration is more specific to the WFD.

Integration of policies is important and some of the existing policy targets and measures are in conflict. The Renewables Directive for example requires energy in Europe to be produced from 20 % renewable sources by 2020. This results in investments and upgrades of hydropower and expansion of biomass. Implementation of these policy goals may then have detrimental impacts on the ecological status of waters in terms of infrastructural changes and run-offs from agriculture. The key to avoid such problems is partly better policy integration but also better implementation of current legislation and using collaborative processes to improve policy outcomes where interests converge

[14] This conclusion is supported by IEEP and Deloitte (2011)

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ANNEX I – LIST OF INTERVIEWS

- Ana Millan-Villaneda, Consumer Council Water UK.
- Lesha Witmer, Women for Water Partnership
- Sergyi Moroz, WWF
- Michael Bender and Tobias Shaefer, Grüneliga
- Jori Ringman-Beck and Bengt Davidsson, Confederation of European Paper Industries

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