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European waters — current status and future challenges

Synthesis

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European Environment Agency

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Contents

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Executive summary

The Europe 2020 strategy is the European Union's strategy for economic growth in Europe over the next decade. This strategy envisages the development of a 'greener', more environmentally friendly economy in Europe. Sustainable water management is a critical element of this green economy because healthy and resilient ecosystems provide the services needed to sustain human well-being and our economy. For this reason, we need to ensure that other economic sectors, such as agriculture, energy and transport, also adopt management practices that can keep water ecosystems healthy and resilient.

Some improvements in water quality have been made in the past two decades with e.g. the implementation of the urban waste water treatment directive. Nevertheless at present, the ecological status of water ecosystems is not good enough. Under the Water Framework Directive, countries were obliged to publish so-called River Basin Management Plans, which detailed the status of the water bodies in their countries. The results of the first round of these River Basin Management Plans show that more than half of Europe's surface water bodies are in less than good ecological status.

These findings corroborate the reporting under the Habitats Directive, which details the conservation status of habitats and species dependent on water in Europe. Over two thirds of all river and lake habitats and inland water species are in unfavourable conservation status.

Chemical status is another cause for concern. About 25 % of all groundwater bodies across Europe are in poor chemical status. High levels of different chemicals, e.g. nitrate in groundwater bodies, are the most frequent cause of bad status. This poor status is the consequence of a range of pressures driven by human activities in different economic sectors.

EEA data for the last decade show that water quality has improved as the concentration levels of oxygen-consuming substances and ammonium in water has declined. These pollutants are closely related to the treatment of urban waste water, and the downward trend is a sign of improved treatment following the implementation of the Urban Waste Water Treatment Directive. If this trend continues, and if the Urban Waste Water Treatment Directive is fully implemented, it is likely that water quality levels usually associated with good ecological status will be achieved at least within the next 10 to 15 years.

However, other pollution pressures are on a less positive trend. Pressures from 'diffuse' sources in particular are continuously high. These diffuse pressures are largely driven by nitrates, applied with agricultural fertilisers, which run off into water bodies. If the current trend continues, concentrations of nitrates in water are unlikely to meet good status concentrations within the next 10 to 15 years.

Hydromorphology is another important pressure causing problems for Europe's water bodies. Hydromorphology describes the changes made to the natural shape and flow of water bodies by river straightening, dredging, dams, dikes, barriers and water abstraction. These changes destroy habitats for water plants and animals, making it difficult for them to thrive, feed and breed, and it prevents migratory species from moving along the rivers.

The third and equally important problem area is the 'quantitative' status of the water ecosystems. Quantitative status refers to the volume of water present in a water body at any given time. Problems in quantitative status can include phenomena like droughts, floods and water scarcity. A number of sub-surface groundwater bodies are in less than good quantitative status, for example because of a drop in the groundwater table. Climate change is an important driving force for both floods and droughts. On top of the increasing drought risk over-abstraction of water has led to water scarcity becoming a widespread problem for many river basins in Europe, in particular around the Mediterranean.

The current, poor status of so many water bodies and aquatic ecosystems reflects a situation in which the health and functionality of water ecosystems is impaired. As a result, the resilience of the ecosystem (its ability to absorb further disturbance) is reduced. Healthy ecosystems should be able to function as habitats for a rich biodiversity. They should be able to retain water in a natural way and help regulate the hydrological cycle, purifying and filtering water to provide humans and nature with enough clean water. This is the best way to improve water quality and minimise water scarcity and floods.

All these pressures on Europe's waters (diffuse pollution, hydromorphological alteration and over abstraction) are driven by the way agricultural land is managed, and by society's need for energy, transport and urbanisation. To solve this problem we need to look at water and water ecosystems as one of the natural resources — like food or energy — needed in an economy. There are close interactions and interdependencies between these resources. To ensure that the boundaries of sustainability of our water ecosystems are respected and their natural capital is maintained, we therefore need to ensure that sustainable water management is closely integrated into land management and energy management.

The Water Framework Directive is the most important policy to achieve this. The good status objective under the Water Framework Directive defines what these boundaries of sustainability are. However, with respect to the issue of water quantity the definition of good status needs to be specified in greater detail. Good status should therefore include the concept of 'ecological flows', a term that describes the volume of water required for an aquatic ecosystem to continue to thrive and provide the services we rely on. As part of a green economy, sustainable water management is an important instrument to ensure sustainability in other sectors, such as land use, energy and transport. Therefore, cohesion policy and the Common Agricultural Policy need to take into account new concepts such as 'green infrastructure' and natural water retention measures like the restoration of wetlands and forests.

There is also a need for water management in different sectors (and the water service sector itself) to implement measures and targets to increase water (and energy) efficiency through water demand management. Economic instruments can play an important role to this effect, incentivising sustainable water use, and discouraging inefficient use of water resources.

The 'Blueprint to safeguard Europe's water resources', issued by the European Commission, is expected to provide policy options that help address the pressures and challenges to which our water ecosystems are exposed.

Part of the challenge will be integrating sustainable water management into the EU's Europe 2020 strategy, the EU Roadmap for Resource Efficiency, and the targets of the Biodiversity Strategy 2020. There is also a challenge of governance. This governance challenge will have to address the 'vertical' integration problem of how best to integrate water policy between different levels of government — regional, national and European. It will also have to address the 'horizontal' problem of how best to integrate different sectoral policies such as agriculture and industry into broader water policy. Integration of governance means an intense dialogue between all stakeholders with an interest in water and water ecosystems.

Improving governance in this way depends on making quality information available to decision makers and stakeholders. This information must be presented on a pan-European level in order to inform the framework for future EU water policy. But it must also be assessed and presented on the regional river basin district level in order to form the basis of well-informed local stakeholder dialogue. Environmental capital accounts and water accounts can be part of this information process. It is vitally important that the knowledge base for water is accurate and up-to-date. It also must be gathered and distributed in such a way that water information is comparable between regions, and 'scalable' up to national and European level. Water information systems must be made interoperable across Europe. The reporting under the Water Framework Directive was a good step forward to build up this knowledge base. The Water Information System for Europe (WISE) with its European water data centre is hosted at the European Environment Agency, and has proved to be an effective tool for the reporting and management of the information under the Water Framework Directive as well as the other water directives.

However, it is now apparent that further improvements are necessary. The Water Framework Directive reporting process revealed gaps in many areas such as water resources and water economics. Information on these areas was either missing or insufficiently detailed to be comparable across regions, but this information will be needed on both EU and national levels in the future. The development of WISE requires closer cooperation with national Member State information systems. There are also many possibilities to further streamline the reporting process and to build the knowledge base in a more coherent and effective way. These possibilities are most evident in the reporting and assessment processes under the Urban Waste Water Directive and the other directives on bathing and drinking water. Making more efficient use of better information will help support better and more coherent policies and to develop a seamless structure for efficient information exchange and reliable assessments.

1 Introduction

2012 is European year of water. As part of European year of water, the European Commission will publish its 'Blueprint to safeguard European waters' (referred to hereafter as the Blueprint, EC, 2012a). The Blueprint comprises reviews of the Water Framework Directive (WFD, EC 2000) as well as of Europe's policies on water scarcity and drought, and of the water-related aspects of climate change adaptation and vulnerability.

The Blueprint is a step forward to sustainable and resource efficient water management. It will help to better implement the existing water legislation, and show opportunities for further improvement in water policy.

To accompany and inform the Blueprint, the European Environment Agency (EEA) throughout 2012 produced six reports on the state of Europe's water. These reports are: *Towards efficient use of water resources in Europe*; the annual *Bathing water report; Territorial cohesion and water management in Europe: the spatial perspective, Water resources in Europe in the context of vulnerability*; *European waters — assessment of status and pressures* and *'Europe'state of coasts report* (EEA, 2012a, b, e, h, i; EEA, 2013b).

All six of these reports were developed in coordination with the EEA's member countries and with the European Commission DG Environment and its work for the preparation of the Blueprint. They were also produced in coordination with three other review processes led by DG Environment: the review of Europe's water scarcity and drought policy; the review of water vulnerability and climate change adaptation policy; and the review of the River Basin Management Plans established under the Water Framework Directive (EC, 2012b,c; CESR, 2011).

In addition to these six water-focused reports, the EEA also produced three other reports of relevance to water policy. These reports were: *Urban adaptation to climate change in Europe*, *Environmental indicator report 2012*, and *Climate change, impacts and vulnerability in Europe 2012* (EEA, 2012c, d, f).

This report is a synthesis of the main messages from the nine EEA reports mentioned above. It is the last in the series of reports published by the EEA in support of water year 2012. It seeks to first provide an overview of the state of Europe's waters and the pressures acting on those waters. It then looks in greater detail at the economic and social factors driving these pressures, and concludes with a summary of the societal and policy challenges that must be met if water is to be managed sustainably.

The most important message in this synthesis report is the necessity for water policy to both promote water resource efficiency and further protect water ecosystems and ensure their resilience. Achieving these two goals requires integrating water policy in a coherent fashion from local level to European level by means of administrative cooperation based on accurate water information. It also requires much more effort to integrate water management concerns into different sectoral policies such as agriculture and transport. Finally, and perhaps most importantly, it also requires the further involvement of all relevant stakeholders (whether they be farmers, industry, utilities, or citizens' groups) in decisions concerning water management.

2 The current status of Europe's water

This chapter provides an overview of the current status of Europe's water environment. It is divided into four main sections. In Section 2.1, we discuss the conceptual approach toward water and water ecosystems taken in the main EU policies that govern water. This section gives an outline of the concept of 'good status' found in the Water Framework Directive, and connects this concept to the 'ecosystem approach', which is also used in European water policy. In Section 2.2, we summarise the results of the first implementation phase of the Water Framework Directive, the major policy instrument governing water management in Europe. This second section contains information on the status of Europe's water and the pressures that act upon it. In Section 2.3, we consider the status of biodiversity in water. In Section 2.4, we discuss the issue of water quantity, a topic that has been relatively neglected so far, but which merits far more attention.

The objective of the chapter is to set a 'baseline' of Europe's water status, against which the effectiveness of future water policies can be analysed. However the information on the status of our water environment comes from different sources, directives and information flows. In many cases therefore, it is difficult to establish this baseline, as the information provided from one source is often not easily comparable with information provided by another source. Some of the main conclusions of this chapter are contained in the box below.

- The Water Framework Directive aims to ensure that human use of water is compatible with the environment's own need for water to protect ecosystems. This so-called ecosystem-based approach uses the standard of 'good status' to measure the extent to which there is enough water of sufficient quality to support ecosystems and societies.
- The Water Framework Directive states that all of Europe's water should be in good status by 2015. This applies both to above-ground 'surface' water such as rivers and lakes, as well as to 'groundwater' — water below the soil in underground aquifers.
- It is not likely that Europe's water will meet this goal in terms of either water quality or water quantity in spite of improvements made in emissions of pollutants.
- In quality terms, almost half of Europe's surface water is likely to be in poor ecological status by 2015. The picture is more difficult to assess for chemical status. More than 40 % of Europe's surface waters have unknown chemical status.
- In quantity terms, a range of sources show there is an imbalance in much of Europe's surface waters with water use often exceeding water availability. This is leading to water stress across much of Europe.
- The picture for groundwater is better than for surface water. By 2015 more than 90 % of Europe's groundwater is expected to be in good status in terms of both quantity and quality.

Photo: © Peter Kristensen

2.1 Water ecosystems, their functionality and 'good status'

Water is essential for our economy and society. It irrigates our crops, maintains our fisheries, and provides water for cooking, cleaning and drinking. These direct benefits are often referred to as the 'provisioning' functions of water. But healthy water systems also have another role: filtering and diluting pollution, preventing floods, storing freshwater, maintaining microclimatic balance and safeguarding biodiversity. This second type of benefit is often referred to as the 'regulatory' or 'supportive' functions of water, and it is intricately linked to the broader ecosystems of which water is a part. These provisioning, regulatory and supportive functions are known collectively as 'ecosystem goods and services', a term that was developed by the Millennium Ecosystem Assessment (UN, 2005).

When we consider the provisioning, supportive and regulatory functions of water, it is apparent that we cannot treat any one of these functions of water as a discrete element, separate from other considerations. We cannot secure the provisioning services of water without also securing the regulatory and supportive services of water and the ecosystems in which that water plays a role. Prudent management of water for human use will ensure healthy ecosystems, which will in turn secure the continued availability of water for human use.

The Water Framework Directive had taken this so-called 'ecosystem approach' to water already 5 years earlier with its adoption in 2000. It seeks to ensure that ecosystems have access to water of sufficient quality and quantity in order to provide the services on which humans depend. The key criterion used by the Water Framework Directive to measure the quality of water ecosystems is the concept of 'good status'. 'Good status' is archived when a set of defined quality criteria ([1]) are to be found in the high or good status. The objectives in the Water Framework Directive stipulate that a good status for water must be achieved by 2015. Extending the deadline beyond 2015 is permitted in certain conditions. In the context of the concept of ecosystem goods and services as introduced with the millennium assessment (UN, 2005) 'good status' can also be seen as a measurement of the extent to which European water is available in sufficient

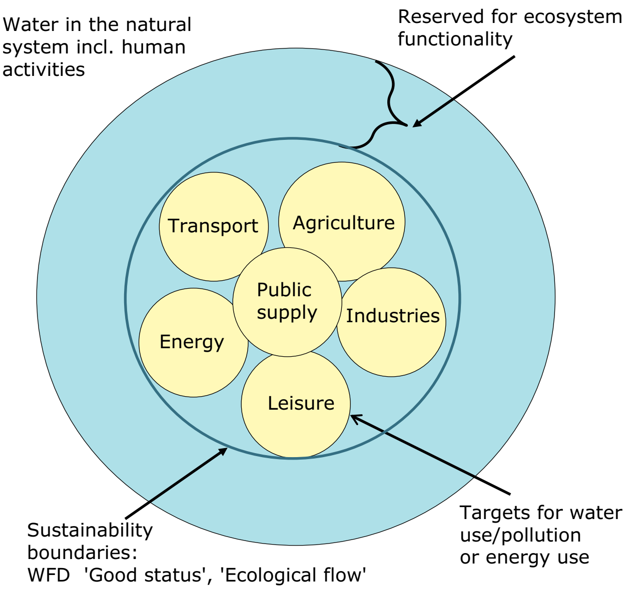
([1]) As defined in Annex V of the WFD (EC, 2000).

quality and quantity to secure both the health of ecosystems and the goods and services they provide (Wallis et al., 2012).

It is important that water use by humans does not at any point threaten the ecosystems that depend on and contribute to the availability of water (Postel, 2003). There are clear boundaries of sustainability beyond which human water use can damage the functioning of ecosystems, making it more difficult to secure future water resources (EEA, 2012a). It is vital therefore that the criterion of good status is accompanied with an assessment of the health of the 'ecological flow' (a term that describes the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon) to establish the relevant boundaries of sustainability for quantitative water use. Figure 2.1 illustrates these boundaries of sustainable water use. It should be noted that these sustainability criteria are region-specific. Therefore the policy objectives related to this criteria need to be developed in cooperation with Member States in each relevant eco-region.

The Commission's Blueprint seeks to focus on these concerns for sustainable water use, and sustainability needs to be further developed and better integrated into the ongoing implementation of the Water Framework Directive and other relevant

Figure 2.1 Sustainable water allocations to ecosystems and competing users



Source: EEA, 2012a.

policies. If water is to be managed sustainably, these boundaries of sustainability have to be understood as a common concern for all relevant water users and stakeholders.

Integrating water policy more closely with the ecosystem approach taken in the Biodiversity Strategy 2020 will ensure that the good status assessment under the Water Framework Directive becomes the best guarantee for healthy ecosystems. The downstream requirements and criteria for healthy and fully functional water ecosystems need to be integrated into the sustainability provisions of all relevant policies, such as the CAP, cohesion policy, energy policy, and transport policy. This is dealt with in further detail in Chapter 3.

2.2 Water Framework Directive results on status and pressures

The Water Framework Directive provides the most comprehensive information about the status of our water ecosystems. As part of the Water Framework Directive, EU Member States were obliged in 2009 to publish River Basin Management Plans, which detailed both the status of their river basins and the countries' management plans for these river basins.

The information in the River Basin Management Plans was divided in different categories: groundwater and the surface water categories rivers, lakes, transitional and coastal waters. Groundwater is all the water held in subsurface aquifers. Under the Water Framework Directive, water quality for surface water is measured according to two different criteria: ecological status and chemical status; Groundwater is measured in chemical and quantitative status For a water body to be considered in overall 'good' status from a quality point of view, both the ecological and chemical status must be at least 'good'.

In addition to making a status assessment about their water bodies, Member States also gave information on the most significant pressures to which their waters were exposed.

In total, EU Member States reported results on the status, pressures and impacts for more than 13 000 groundwater bodies and 125 000 surface water bodies. Of these surface water bodies, 82 % are rivers, 15 % are lakes, and 3 % are coastal and transitional waters.

The following sections (Sections 2.2.1 to 2.2.4) summarise the main results of the status and pressures on Europe's water as reported under the Water Framework Directive (further information on status and pressures can be found in EEA, 2012i).

2.2.1 *The ecological status of water*

The ecological status of a water body is made up of two factors: the biology or living parts of the water body, and the non-living 'abiotic' conditions of the water-body. These abiotic conditions are the result of the so-called 'hydromorphology' of the water body – the extent to which the physical shape and flow of the water body is natural or has been altered by dams, dykes, canal walls, or river re-routing. Abiotic conditions are also affected by the chemical and 'physico-chemical' status of the water caused by factors such as temperature, salinity, nutrients and the concentrations of pollutants like heavy metals and chemicals.

The results from the River Basin Management Plans show that the ecological status of many of Europe's waters is quite poor. Here are some key findings:

- More than half of the surface water bodies in Europe are reported to be in less than good ecological status or potential, and will need mitigation and/or restoration measures to meet the Water Framework Directive objective (see Map 2.1). By 2015, 52 % of water bodies are expected to reach good status, compared with 42 % in 2009. This falls well short of the objective, with only a modest improvement expected between 2009 and 2015.
- River water bodies and transitional waters were reported to have worse ecological status or potential and more pressures and impacts than water bodies in lakes and coastal waters.
- The most common pressures affecting surface water bodies in Europe are pollution from diffuse sources causing nutrient enrichment, and hydromorphological pressures causing altered habitats.
- The worst areas of Europe concerning ecological status and pressures in freshwater are in Central Europe, in particular in northern Germany, the Netherlands and Belgium, while for coastal and transitional waters, the Baltic Sea and Greater North Sea regions are the worst.

Photo: © Peter Kristensen

2.2.2 *Chemical status*

Chemical status is a component of 'the good' status, and a water body must also have good chemical status if it is to be in overall good status. To reach good chemical status, surface or groundwater bodies need to comply with certain quality standards defined in the Water Framework Directive and subsequent directives ([2]). The results from the first round of River Basin Management Plans (reported by Member States in 2009) show poor chemical status is still a problem for water quality in Europe:

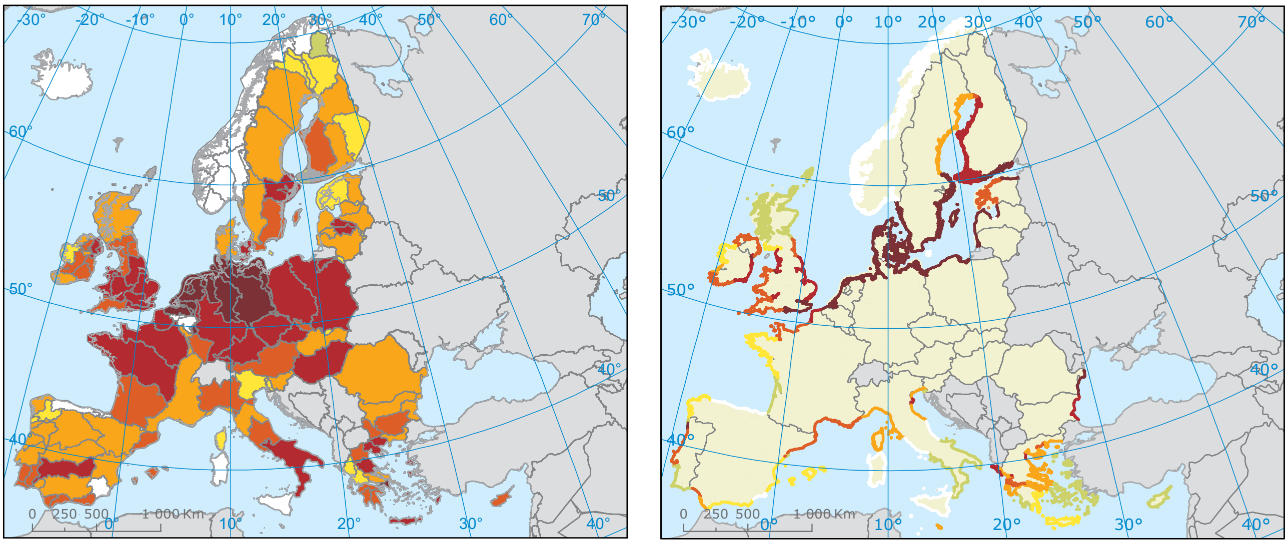
- By area, about 25 % of groundwater across Europe is in poor chemical status. Sixteen Member States have more than 10 % of groundwater bodies in poor chemical status, whilst this figure exceeds 50 % in four Member States. Excessive levels of nitrate are the most frequent cause of poor groundwater status across much of Europe. However, by 2015, some 89 % of groundwater bodies is forecast to be in good chemical status.
- Poor chemical status for surface water (rivers, lakes, transitional and coastal waters) does not exceed 10 % aggregated across Europe as a whole. Notably, the chemical status of 40 % of Europe's surface waters remains unknown, ranging between one third of lakes and more than half of transitional waters. This makes it difficult to establish a baseline for chemical status for 2009.
- Ten Member States report poor chemical status in more than 20 % of rivers and lakes with known chemical status, whilst in five Member States this figure rises to above 40 %.
- Polycyclic aromatic hydrocarbons (PAHs — a by-product of fuel burning) are a

([2]) The full range of substances relevant for the chemical status are to be found in Annex VIII 1–9 and Annex X (Priority substances) of the WFD, the EQS directive (EC, 2008a) and its amendments.

Map 2.1 Proportion of classified surface water bodies in different RBDs holding less than good ecological status or potential, for rivers and lakes (a) and for coastal and transitional waters (b)

(a) Rivers and lakes

(b) Coastal and transitional waters



Percent of classified water bodies in less than good ecological status or potential

< 10 % | 10–30 % | 30–50 % | 50–70 % | 70–90 % | ≥ 90 % | No data

Notes: See the EEA ETC/ICM technical report for more details and the methodology used for assessing ecological status or potential (EEA ETC/ICM, 2012a). The results are calculated as a percentage of the total number of classified water bodies.

Source: WISE-WFD database, May 2012. Detailed data are available at http://discomap.eea.europa.eu/report/wfd/SWB_STATUS.

widespread cause of poor chemical status in rivers. Heavy metals are also a significant contributor to poor status in rivers and lakes. Industrial chemicals such as pesticides and the plasticiser DEHP are also widespread causes of poor chemical status in rivers.

- Six Member States report poor chemical status in transitional waters to be more than 50 % of the water bodies with known chemical status. PAHs, heavy metals, and the 'antifouling' biocide tributyltin (TBT — used to prevent algae growth on ships' hulls) are the most common cause.
- Six Member States report all their coastal waters to be in good chemical status, although in five others poor chemical status exceeds 90% of those water bodies with a known chemical status. A variety of pollutant groups contribute to poor status in coastal waters reflecting a diverse range of sources.

Furthermore, new and largely unknown groups of substances keep appearing in the aquatic environment. The effects of these substances may be even more significant than more traditional pollutants. Examples include antibiotics, medicines and substances that disrupt hormonal balance in humans and animals. Emissions of these emerging pollutants must also be reduced.

These new substances, and the fact that the chemical status of 40 % of surface waters is unknown, show that monitoring and knowledge about chemicals is clearly insufficient in many Member States. The recent proposal from the Commission for a Priority Substances Directive (EC, 2011a) deals with these problems by proposing the regulation of additional substances, and the harmonisation and improvement of monitoring and reporting.

2.2.3 *Pollution pressures*

The pollution of water with nutrients such as phosphorus and nitrogen compounds (nitrite, nitrate or ammonium) comes typically from their emission via urban waste water or the use of these nutrients in agriculture as fertiliser. When these nutrients find their way into water, they result in increased aquatic plant growth and a corresponding decline in oxygen levels in water, a process known as eutrophication ([3]).

Analysis of the pressures causing poor status shows that between 30 % and 50 % of the surface water bodies are affected by pollution pressures, with diffuse sources (principally due to agriculture) being the most important pollutant pressure. More than 40 % of the river and coastal water bodies are affected by diffuse sources, whilst 20–25 % of them are also subject to 'point source' pollution (pollution from a large single source, generally related to human settlement). Map 2.2 shows a map of water bodies in different river basin districts affected by diffuse or point source pollution pressures.

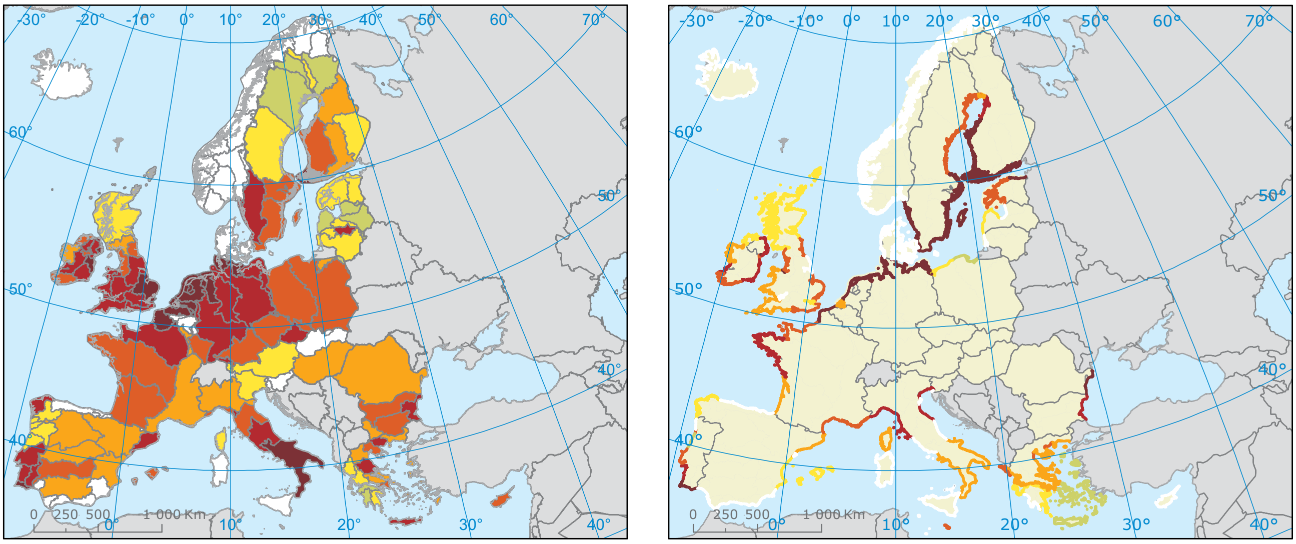
Agriculture and population density are key causes of pollution pressure on river water bodies. River basins with over 40 % of arable land and a population density of over 100 inhabitants per km^2 have over two thirds of their water bodies in less than good status (EEA, 2012i).

Poor status in spite of improvements

The widespread poor status of water ecosystems is in spite of clear improvements that have been made in reducing emissions in the past 25 years. Implementation of the Urban Waste Water Treatment Directive (UWWTD), together with national legislation, has led to improvements in wastewater treatment across much of the continent.

Map 2.2 Proportion of classified water bodies in different RBDs affected by pollution pressures, for (a) rivers and lakes and for (b) coastal and transitional waters

(a) Rivers and lakes **(b)** Coastal and transitional waters



Percent of classified water bodies affected by point and/or diffuse pressures

< 10 % | 10–30 % | 30–50 % | 50–70 % | 70–90 % | ≥ 90 % | No data

Notes: See the EEA ETC/ICM technical report for more details and the methodology used for assessing pressures (EEA ETC/ICM, 2012a).

A water body is considered to be affected by pollution pressures if it is reported with the aggregated pressure type 'Point sources' and/or 'Diffuse sources' and/or any of the corresponding disaggregated pressure types (e.g. urban wastewater, industry emissions or agriculture diffuse pollution). Swedish surface water bodies are defined as not affected by diffuse pollution pressures if the only reported diffuse pollution pressure is airborne mercury contamination.

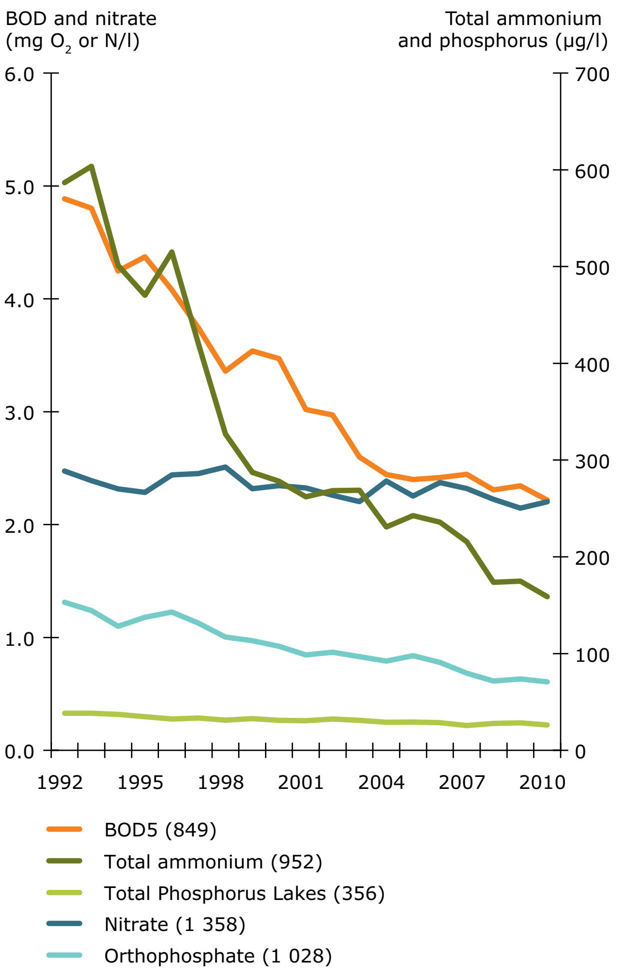
Source: WISE-WFD database, May 2012. Detailed data are available at http://discomap.eea.europa.eu/report/wfd/SWB_PRESSURE_STATUS.

([3]) Eutrophication is characterised by increased plant growth, problematic algae 'blooms' and subsequent depletion of oxygen. This can lead to the disappearance of life in bottom waters and an undesirable disturbance to the natural balance of organisms in the ecosystem.

This has resulted in reduced 'point' discharges of nutrients and organic pollution to freshwater bodies.

For example, the data provided by the EEA network of member countries Eionet show a clear improvement in water quality of both phosphorous and nitrogen compounds (see Figure 2.2). The yearly report for European bathing waters (EEA, 2012b), which the EEA publishes in cooperation with the Commission, also shows a continuous improvement for the quality parameter laid down in the Bathing Water Directive. Most waters assessed under the Drinking Water Directive also have good quality. This indicates a general improvement in water quality in Europe as far as human health is concerned. But this improvement does not mean that the overall ecological status of water is therefore satisfactory.

Figure 2.2 Changes in water quality variables during the last two decades



Source: CSI 19 and CSI 20 (Version August 2012); EEA, 2012j, k.

The large number of water bodies with less than good ecological status does not mean that water quality has not improved. It merely shows that these achievements were only a first step. Challenges related to urban and industrial waste water and pollution from agricultural sources remain.

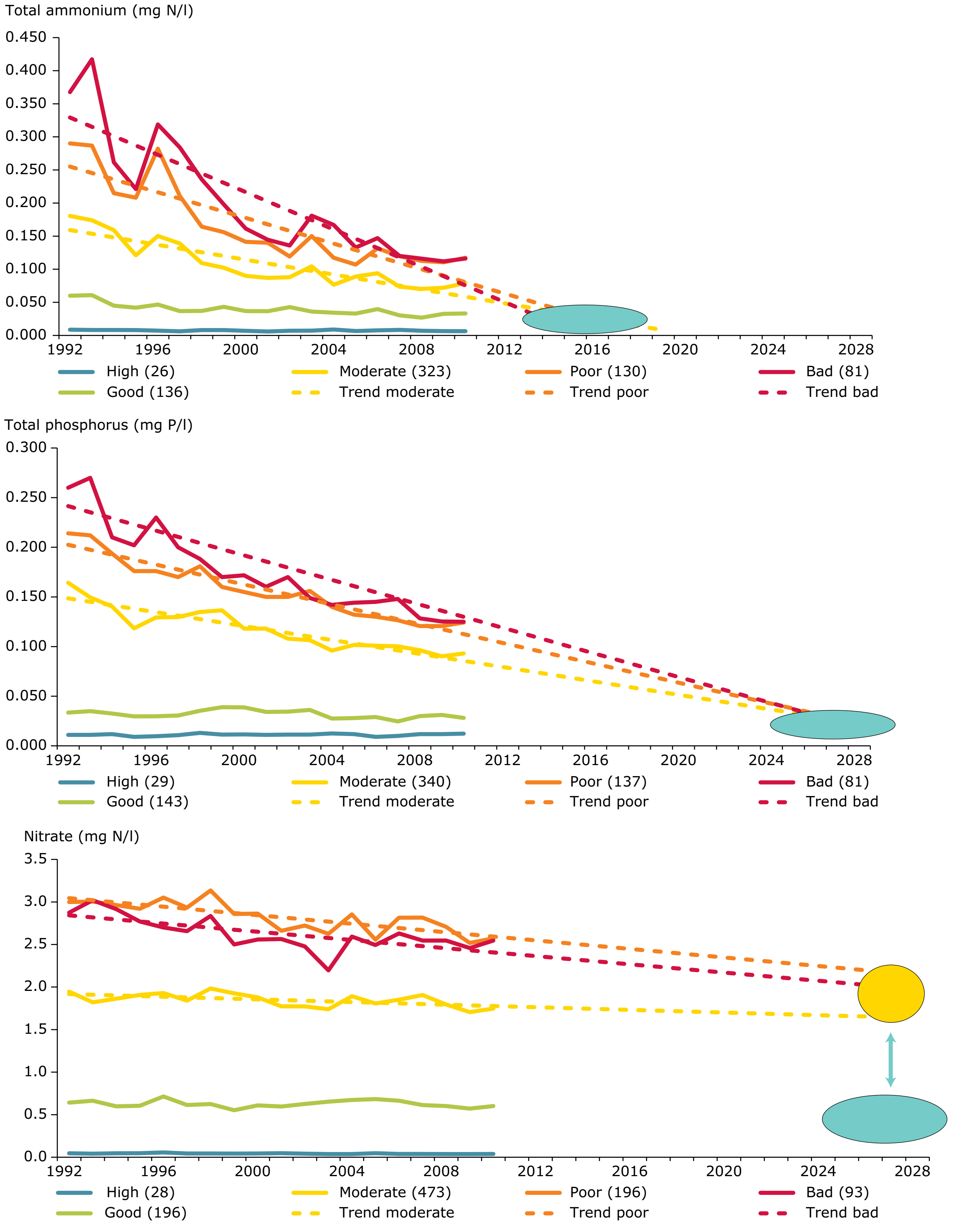
Problems preventing the achievement of good chemical status by 2015

The linear projections below (Figure 2.3) show the nature of these challenges in greater detail. These projections are a simple extrapolation of current trends in the reduction of nutrient compounds in rivers. A possible interpretation of the figures is that the downward trend for phosphorous and ammonium highlights the success of the Urban Wastewater Treatment Directive. These two pollutants are in principle more related to 'point' sources (where pollution comes from single sources such as sewage and wastewater treatment plants) such as those addressed by the Urban Waste Water Treatment Directive. A continuation of the current downward trend means that on this measure, water could reach concentrations usually associated with the level of good ecological status within the 2015 deadline of the Water Framework Directive, or at the latest after the fourth round of River Basin Management Plans in 2027. This would assume continuous progress in the implementation of basic measures as set up and executed in the last decade, and full implementation of the Urban Waste Water Treatment Directive in particular.

However, the trend line for nitrate looks different and can be taken as an indication of 'diffuse' pollution, mainly from agricultural sources. Agriculture contributes 50–80 % of the total nitrogen load observed in Europe's freshwater (Bouraoui et al., 2011; Sutton et al., 2011). Here we observe a large gap between the trend line and the likelihood of achieving good status. The likely failure of the EU to achieve good status in the timeframe envisaged by the Water Framework Directive indicates that additional, radically different measures have to be taken — in particular to reduce nitrate concentrations — if Water Framework Directive deadlines are to be met. Existing measures to tackle agricultural pollution also need to be better implemented.

We must ensure that all measures in the Nitrates Directive, the Urban Waste Water Treatment Directive, and the Priority Substance Directives are implemented in all Member States. The quality of water must be improved by reducing nutrient and chemical pollution before it enters water bodies. But equally important is the reduction of diffuse

Figure 2.3 Trend in median total ammonium, total phosphorus and nitrate concentration of river water bodies, grouped by ecological status/potential class



Note: Concentrations are expressed as a median of annual mean concentrations. Up to 3-year gaps of missing values have been interpolated or extrapolated. Only complete series with no missing values after this interpolation/extrapolation are included. The number of time series/river stations is shown in parentheses. The trend 1992–2010 for each of the ecological quality classes has been linearly extended to 2027 — or when the concentration level became negative.

Source: WISE-WFD database May 2012. and EEA Waterbase Rivers Version 8, see EEA 2012i.

pollution from agriculture. As Chapter 3 further specifies, the forthcoming reform of the Common Agricultural Policy provides an opportunity to further strengthen water protection.

A more detailed analysis of the relationship between pollution pressures and ecological status is also needed at river basin level in order to inform as precisely as possible the actions that have to be taken in the programmes of measures under the Water Framework Directive.

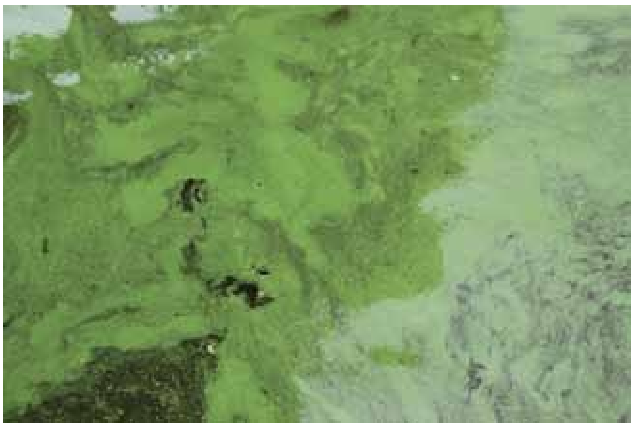


Photo: © Peter Kristensen

2.2.4 Pressures affecting ecological status — hydromorphology

Hydromorphology is the other component of ecological status. In the River Basin Management Plans, information was provided on hydromorphological status and on hydromorphological pressures having an impact on the good status of their water bodies. An analysis of these pressures gives a good insight into the way that water habitats are altered, and can help suggest which measures need to be taken to improve water ecosystems.

Hydromorphological pressures and altered habitats are the most commonly occurring pressure and impact in rivers, lakes and transitional waters, affecting 40 % of river and transitional water bodies and 30 % of lake water bodies (EEA, 2012i).

Hydromorphological pressures affect water bodies in their role as structured ecosystems and habitats for various species and biodiversity. Hydromorphology is particularly important for the provision of ecosystem services, such as water retention and filtering, spawning grounds for fish, and habitats that foster a rich biodiversity. Pressures that cause hydromorphological alterations are coming from a range of human and economic activities, such as flood defence, pressure from regional and urban development, navigation, or water storage in the form of reservoirs (EEA, 2012h).

A significant proportion of River Basin Management Plans now include measures to restore the original hydromorphological conditions of surface water bodies. Any attempt at restoration of the hydromorphological conditions in a river basin should be undertaken by assessing the basin and the full length of the river. Particular attention should be given to the river's capacity to allow access to migratory species along its full length, i.e. its continuity and connectivity. This means examining hydraulic structures upstream, and coastal structures and 'hard' flood protection measures downstream. Such projects must involve all public and private stakeholders in the river basin.

But because humans have been altering the structure of surface water bodies for centuries, in many cases a restoration of the original structure might be not possible without impairing the social or economic use of a water body. The Water Framework Directive recognises this and allows for water bodies to be designated as either 'heavily modified' or as 'artificial'. For these water bodies, the goal is not good ecological status, but rather 'good ecological potential', an objective that takes more account of the constraints imposed by social or economic use. Densely populated areas tend to have high concentrations of water bodies designated as 'heavily modified' or as 'artificial'.

2.3 Freshwater ecosystems — results of the nature legislation

The status of freshwater biodiversity
Generally, the EU aims to ensure that its policies on water, the marine environment, nature and biodiversity are all closely integrated. The objective of this integration is to ensure that each individual 'sectoral' policy contributes to the overall goal of protecting ecosystems. This integrated approach to policy making is part of the 'ecosystem approach' discussed in Section 2.1.

In addition to the Water Framework Directive, there are two other directives that play an important role in dealing with the biodiversity in water ecosystems and wetlands. These two directives are the Habitats Directive and the Birds Directive, known collectively as the 'Natura 2000 directives' or the Nature Directives. These directives aim to protect, maintain or restore selected species and habitats to favourable conservation status and to ensure a coherent network of protected areas, known as Natura 2000 sites.

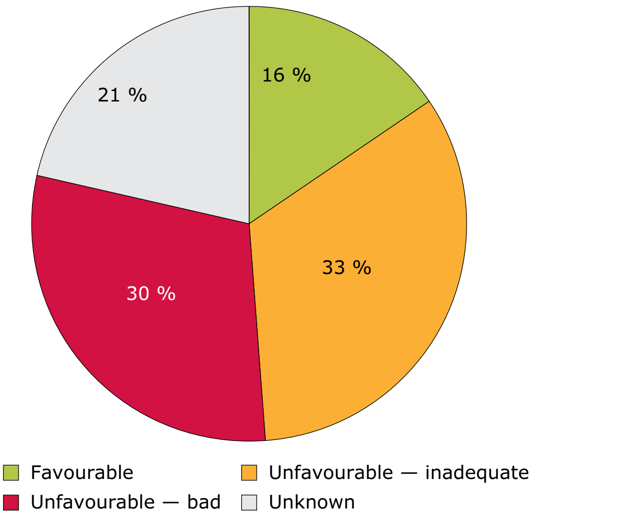
Assessments made under the Habitats Directive (EC, 1992) show that when it comes to water habitats or water-dependent species, Europe is a long way from achieving its goals of favourable conservation status (EEA, 2010b). Only 15 % of the assessments for the river and lake habitat types (Figure 2.4), and 13 % of the assessments for inland water species were in favourable conservation status. This leaves over two thirds of all habitats and species in an unfavourable status. More than one-fifth of the habitats and species in rivers and lakes have unknown conservation status. Habitats in coastal areas are in an even more worrying condition, with 83 % in unfavourable status and 11 % in unknown status. Other non-EU assessments have reached similar conclusions on water-based biodiversity in Europe (IUCN, 2008; Cuttelod et al., 2011; Freyhof and Brooks, 2011). This picture from the Nature Directives of water species and habitats in poor status supports the findings from the Water Framework Directive with its high percentage of water bodies not in good ecological status.

The objectives of both the Water Framework Directive and the Nature Directives are closely related. This means that in the event that the directives are applied in the same policy area, the requirements of the more stringent directive must be met. This should mean that the improvement of the status under one directive would also lead to an improvement of the status under the other. However, as these directives are currently implemented there are three problems that need close case-by-case coordination. These problems concern the creation both of the River Basin Management Plans and of the management plans for the Natura 2000 sites under the Birds and Habitats Directives.

The first problem is the differences in scope between the Water Framework Directive and the Nature Directives. These differences in scope have an effect on small water bodies such as ponds and creeks. In theory, the Water Framework Directive

Photo: © Peter Kristensen

Figure 2.4 Conservation status of rivers and lake habitat types as example for results under the HB directive



Note: Geographical coverage: EU except Bulgaria and Romania; number of assessments in brackets.

Source: ETC/BD, 2008.

should protect all of these water bodies, but because many Member States apply a size threshold in the delineation of water bodies when implementing the directive, small water bodies are often excluded from this protection. These small water bodies should in theory be protected indirectly by the Water Framework Directive provision to apply the objectives of the Habitats Directive in the so-called 'water-dependent' Natura 2000 sites. However, there is no single definition of what 'water dependent' means, and this means that small water bodies escape the protection of both directives. Particular care needs to be taken to include small water bodies in the programme of measures under both directives in a coordinated way.

The second problem with reflecting biodiversity elements in the assessments under the Water Framework Directive concerns invasive alien species. Some of the River Basin Management Plans established under the Water Framework Directive do not mention the impact of invasive alien species, even though they are a serious problem and can have an impact on ecological status. In the Thames River Basin District for example, approximately 56 % of the rivers and 11 % of lakes are affected by invasive species.

Finally, there might even be conflicts between the objectives under the Water Framework Directive and the objectives of the Nature Directives regarding the establishment of protected areas. For example, the Water Framework Directive might favour the restoration of a 'more natural' status to an altered habitat, but this might lead to the loss of certain habitats of species that perhaps flourished in this modified or artificial environment. In principle, the objectives of the Water Framework Directive should prevail in those cases, as the Water Framework Directive looks at the whole ecosystem that should benefit from the changes. But conflicts such as these make clear that a final management decision can only be made on a case-by-case basis and in close dialogue between protected area managers and water managers.

2.4 Water quantity and related pressures

This sub-section deals with the status of Europe's water quantity, including the risks for floods, droughts and water scarcity. It should be noted that while EU legislation has extensively focused on water quality, there has been far less attention paid to the issue of water quantity. As a result, water quantity assessments are usually not based on data reported under EU legislation, and these assessments instead need to draw on a variety of different reporting processes (details on the assessment can be found in EEA, 2012h; EEA-ETC/ACC, 2012; EEA-ETC/ICM, 2012c).

Floods and droughts are part of the natural hydrological cycle and the natural development of ecosystems. In the different climatic regions of Europe, adaptations to these events developed over millions of years, forming fluvial forests, wetlands, or arid areas like half-deserts with seasonally dry water sheds. In these conditions, specific ecosystems developed that adapted to these patterns of flooding and dryness.

However, this natural hydrological cycle is now being disturbed. Climate change pressures such as changing precipitation and temperature patterns over Europe are likely to increase the frequency of both drought events (too little water) and flood events (too much water). The role of climate change was not integrated into the first round of River Basin Management Plans that were issued in 2009, although it was a subject that was highlighted and intensely discussed in the Common Implementation Strategy, which established a common framework for implementing the Water Framework Directive.

These climate change pressures are being exacerbated by human activity in the form of

Photo: © Peter Kristensen

construction works (such as dikes, dams, or large reservoirs) or over-abstraction (excessive human use of water). These human pressures exacerbate water shortages in drought situations.

From the evidence of several assessments described in 2.4.2 and earlier EEA reports (EEA, 2010a; CESR, 2011; EEA, 2012a, h; EEA-ETC/ICM, 2012; Schmidt and Benitez, 2012) it obvious that many parts of Europe face increased risks of water scarcity.

One way of conceiving problems of water quantity is the concept of a 'flow regime', which describes the volume and seasonal rhythm of water flow in a water body. The 'ecological flow' is defined as the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon. Ecological flow needs to be part of the overall good status assessment. Climate change and human use both pose threats to the flow regime of water ecosystems. Altered flow regimes can have a high impact on the functionality of the ecosystem as outlined in Section 2.1. Some river basins have included flow regime concepts in the good status assessment (Sánchez and Schmidt 2012, Bunn and Arlington 2002), but it is very difficult to precisely monitor how the status of ecosystems is affected by changes in flow regimes. More conceptual work is therefore needed to develop the concept of 'ecological flow' in the good status assessment.

The Commission is now reviewing its policies on water quantity and how it will be affected by climate change as part of the ClimWatAdapt project (CESR, 2011). Furthermore the Water Scarcity and Drought policy review summarises the current state of implementation of resource management policies in the Member States (EC, 2012c). The following section complements these two policy reviews in order to help develop the baseline for the quantitative status of Europe's water environment against which further policy developments can be measured.

The Blueprint is expected to set out a range of entry points to ensure that sustainability targets are met. The Blueprint and its implementation are also expected to improve and integrate the implementation of the Water Framework Directive to take water resource aspects more widely into account.

2.4.1 *Floods*

The broad trend that appears most clearly in studies of flooding is that flood events are increasing in frequency in northern Europe, especially in western Britain and coastal Scandinavia.

More than 325 major river floods have been reported for Europe since 1980, of which more than 200 have been reported since 2000. The rise in the reported number of flood events over recent decades is mainly the result of better reporting and changes in land use. Apart from river floods, the other area where flood risks occur is in urban water management, where rain-related floods and surges of storm water can overflow out of the sewage system and have effects on water quality (EEA, 2012f; EEA-ETC/ACC, 2012).

Global warming is projected to intensify the hydrological cycle and increase the occurrence and frequency of flood events in large parts of Europe. However, estimates of changes in flood frequency and magnitude remain highly uncertain. This is due to the effects of long-term natural variability in climate, and human disturbance of catchments and river systems. In regions with reduced snow accumulation during winter, the risk of early spring flooding would decrease. But the lack of comparable long-term river flow data across Europe also makes it difficult to detect more nuanced trends in floods (EEA, 2012f).

It should be remembered that floods are an integral part of water related ecosystems such as wetlands and fluvial forests. The environmental damage caused by floods is thus more a consequence of man-made flood defence than it is of the water ecosystems themselves. We must balance the direct damage of floods to society and the economy against the value ecosystems would gain by being undisturbed and allowed space for the appearance of natural flood events (EEA, 2012h).

2.4.2 Droughts and water scarcity

While floods can develop in rather short timescales such as a couple of days, droughts usually develop as a result of low precipitation over several months or years. This can make it difficult to find good data on the long-term drought trends. It is also difficult to distinguish whether a drought is natural, directly man-made (by human alteration of the landscape) or indirectly man-made (caused by climate change).

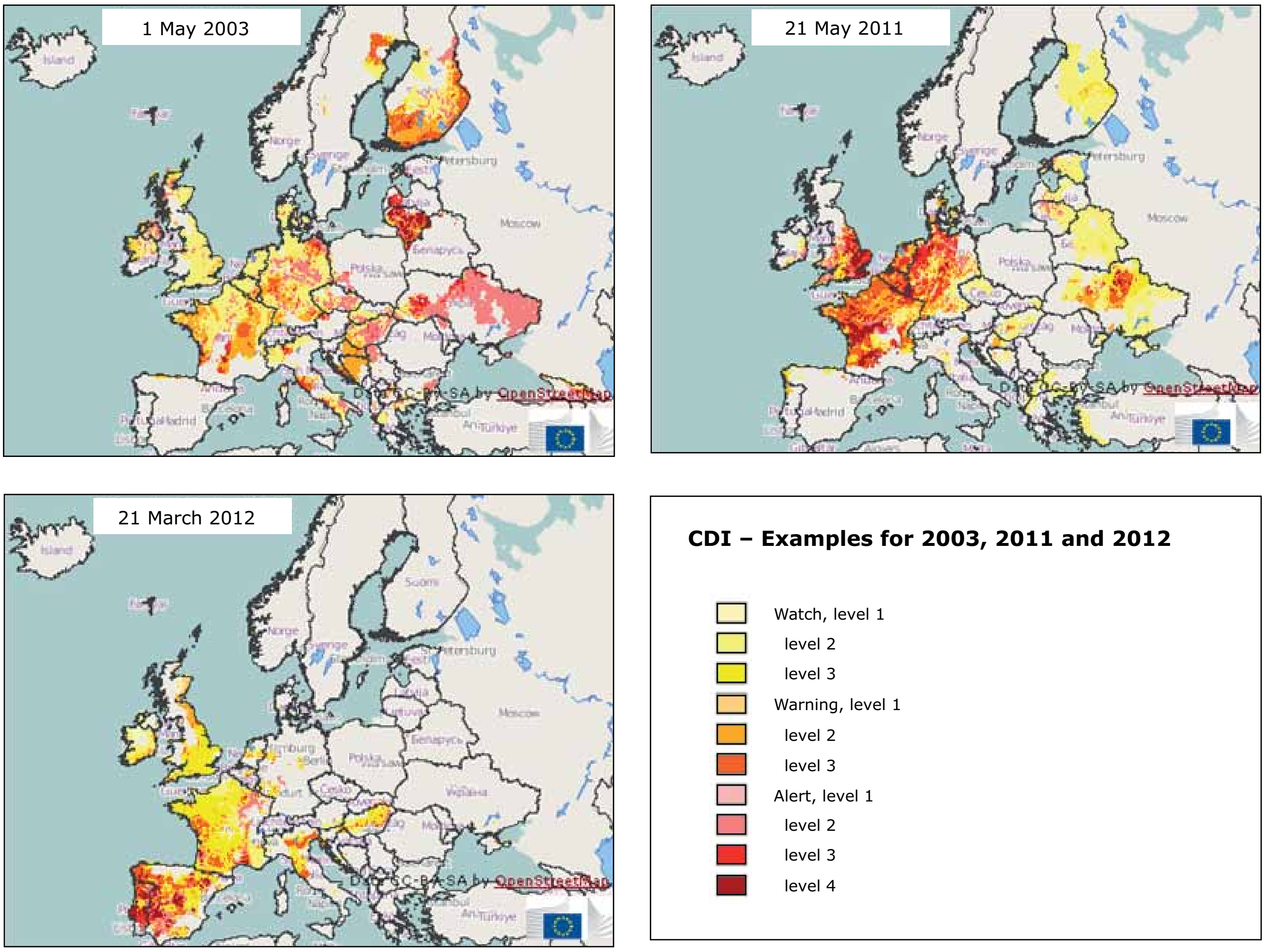
Drought is generally defined as a lack of freshwater from precipitation. This distinguishes droughts from water scarcity, a state where human demand for water exceeds the available resources of clean fresh water (EC, 2007a; EC, 2010b).

The European Drought Observatory (EDO), led by the European Commission's Joint Research Centre, compiled a drought assessment that details changes in drought conditions in Europe. For the critical areas, there is a need for more detailed local-level analysis based on locally available data. Map 2.3 presents a snapshot of drought conditions in Europe as assessed by the EDO using the Combined Drought Indicator (JRC, 2011; 2012).

In 2012, the EEA conducted an analysis of drought episodes in Europe in every decade from 1971 to 2011 (EEA-ETC/ICM, 2012c). The analysis summarised every drought episode that occurred in a country during a decade regardless of the duration of the drought (whether it was a few months or many years) or its spatial extent (whether they happened locally or nationwide). Our analysis shows an increase in the number of countries affected by drought per decade, rising from 15 in the period 1971–1980 to 28 in the period 2001–2011 (17 in the decade 1981–1990 and 24 in the decade 1991–2000). A further comparison between the first and last decade in the exercise clearly shows that drought occurrence not only increased in southern and central Europe, but also increased in northern and eastern Europe.

Drought and water scarcity can also cause a change in groundwater quantity as the drop in water table can be an effect of drought as well as water scarcity. The drop in groundwater levels could in turn affect ecological conditions. The quantitative status of groundwater bodies in Europe was reported by Member States in the 2009 River Basin Management Plans they submitted as part of the Water Framework Directive (Schmidt and Benitez, 2012; EC, 2012c). From the total number of groundwater bodies reported in the Water Framework Directive River Basin Management Plans, 87 % were in good quantitative status. However, 6.4 % are classified as being in poor quantitative status. Poor groundwater status is distributed throughout several countries, namely Belgium, Cyprus, the Czech Republic, Denmark, Italy, Malta, and the United Kingdom. By 2015, it is forecast that 96 % of groundwater bodies will be in good quantitative status. Water scarcity is reported for nearly all river basin districts in the Mediterranean area. In two out of three groundwater bodies reported as not being in good quantitative status, abstraction is mentioned as a significant pressure. The relationship between water availability and water abstraction is usually measured using water balances like the Water Exploitation Index (WEI) or water asset accounts. The EEA data collection on water abstraction by sectors (EEA, 2012m) shows that across Europe, overall water abstraction has declined in the past decade. However, water abstraction still remains high in the agricultural sector in southern and south-eastern Europe, where agriculture is a main driver of demand for water through irrigation. By contrast, water use in the domestic and industrial

Map 2.3 Mapping of drought conditions in Europe



Note: Mapping of drought conditions in Europe as calculated by the Combined Drought Indicator (based on SPI, soil moisture and fAPAR) for top left March 21st, 2012 top right May 21st, 2011 and bottom left May 1st, 2003 known as a dry year for large parts of Europe.

There are three classification levels: watch (when a relevant precipitation shortage is observed), warning (when the precipitation translates into a soil moisture anomaly), and alert (when these two conditions are accompanied by an anomaly in the vegetation condition).

Source: European Drought Observatory (EDO), Joint Research Centre, European Commission, Available online: http://edo.jrc.ec.europa.eu.

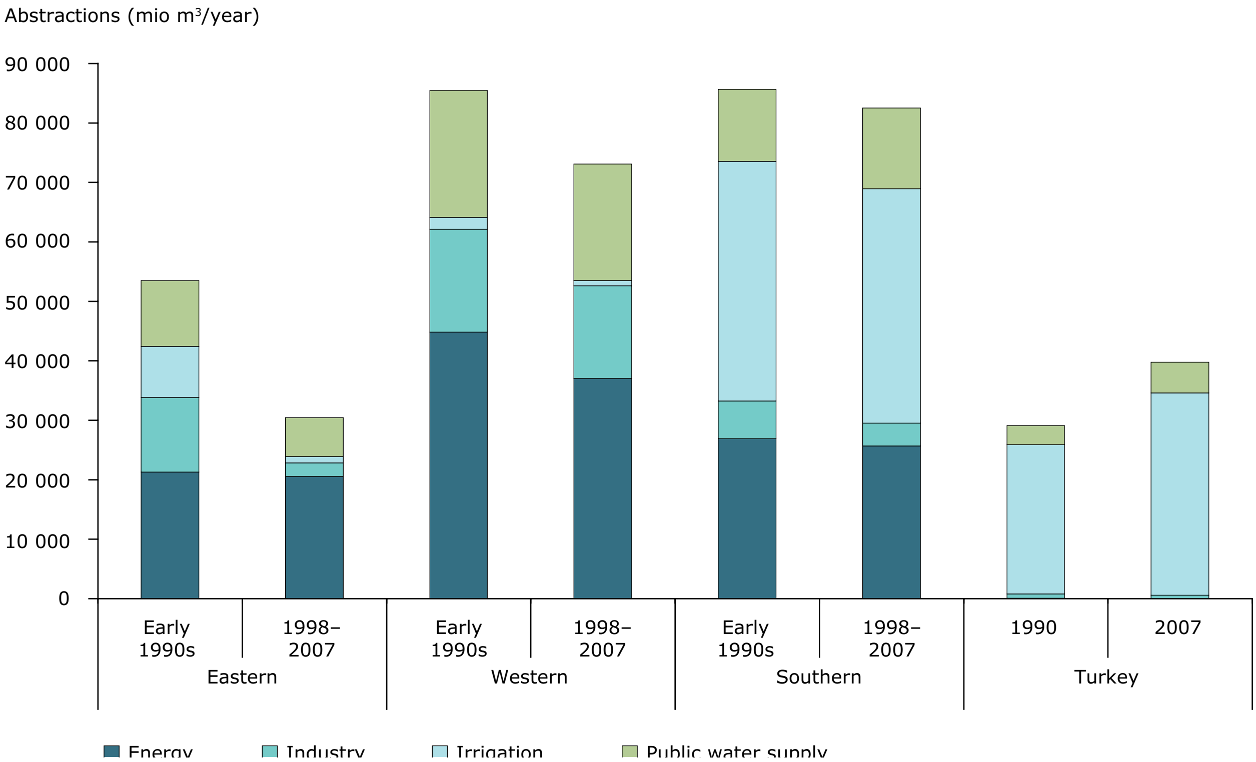
sectors is stable or slightly falling due to increasing awareness and water efficiency technologies. This is illustrated in Figure 2.5.

However, examining water abstraction by sector over several decades does not reveal the full state of water scarcity in specific areas in Europe. This is because water is intricately linked to time and space. For example, water use across Europe could be increasing, but if that water was used at certain times of year and taken from certain river basins it might not lead to water scarcity. Equally, it is possible for there to be an overall decline in water use across Europe, but if that decline is not also occurring in water-scarce regions, then vulnerable river basins could still be at risk. This is why the balance between water use and availability has to be assessed on catchment level, or at least at river basin district level. It is also why water use has to be measured on a monthly basis to take account of the importance of seasonality and changes in rainfall. In southern Europe in particular, large water 'deficits' develop due to intense irrigation in the summer, a time when climatic conditions mean the region is prone to droughts.

In spite of the need for more local data gathered on a monthly basis, the Water Exploitation Index (WEI) used in a wide range of literature so far calculates water balances on a national and annual level, because in most countries this is the way statistical data is gathered. The index is now being reviewed to better capture the actual risk situation for the environment in Europe.

Central to this improvement is the convergence with the 'Water asset accounts' as part of the environmental accounting for water, further explained in Section 4.3.1. Within this framework the water accounts are understood as a balance calculation of water resources within a specific area (e.g. catchment, administrative river basin). Given the flexibility of the system (spatially and temporarily disaggregated) a more precise reflection of the water scarcity risk can be given. Recent calculations of water accounts and the further developed WEI+ by EEA currently in consultation with member states show high scarcity risks in large parts of the Mediterranean area, but also in parts of Western and Eastern Europe (EEA, 2012h; 2013c).

Fig 2.5 Water abstraction by sectors (CSI 18)



Source: EEA, 2012m.

3 Future sustainable water management in a green economy

This chapter deals with pressures in the three areas that are most critical for the future health of our water ecosystems: land use, energy and water management. These economic areas must all be addressed in an integrated fashion if our economies and societies are to prosper while protecting our ecosystems. In the first section of this chapter (Section 3.1), we begin by introducing the idea of a 'green economy', a concept that links environmental sustainability with economic growth. We then turn to the role of land use in water management (Section 3.2), before moving to the topic of energy (Section 3.3) and the demands that our energy infrastructure places on our water resources. We finish with a consideration of water economics (Section 3.4) and the extent to which water use can be altered by taxes, subsidies and other economic instruments. Key messages from this chapter are summarised in the box below. This chapter builds up largely on information from several EEA reports on resource efficiency and urban and regional planning (EEA, 2009, 2010, 2011c, 2012a, c, d, e, h).

- Sustainable water management can be achieved as part of the broader goal of a 'green economy', an economy that promotes improvements in resource efficiency, resilient ecosystems, and human wellbeing.
- Agriculture, land use, and regional development all create pressures on water quality and water quantity. EU policy in this regard — especially the CAP and cohesion policy — should better integrate water quality objectives to reduce these pressures.
- Water, energy and food are inextricably linked to each other as economic resources. Production of energy and food requires water, while the production of water requires energy. This interdependence must be recognised in sustainable water management policy.
- The quality of waste water must be further improved in the most energy efficient way. This can be accomplished by technology, efficiency measures, and reduction of water pollution at source.
- Water use and supply (including the supply of drinking water) must become more efficient also as measure of energy efficiency. It has to follow the principles of demand management. This can be accomplished in all sectors by water saving through technology and behavioral changes.
- The impact of energy production on water must be reduced. This can be accomplished by careful planning in the sectors of biofuels, hydropower, offshore wind power, unconventional recovery of oil and gas (e.g. shale gas), and full application of the environmental assessment tools (SEA and EIA).
- Placing a price on water can also help improve water efficiency and sustainable water management. It can also help to highlight the 'hidden' non-monetary benefits of water such as flood retention and pollution absorption.
- Economic instruments such as taxes and subsidies can act as incentives for prudent water management. These instruments are a vital complement to water regulation, and can also help allocate water between competing user demands.

3.1 The green economy and the interdependency of resource use

The twin crises of global finance and the environment have prompted many people to argue that these two challenges can be resolved simultaneously by the creation of a 'green economy'. The green economy, is here understood to be an economy in which policies and innovations enable society to use resources efficiently and enhance human well-being, all while maintaining the natural systems that sustain us (EEA, 2012c).

The goal of a green economy was endorsed by the UN in their report *Towards a Green Economy* (UN, 2011), and by the Rio+20 conference on sustainable development in 2012 (UN, 2012a). In concrete terms, it has three main elements (EEA, 2010), all of which are important to the issue of water management.

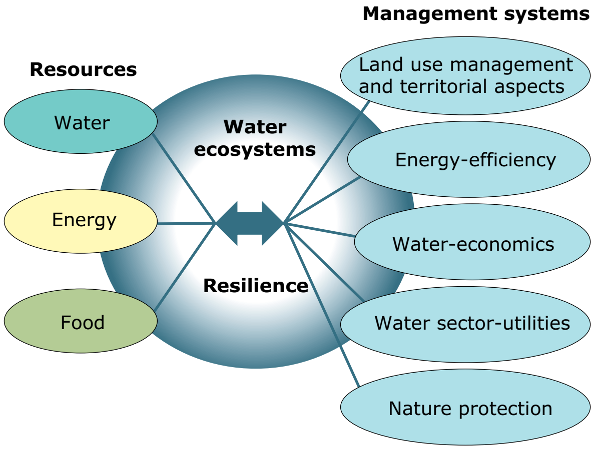
Firstly, the green economy is one that is resource efficient, increasing prosperity without increasing our use of resources. But resource efficiency is not sufficient to ensure a decrease in resource use. After all, the world could create more wealth from each unit of natural resources, but still increase its overall use of resources.

For this reason, the green economy has a second component: it should achieve 'ecosystem resilience' and ensure that our ecosystems are healthy and capable of recovering quickly from any disturbance. This means that economic growth and resource use should be decoupled from environmental impacts.

The third element of a green economy is human well-being. The green economy secures health, employment, job satisfaction, and the preservation of social capital. It also ensures a fair distribution of the benefits and costs of the transition to the green economy.

The role of water in our economy and environment is highly complex. On the one hand, it is one of the economic resources that society relies on. In this respect water, is similar to food, energy and materials. But water is also a key component in the production and management of these resources of food, energy and materials. And water also plays a critical role in the healthy functioning of ecosystems, meaning that economic systems and ecosystems can be directly competing for this scarce water resource.

Figure 3.1 The water-energy-food nexus and the way it is managed influence water ecosystems and their resilience



Source: EEA, 2012.

Any discussion of ecosystems and sustainability must recognise this interdependency between the key natural resources. Exploiting one resource type often results in impacts on the environment and on other resources. For example, producing food requires land as well as water and energy. Equally, energy production (including renewable energies like hydropower and bio-energy) has an impact on land management, food, and water resources. And the production or consumption of materials through industrial activities is dependent on energy and water resources. These interdependencies are often described as forming a water-food-energy nexus. This nexus contains synergies, trade-offs and conflicts between its component parts. Figure 3.1 illustrates how the water-energy-food nexus is related to the different management systems of related policy areas (4). The rest of this chapter will examine some of these policy areas in greater depth.

3.2 Water management, land use and territorial aspects

Towards new principles of land use
Land use, land management, and the regional development of our landscapes are some of the main driving forces that threaten the resilience of

(4) For more on these issues, see EEA reports on water vulnerability (EEA, 2012h) and water efficiency (EEA, 2012a).

water systems. Ensuring that these practices are well managed is the best way to reduce the threat they can pose. In the past, the principal concern in land-water interaction was how best to lead water out of the landscape. This could be seen in land drainage and reclamation practices to serve agriculture, or the expulsion of waste water to serve cities, or the straightening of rivers to serve navigation.

There is now a different way of managing land-water interaction that is receiving increased attention. This method involves working with nature and using an ecosystem's natural functions to accept the return of water back into the landscapes. This more natural approach can be achieved by Natural Water Retention Measures (NWRMs), which are a key element in the 'green infrastructure' approach promoted by the EU's Biodiversity Strategy 2020 (EC, 2011e; see Section 4.1). Green infrastructure is the umbrella term given to a series of measures that make use of natural systems to improve the environment. Natural Water Retention Measures are a part of green infrastructure and encompass measures such as restoration of wetlands and forests. This can help store water in the ground, reducing the likelihood of both floods and water scarcity (STELLA Consulting, 2012; EEA, 2009, 2012h).

NWRMs help mitigate several water-related pressures at the same time, such as water pollution, water scarcity, and in particular, hydromorphological alterations. NWRMs help to filter and store water where it is needed, and they can be deployed as a tool in agriculture, and in the management of forests and cities. They typically entail greater development of forests, and in particular the maintenance of 'riparian' forests (forests that are adjacent to rivers). Other NWRMs include the restoration of wetlands or natural flow processes in rivers. In cities, NWRMs include measures to improve the permeability of surfaces where asphalt and paving often prevents water seeping into the soil. In agriculture, the use of so-called 'cover crops' (crops grown especially to retain water and improve soil fertility) and 'buffer strips' (areas of permanent vegetation that maintain soil and water quality) are the most important NWRMs (STELLA Consulting, 2012).

In terms of national and European legislation, the most important policy areas for securing water resilience in land use are the Common Agricultural Policy (CAP) and the policies for regional development, as detailed in the Territorial Agenda 2020 (EC, 2011b). Another important policy instrument is the Green Paper on Territorial Cohesion (EC, 2008b) which defines how landscapes and urban areas should best be developed to ensure social and economic prosperity.

The following sections give an overview on how agricultural management and regional development are influencing the interaction between land and water.

3.2.1 Agriculture

Many of the pressures affecting water ecosystems that were mentioned in Chapter 2 are directly related to agricultural management. These pressures include diffuse pollution (pollution coming from many small and widespread sources such as fertiliser run-off from agricultural land), hydromorphological alterations, and over-abstraction of water leading to water scarcity.

Water quality and quantity are closely linked. Diffuse pollution and hydromorphological pressures are highest in areas of high agricultural intensity (EEA, 2012i). The way the agricultural sector manages nutrients, chemicals, hydromorphological pressures, and water scarcity opens an array of possibilities for better water management that could help relieve all of these pressures.

Over the past decade, the implementation of the Nitrates Directive has led to significant improvement in nitrate loads. But the discussion of nutrient status and diffuse pollution in Chapter 2 shows that Member States need to make further efforts to reduce nitrate loads, which come mainly from diffuse pollution by agriculture. Better implementation of the Water Framework Directive River Basin Management Plans can be supported by means of reinforced Nitrates Directive action programmes and the extension of Nitrate Vulnerable Zones. This would help close the gap between the current trend in nitrate reduction and the objective to reach good status under the Water Framework Directive in 2015 (see Figure 2.1).

Apart from nitrates, there are a number of other sources of diffuse chemical pollution, stemming from pesticide and fertiliser application. The legislation on plant protection and biocides can support water protection by improving the products used, but ultimately agricultural management needs to further reduce pollution at source. This can be achieved both by better emission control and by better water retention measures — for example a more ambitious application of buffer strips of a minimum width in which there is no harvesting or use of pesticides.

Photo: © Anna Sandrini

Agriculture also places great strain on water resources in terms of the quantity of water it requires. Efficiency measures need to focus on improved cropping patterns and irrigation systems that reduce evaporation (from soils as well as during storage and transfer) and reduce surface run-off (EEA, 2012a; Bio Intelligence Service, 2012a). In addition, it is imperative to tackle the problem of illegal water abstraction on a national level, possibly with the help of remote sensing equipment. Efficiency in agricultural management could also be improved by increasing the re-use of waste water in irrigation or using biomass from sewage sludge digestion (a by-product in the bioenergy production and increasing the carbon sequestration) (see Section 3.2). However, these measures all require common EU quality standards to ensure adequate soil and water protection. Controlling emissions and managing demand for water in agriculture could both be helped by the creation of water trading schemes, which could incentivise demand management. The 'polluter pays' and 'user pays' principles both play an important role in this respect, and there needs to be a careful application of these principles that takes into account the economic and social aspects of agricultural management.

Bio-energy targets — originating in both the EU and in Member States — have also emerged as an important driver of agricultural land use, influencing water quality and quantity over the last 10 years. Bio-energy is the production of energy from crops. These targets can have a knock-on effect on water quantity and quality. While the share of bio-energy crops in the EU-27 cropping area is still below 5 %, it is much higher in many regions and is projected to grow substantially to meet EU targets for 2020. Nearly all EU bio-energy production currently relies on standard agricultural crops such as oilseed rape or wheat (the so-called first-generation crops). This means that 'energy cropping' (growing crops to use as a feedstock for energy production) has the same environmental impacts as standard agricultural land use, and can lead to increased pressure on water quality and quantity. EU biofuels policy includes 'sustainability criteria' that prohibit the conversion of carbon-rich and biodiversity-rich land cover types (e.g. permanent grassland or forests) to energy crops, and thus limit the most important direct impacts of bio-energy cropping. However, secondary effects, such as the displacement of food crops to currently forested areas outside the EU or the intensification of agriculture where energy cropping is permitted, cannot be effectively tackled with the current set of EU policy instruments (Petersen, 2008).

The most important policy development that will influence future agricultural management and its effects on water is the proposals for the CAP after 2013 (EC, 2011c). From the perspective of water management, the proposal shows good potential but they do not address a number of critical issues (Altvater et al., 2011) ([5]).

The CAP consists of two 'pillars'. Pillar 1 comprises the system of direct payments to farmers as well as the system of price support and other interventions in the market for agricultural products. Pillar 2 aims at improving rural development and reducing the environmental impact of farming.

Under the proposal for a post-2013 CAP (EC, 2011c), a series of 'green payments' would be introduced under Pillar 1 to support crop diversification, permanent grassland, and ecological focus areas such as buffer strips. While these ideas are to be welcomed, there is insufficient detail on the nature of the measures. More information is needed about the types of crops covered, the crop rotation requirements, and the places targeted as ecological focus areas. The measures could also be more ambitious. For example, the so-called Good Agricultural and Environmental Condition standard (GAEC) on buffer strips should include limitations on pesticide use, or requirements on the size and type of plants permitted in these strips. The measures could also be more ambitious as regards the promotion of 'green cover' (crops that are not harvested but which reduce erosion and nutrient loads in water). At present, the promotion of green cover is not included in the green payments.

The reform also envisages that the Water Framework Directive and the Pesticides Directive would be included into the mechanism known as 'cross compliance', under which payments under the CAP would be made conditional on compliance with other EU regulations. Including the Water Framework Directive as a condition of cross compliance would be highly important, and further specifications on the details would be needed.

Under Pillar 2, the rural development component of the CAP reform enables the funding of a wide range of measures that can support water protection. One promising funding proposal under Pillar 2 is to allow Member States to transfer up to 10 % of funding to rural development. It is important that this 10 % be used to improve water management. It should be a legally binding requirement that 25 % of this 10 % allocation be used for measures beneficial to water management ([6]).

Other reforms proposed for Pillar 2 seek to foster better irrigation efficiency, aiming at compulsory water metering and a 25 % improvement in water efficiency. However, it is important that these measures do not lead to a 'rebound effect', where improved efficiency can perversely encourage greater levels of overall water consumption, because each unit of water can grow more crops, making each hectare of land cheaper to farm. Safeguards should therefore be included to ensure that the saved water returns to the environment.

It is also advisable to review crop-specific payments such as for cotton in countries which have water scarcity problems such as Bulgaria, Greece, Portugal and Spain. Cotton requires significant irrigation, and crop-specific payments for cotton could hamper adaptation to water scarcity. In addition, Member States need to revoke certain environmentally harmful subsidies for water services or related activities as these are contrary to the 'polluter pays' or 'user pays' principles and distort the market further. Certain types of agricultural subsidies under the CAP fall into this category of environmentally harmful subsidy.

Finally, the proposals for new procedural requirements under Pillar 2 provide potential for improved targeting of spending. However, the proposal to exempt small farmers from cross-compliance, greening and control obligations, could lead to increased water problems in sensitive areas, and needs further evaluation.

There is clearly a need to further rethink the traditional intervention logic of the CAP and link more of the payments to tackling agricultural impacts on water in an integrated manner. Incentives should be geared towards improving the overall resource efficiency of the agricultural sector in terms of land use, water use, energy use, and chemical inputs (fertilisers and pesticides). So-called 'precision farming', where farmers vary their use of fertiliser on a field-by-field basis to account for variations in the land has great potential in this respect, as do organic practices that combine crop rotation and non-chemical crop protection. Apart from concrete measures on management practices, sustainable agriculture needs scrutiny of the food system through complementary measures to promote environmentally friendly consumption and to reduce waste along the food-chain (EEA, 2010o).

([5]) Based on an analysis by the EEA-ETC/ICM partner ECOLOGIC and the consulting group Fresh Thoughts.

([6]) Recitals: funding to 'climate change mitigation and adaptation and land management, through the agri-environment-climate, organic farming and payments to areas facing natural or other specific constraints measures'.

3.2.2 *Regional development*

Regional development is vitally important for the balanced social and economic development of our societies. But it can also have many adverse effects on our environment and on water. There is a close correlation between areas with high population densities and areas where water bodies are in less than good status. Urbanisation often leads to increased pollution emissions in water, and leaves hardly any natural functioning water ecosystems in urban areas. Roads and other infrastructure lead to surface sealing, which prevents rainfall from seeping into the ground and thus increases surface run-off that can overwhelm local drainage capacity.

But urban areas can also provide highly innovative and efficient solutions to these problems. Rainwater harvesting, waste water re-use and water-energy integration (see Section 3.4) are all relatively cost-efficient in urban areas. 'Green infrastructure' measures that restore natural water ecosystems can also improve the urban environment and help develop urban ecosystems (EEA, 2011c).

Hydropower and river navigation — two typical results of regional development — also put pressure on hydromorphology by dams, sluices and reservoirs. Moreover, water transfers and flood prevention measures often involve extensive civil engineering work that also has severe environmental impacts (EEA, 2012i).

Tools for regional development — regional and spatial planning

The Territorial Agenda 2020, a statement of objectives for EU regional policy, stresses the importance of environmental concerns in regional development (EC, 2011b). There are two major tools influencing regional development: regional/spatial planning and cohesion policy.

Regional and spatial planning provides the institutional-level instruments relevant for the implementation of water policies throughout all sectors. The Directives on Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) are two planning instruments that have increased the attention given to water considerations (and other environmental considerations) in the planning of major projects (EEA, 2012e).

However, the environmental effects of these tools need to be further refined and integrated. In a study on territorial cohesion and water management in

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Europe, the EEA analysed several draft River Basin Management Plans to assess the influence of spatial planning tools and water management, and found that the two systems are much less interlinked than they should be (EEA, 2012e). To facilitate the integration of spatial planning tools with water management, there needs to be closer cooperation on the institutional level between the responsible authorities, and a better use of existing integration mechanisms between the different sectors. To facilitate this cooperation, a harmonisation of the relevant units of analysis and management is needed. At present, regional planning primarily uses traditional administrative boundaries that do not correspond to the natural hydrological boundaries in River Basin Management Plans. This often leads to information that cannot easily be compared between spatial management tools and River Basin Management Plans.

In terms of how regional planning can deal with floods and droughts (including in the context of climate change adaptation), there should be more focus on risk assessment and flood and drought prevention. This means that in the case of water scarcity, regional and spatial planning needs to support water 'demand management', water savings, and greater water efficiency. Flood risk management also needs to draw on concepts like 'room for the river', where rivers are allowed space to periodically flood. More generally, it requires good dialogue between stakeholders, the enhancement of Natural Water Retention Measures, and the improvement of the natural functionality of wetlands and fluvial areas. This will help mitigate both flood and scarcity risks (EEA, 2012h).

Tools for regional planning — cohesion policy
Funds dedicated under EU cohesion policy play an important role in several infrastructure projects, which can have positive or negative effects on the water environment. One example of how cohesion policy funds can support the implementation of EU water legislation can be seen in the construction of wastewater treatment plants in the poorer regions of Europe. In the current spending cycle (2007–2013), cohesion policy funds have been allocated in significant amounts to projects of this sort, in particular in the 'new' EU-12 Member States (EEA, 2009). This can be an especially cost-effective way of improving water quality and save water (and is equally relevant in the old EU Member States) because the age and condition of a water treatment network plays a role in its effectiveness in reducing pollution or its efficiency in water use and distribution. Given that it is now time to renew a large part of Europe's water infrastructure, it is vital to use this opportunity for technical improvements and innovation (see also Section 3.2).

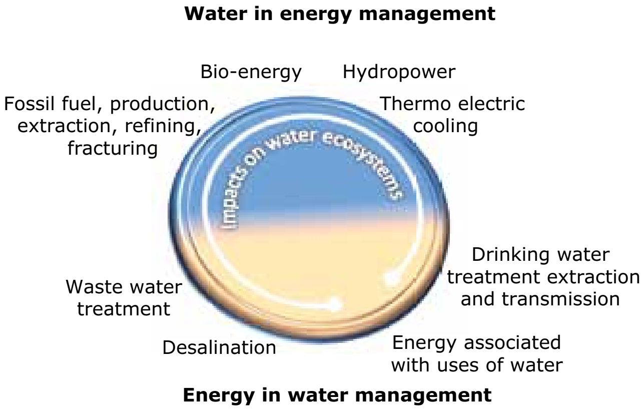
However, many infrastructure projects financed through cohesion policy can also have negative effects on water bodies and need to be assessed before they are approved. Cohesion policy in many cases promotes the development of rivers for inland navigation, which is one of the most important reasons for hydromorphological alterations of rivers and the destruction of natural habitats. However, inland navigation is generally seen as a freight mode that can reduce greenhouse gas (GHG) emissions in comparison to road transport. These inner environmental conflicts show the need to find a balance between infrastructure plans and environmental protection. The EEA (2012e) looked into several case studies dealing with these conflicts to show how cohesion policy and spatial planning tools can help find this balance. More generally, 'green infrastructure' measures such as buffer strips, Natural Water Retention Measures, or the removal of barriers in rivers should be fully included in cohesion policy funding schemes, and made a condition for the approval of programmes and projects. They can also be relevant in guiding possible compensation measures in the context of environmental liability.

3.3 Water management, energy management and efficiency

The previous section looked into the spatial dimension of water management and its relation to land use. This section looks at the relation between water management and energy management, and the principles of resource efficiency for both.

Our use of water and energy is based on the mutual interdependence between these two resources. Energy is used in the production and delivery of drinking water, and the treatment of waste water. Water is also used in the production of energy, such as for cooling water, hydro-electric power, growing crops for biofuels, shale gas fracturing, and other types of fossil fuel extraction. Water and energy use are combined in many industrial production processes. Resource efficiency in both water and energy management can therefore have impacts on the good status of water quality, water quantity and hydromorphology. And both these types of resource efficiency depend on our behaviour as consumers of water and energy, whether we are consuming these products directly or indirectly through products and services that themselves use up water or energy.

Figure 3.2 Two sides of a coin — water and energy management



Source: Modified after Olssen, 2012.

As a general observation, these impacts should be assessed in an integrated fashion that measures the use of water, energy and materials over their whole life cycle. Water stewardship and methodologies to assess resource efficiency and environmental impacts need to take full account of a sustainability assessment on the river-basin level and consider the full supply chain of a product (UN, 2012b).

To further develop and establish new efficiency technology, there is a need to boost innovation, for example via the Commission's innovation partnerships (EC, 2012d). As a highly industrialised and developed region, Europe should aim to lead global development in water efficiency.

Figure 3.2 shows the interrelation between the water and energy domains. The following two sections discuss some key aspects of this interdependence, covering the efficiency and energy aspects of water management (Section 3.3.1), and the water aspects of energy management (Section 3.3.2).

3.3.1 *Water management and its energy aspects*

The energy used in the provision of drinking water and the treatment of wastewater can be greatly reduced when water is used efficiently and pollution is avoided at source. Both the Urban Waste Water Directive and the Drinking Water Directive provide the basic measures to implement the objectives of the Water Framework Directive.

Drinking water and water supply

Energy is used in producing drinking water for processing, treatment and pumping through the distribution network. This type of energy use is site-specific, depending on the availability of clean freshwater (often from remote areas), the pollution status of the water used, and the altitudes and distances involved in the delivery of the water. Worse water quality and greater water scarcity in a river basin implies greater energy use for the treatment and transportation of freshwater over large distances. The consequences for potential energy savings and water pricing are obvious.

The efficiency of water supply can be increased by better water demand management (EC, 2007a; EC, 2010b; EEA, 2012a) that incentivises water savings and changes consumer behaviour, for example through the introduction of water metering and an efficient tariff system (see Section 3.3 for more on water economics). This should be complemented by the inclusion of more technical efficiency measures such as water saving devices (Bio Intelligence service, 2012b). Another important efficiency measure is the reduction of leakages in the network. In some parts of Europe, leakage rates from water pipes are less than 10 % and close to what is technically and economically feasible. However, conveyance efficiency is highly variable and elsewhere in Europe, water loss remains considerable (20 % and more, up to over 40 %). When this causes a scarcity risk further efforts are needed to work towards Sustainable Economic Level of Leakage — SELL.

Urban waste water management

The recent improvements in urban waste water treatment had a positive effect on the environment ([7]). Although in spite of these relative improvements, the overall treatment of urban waste water in many areas is still not good enough. Furthermore, urban waste water treatment is also an energy-intensive process. Reducing pollution at the source will help improve water quality further in order to reach water policy targets in an energy efficient way. Some treatments, such as greater use of anaerobic processes, can improve water status while using less energy. There are several examples of CO_2-neutral plants that employ sewage sludge digestion to produce biogas, which is used to power the treatment process or vehicles in the public transport system (EEA, 2012a). However, other methods for further improving the treatment of waste water, for example in so-called tertiary

([7]) See the assessment in Chapter 2 dealing with declines in P-compounds and ammonium.

Photo: © Peter Kristensen

treatment (which involves advanced nutrient removal and filtration, as well as the removal of some hazardous substances), can help to remove several chemical compounds (see below) more effectively, but could also require greater amounts of energy.

In the urban waste water sector, the recovery of phosphorous and nitrates from urban wastewater is another important efficiency measure, saving energy, but also materials. Worldwide phosphorous stocks, needed in particular for fertilisers, are limited and expected to become more costly in the future. A viable option for the removal of phosphorous and nitrates is struvite recovery, currently practiced at several locations in the United Kingdom and the Netherlands. An upstream reduction in the use of phosphates in detergents will also prevent downstream eutrophication, reducing the need for downstream treatment. Further reduction at source can be achieved by changing consumption patterns. Be it the application of fertilisers and pesticides by farmers, or the use of chemicals and pharmaceuticals in private households and public institutions.

The reduction of chemicals in industry effluent is also an important 'upstream' measure to improve energy efficiency. EU legislation such as the Industrial Emissions Directive should support this drive to reduce pollution at source. Pharmaceuticals are another important area where the impact on the water environment has to be further assessed (EEA, 2011; EEA, 2012g). The area of plant protection and biocides needs the full implementation of the Directive on the Sustainable Use of Pesticides (see Section 3.2.2 for its relation to the CAP).

Urban waste water treatment is closely connected to urban water management more generally. Measures such as green infrastructure, mentioned in Section 3.2, and innovative solutions like decentralised water treatment can play a role as efficiency measures. Most European cities face an ageing water and waste water network, which requires additional investments. But this need for new investment also opens up possibilities to apply more integrated approaches, interlink green infrastructure with 'grey infrastructure' (conventional water treatment though pipes), and make the storm water management system better able to cope with climate change.

Desalination

In many countries with high agricultural water demand and high water demand from tourism (for example in the Mediterranean), desalination can appear to local authorities as the ideal solution to their water scarcity constraints. But there are important costs involved in desalination, which should be reflected in decision-making. In addition to environmental impacts from discharges of brine, desalination is very energy intensive, undermining regional efforts to meet EU energy reduction targets.

The thermodynamic minimum energy needed to separate water and salt means that desalination will always be an energy-intensive technology. Therefore the best solution is to reduce overall water use and increase water efficiency in regions with water scarcity problems. Developing renewable energies to power desalination plants offers the chance to both reduce greenhouse gas emissions and provide more freshwater (EEA, 2012a).

3.3.2 *The water aspects of energy management*

As we saw in the previous section, the provision of water uses up energy. But the provision of energy also uses up water, affecting its quality, quantity and hydromorphology. This reliance on water could well increase with the development of renewable energy sources, as a number of alternative and renewable energies also rely on water. This raises the prospect of a potential conflict between sustainable energy and sustainable water use. For this reason, the development of the three water-relevant types of renewable energies (hydropower, bio-energy cultivation, and off-shore wind energy) needs coordination between the relevant EU legislation, the River Basin Management Plans, and national renewable energy action plans under the Renewables Directive (EU, 2009a). Energy–related projects also need thorough environmental assessment through the SEA and EIA (see Section 3.2.2).

Hydropower

Hydropower capacity in the EU is currently considerable, although in comparison to wind and solar energy, the potential for further increases in hydropower capacity in the EU is rather limited (EEA, 2012a). Nevertheless, hydropower will remain an important element in compensating for the intermittent character of renewable wind and solar energy in future decentralised energy networks. So-called 'pumped hydro systems' are today the most widely applied energy storage technology ([8]).

Hydropower is one of the main reasons why the hydromorphological status of water bodies in many Member States is a major threat to their achieving the Water Framework Directive goal of good ecological status. The main measures for reducing the ecosystem impacts from hydropower focus on improving access for fish by enabling migratory species to pass through hydropower installations by means of fish passes, ladders or lifts. The impact of hydropower stations can also be mitigated by restoring and maintaining ecological habitats in the river areas that surround these installations, for example by restoring connected wetlands and oxbow areas. So-called 'pumped' hydropower has less impact on surrounding water bodies when it operates a closed system. Closed systems re-use the same body of water each time the water is pumped to an upper reservoir rather than taking 'new' water from a river each time. Strategic planning and environmental impact assessments of new and refurbished hydropower installations should encourage these measures. The environmental impacts should be assessed against the energy produced or stored. In general, the hydropower schemes with the least impact per TWh (terawatt hour) at the level of the river basin plan should be chosen.

Other renewable energy areas

The current growth of bio-energy (energy sourced from plant crops) is a source of concern. Biomass crops often demand large amounts of water and have considerable pollution potential. Sustainability criteria that reflect these pressures on the water environment should be included in all EU-level policies concerning bio-energy, and should also be included in agricultural management practices on a regional level (for agricultural pressures see also Section 3.2.1).

The development of offshore wind energy also effects water in coastal areas. The environmental impacts of offshore wind farms need careful evaluation. The good status of coastal water bodies under the Water Framework Directive and the good environmental status under the Marine Strategy Framework Directive need to be taken into account to avoid further unreasonable pressures on coastal waters (EEA, 2013b).

Water related impacts from fossil fuel exploitation

It is well known that the consumption of fossil fuels emits greenhouse gases, but it is less well

([8]) Pumped hydropower involves using off-peak electricity production to the grid to pump water to a reservoir above a turbine. When electricity is required, the reservoir is opened to allow the water to flow downwards and drive the turbines.

Photo: © BMLFUW/Rita Newman

known that the production of fossil fuels also use up considerable amounts of water. The growth in production of oil and gas from non-conventional methods involving steam injection, hydraulic fracturing, and horizontal drilling means that water consumption per megajoule of fuel is set to increase further (Olsson, 2012; World Energy Council, 2010).

There has recently been an increased focus on the exploitation of shale gas in Europe. The Commission has initiated and published a series of studies that outline some of the legislative, technical, environmental, commercial and human health issues related to shale gas (COM, 2012a, c). The results of a study on the environmental impacts of shale gas extraction show that the process generally imposes a larger environmental footprint than conventional gas production (COM, 2012a, b). In many instances, there is a high risk of surface and groundwater contamination, water resource depletion, air and noise emissions, land use, disturbance to biodiversity, and impacts related to traffic. A considerable number of questions relating to legislation and regulation have been identified, implying the need for an appropriate framework to ensure the environmentally acceptable extraction of shale gas in Europe. As with other infrastructure measures, it is essential to conduct environmental impact assessments before beginning any shale gas project.

3.4 Water economics

3.4.1 Water pricing — a complement to water legislation

Water economics seeks to put a value on water and its associated ecosystem services. This can serve multiple purposes: not only can it pay for the cost of water infrastructure it can also help implement the 'polluter-pays' principle; it can support an efficient allocation between competing human water uses; it can incentivise behavioural change among water users in order to ensure good water quality and status; and it can support decision making in the implementation of the Water Framework Directive.

The total value of water includes not only water's market value (the financial costs of providing and treating the water), it also includes 'externalities' — non-monetary costs and benefits that are far more difficult to determine. An example of a non-monetary benefit from water is the range of ecosystem services like regulatory functions provided by water bodies, that help flood prevention, pollution absorption and so on. How these ecosystem services should be valued and paid for is the subject of much debate (TEEB, 2010; Braat et al., 2012).

In the absence of full internalisation of the externalities in the water sector, economic instruments such as taxes, tradeable permits and liability schemes offer a way to reduce pollution and avoid the overconsumption of water resources. Revenues generated in this way can also be used to fund measures that help restore the state of the environment.

There are different forms of economic instruments that can be used to place a price on water use, and not all instruments work under all conditions. In many cases, the best results can be obtained by a mix of economic instruments and policy legislation. Pricing water use also requires strong governance structures for monitoring, reporting, verification, and enforcement. These structures can be state-run, but they can also be structures of self-governance at national, river basin, regional or local levels. Regardless of what level these structures exist on, it is imperative that they involve local stakeholders.

Acceptance of these instruments and policy structures by water users requires transparency regarding water pricing, and transparency regarding the way in which investments are made in water infrastructure. At present this transparency is lacking. Current reporting of water costs is insufficiently specific and only allows for rough estimates of the total costs for implementing the water-relevant policies.

Economic policy instruments in water management are not meant as a replacement to existing water policy in the form of EU regulations (Lago et al., 2012). Regulatory measures are essential tools to ensure compliance with environmental standards of water quality and quantity, like good status. Instead, these economic policy instruments should be seen as refinements and aids to these regulations. For example, economic instruments can be used to finance investment, restore areas that have experienced environmental degradation, encourage and incentivise best practice, or decide between competing demands for water. Before continuing the discussion on economic instruments in water policy, it is necessary to highlight a problem with legislation as it currently stands. Article 9 of the Water Framework Directive calls for the adequate recovery of the costs associated with water services. In practice, this means the application of the 'polluter pays' principle to all uses of water. It also means placing a price on water abstraction, water impoundment, water storage, water treatment, and the distribution of surface water or groundwater. And 'adequate recovery' means recovering not only the visible financial costs, but also the environmental and resource costs. But an assessment of the River Basin Management Plans suggests that at present, this is not fully implemented. Adequate cost recovery can in theory be achieved with a mix of economic instruments, but there is still insufficient clarity on the calculation of the environmental and resource costs. This has led to different interpretations of the requirements across the EU. The Water Framework Directive can only be successfully implemented if Member States aspire to the same standards.

3.4.2 Economic instruments as incentives

Any economic instrument incentivises changes in behaviour. While many economic instruments can be designed as a penalty for non-desired behaviour, it is also possible to use them via e.g. subsidies to encourage environmentally beneficial behaviour such as changes in agricultural practices. Payments for ecosystem services' (PES) offer the potential to align farmers' interests with environmental goals (Wallis et al., 2012). They ensure the economic survival of farmers while encouraging environmentally friendly farming practices. However, payments for ecosystem services require a clear specification of the services that reflect the full functionality of a healthy ecosystem. In this sense they form on the one hand an evaluation to find the price for restoration and maintenance. On the other hand in the cost effectiveness analysis the benefits of the restoration and maintenance of specific functionalities and status needs to be specified (not necessarily in monetary values) to provide the arguments in cases where the price of certain measures in a short term is deemed to be disproportionate.

In order to deliver the expected results, the economic instrument needs to be incentive-compatible, i.e. address the actual driver of the environmental issue. The water user needs to be able to adjust his behaviour and thus reduce the payment he makes. If the determinant for the level of his payments is not transparent or not at all under his control, then the instrument won't encourage environmentally favourable practices but will be perceived solely as an additional levy.

This implies that tariff structures need to reflect actual scarcity, and waste water charges need to differ according to the degree of contamination of the discharge. It also implies that both abstraction and discharge costs need to be based on the volume of water involved. Metering is therefore an essential element to support any effective economic instrument and needs to be included in the monitoring and reporting strategy.

3.4.3 *Economic instruments as tools for water allocation among stakeholders*

Economic instruments can allocate water efficiently and can thus offer a solution to disputes over competing water uses. However, an economically efficient allocation does not necessarily deliver solutions that are socially or politically acceptable. It is therefore crucial to introduce economic instruments as part of a dialogue with affected stakeholders (Arcadis, 2012).

One economic instrument that can help mediate the social and political context of water use is the tradeable water right. Introducing tradeable water rights within and beyond the agricultural sector offers the potential to cap water use at environmentally safe thresholds as for example established via 'ecological flows'. The initial allocation can best be achieved via an auction process, in order to avoid distortions to the efficiency of the trading scheme and ensuing windfall profits. Water trading requires clearly defined, enforceable and transferable property rights. To not prevent any over allocation water availability and needs must be known on the appropriate scale. Water balances and accounting methodologies enable transparency between water authorities and water users. Only under these conditions can a functioning market for water rights emerge and flourish.

The functioning of the water market requires a relatively large number of participants in order to reduce individual influences on the price signal. However, this must also be achieved while keeping water markets local. In terms of their geographical spread, a water market should be restricted to a single river basin as this is the best administrative level for a market to operate within environmentally-sound (i.e. hydrologically sound) boundaries. The monitoring of this market should be carried out on a monthly basis to ensure the necessary transparency and flexibility.

Tradeable water rights do not necessarily apply to abstraction and use only. They can also be

Photo: © Peter Kristensen

considered as a means to create a cost-efficient market for pollution rights. However, this can create a risk of environmental 'hotspots' where pollution loads are particularly severe. Effective governance structures are therefore a prerequisite for any such market.

3.4.4 Other applications of water economics

The valuation of water and associated ecosystem services plays a key role in assessing the costs and benefits of water restoration measures, such as returning rivers and wetlands to a more natural hydrological or chemical status. While the valuation of the market-based components of water services is reasonably straightforward, further guidance is needed on the monetary and non-monetary valuation of non-market costs and benefits. The System of ecosystem capital accounts as developed at EEA can play an important role in this valuation. Environmental accounts are further discussed in Section 4.3.1. A more harmonised approach to water valuation will encourage a more coherent interpretation of the requirements of the Water Framework Directive, especially with regards to the cost-recovery of water services, but also with regards to the cost effectiveness of other water-related policy measures.

However, water economics is not only related to water policies. It is also closely related to the economics of energy and agriculture. Fair pricing and subvention systems can only be realised when water, food and energy prices are treated as a whole.

4 Sustainable water management — towards 2050

This chapter discusses the societal and policy challenges that must be addressed if Europe is to create a sustainable system for water management. It begins (Section 4.1) with a summary of the basic elements of the Europe 2020 strategy, which comprises several pieces of European legislation and Commission strategies, all of which will inform future water management. In Section 4.2, it discusses the issue of water governance in general. In Section 4.3, it considers the knowledge-base and water data required to implement the policies and governance aspects discussed in Sections 4.1 and 4.2. A summary of the key messages from this chapter is contained in the box below.

4.1 A new generation of policies

The Water Framework Directive (EC, 2000) and the Marine Strategy Framework Directive (EC, 2008c) have already taken the first steps towards an ecosystem-based approach to water policy. But future water management under the Europe 2020 strategy for economic growth (EC, 2010a) will have to go further. Future water management will have to develop the ecosystem-based approach in conjunction with the principle of resource efficiency to realise a green economy in Europe. In terms of water policy, the two most important documents that move in this direction are the EU Biodiversity Strategy 2020 and the EU Resource Efficiency Roadmap (EC, 2011d, e). The Blueprint will constitute the water 'milestone' of the Resource Efficiency Roadmap. It is expected to integrate elements of previous water policies, and further develop them in the light of the principle of resource efficiency and the ecosystem approach to ensure efficient water resource management and a better implementation of the Water Framework Directive. If implemented in an integrated fashion

- The Blueprint is expected to help better integrate water objectives into other EU policies, and to achieve good status for water ecosystems and water-related biodiversity while also encouraging water efficiency.
- In order to successfully establish sustainable water management, there needs to be 'vertical integration' between water management at different levels of administration such as local, regional, national and European.
- 'Horizontal integration' of water stakeholders and water-using sectors is also essential. This means integrating water management into sectors such as agriculture and industry at EU, national, and regional level.
- Successful water management should be informed by accurate, up-to-date information on the state of water in a particular place and time. The Water Information System for Europe is designed to function as a European data exchange platform and provide the main entry point for water information in Europe.
- For water resources, this information could be presented in the form of water accounts, analogous to financial accounts, and integrated with other environmental data, such as biodiversity and land use.
- The EEA is working to further improve WISE to build a comprehensive environmental information system that can seamlessly interact with existing national systems, and better integrate horizontally data on water with data on land use and biodiversity.

Photo: © Peter Kristensen

the Blueprint can lead to considerable further improvements in water ecosystems. The Blueprint also considers the extent to which ecosystems are vulnerable to climate change and how to improve the resilience of ecosystems in the face of climate change.

Chapter 2 of this report discussed the importance of achieving good status for water ecosystems and maintaining their natural capital, while Chapter 3 considered the role of efficient water management in reducing pressures and achieving this status. The following sections outline the role of sustainable water management in the context of the EU Biodiversity Strategy 2020 and the EU's Resource Efficiency Roadmap.

4.1.1 *Improving ecosystems and biodiversity*

Target 2 under the EU Biodiversity Strategy aims *to ensure maintenance of ecosystems and their services by establishing green infrastructure and restoring at least 15 % of degraded ecosystems* by 2015. This means that degraded water ecosystems must also be restored by 2015. However, the specific details of this target have yet to be decided, and this means that there are a number of unanswered questions such as which ecosystem functionalities are most relevant when measuring restoration status, and to what status need ecosystems be restored to ensure the maintenance of the services needed.

For water-related ecosystems, the Water Framework Directive gives answers to both of these questions. The Water Framework Directive objective of 'good status' defines the status to which degraded water ecosystems should be restored ([9]). It further needs to emphasise the role of 'ecological flows' (the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon) as an important guarantor of ecosystem functionalities.

The most important tool for implementing Target 2 is the establishment of green infrastructure, such as the restoration of riparian areas, wetlands and floodplains, which is supposed to deliver regulatory and supportive ecosystem functions for water such as: connectivity, continuity, retention, and purification. For water ecosystems, the establishment of Natural Water Retention Measures (NWRMs) is one of the most important elements of green infrastructure that can help establish 'good status'. NWRMs therefore need to be included in measures that deal with green infrastructure

([9]) In the case of hydromorphologically altered water bodies that cannot attain 'good status', the Water Framework Directive uses the standard of 'good ecological potential' instead.

planning. NWRMs should also have a prominent place in the implementation of both the future CAP and the EU's cohesion policy.

The EEA together with the JRC (Maes et al., 2012) is currently working on a project to assess ecosystems and ecosystem services under the Biodiversity Strategy 2020, in which the results of the status assessments from Chapter 2 of this synthesis report will provide the freshwater component. This could help a common assessment of water and biodiversity status in 2018, when the achievements of the first round of River Basin Management Plans (and the first real achievements of the Water Framework Directive) will be reviewed.

4.1.2 Encouraging water efficiency

After the EU Biodiversity Strategy, the other big environmental policy ambition in Europe is set by the EU Resource Efficiency Roadmap, which aims at the efficient use of natural resources for the sake of sustainable growth. As pointed out in Chapter 3, water efficiency is closely linked to the way other natural resources — especially land, energy and materials — are used. In order to be environmentally effective, efficiency measures need to avoid any 'rebound effect', where the increased efficiency of resource use actually encourages greater overall use of that resource because the efficiency gain makes that resource relatively cheaper to use. Efficiency measures should therefore be steered towards an absolute decoupling. Efficiency measures need to ensure the maintanace of the natural capital. With their objectives for good status, the Water Framework Directive and the Blueprint provide the key elements to guide water efficiency measures in this direction in other policy areas, such as agriculture, renewable energy, regional development, or green transport.

4.2 Water governance

To ensure effective implementation of water-related policies, integration between the different levels of administration (local, river basin district, national and EU) is indispensable. This 'vertical' integration between different levels of administration must be complemented by a 'horizontal' integration across water-using sectors such as between relevant stakeholders in areas like agriculture, energy, and transport. Healthy water ecosystems can only be secured through a combined effort at horizontal and vertical integration of water governance.

4.2.1 Water governance — the vertical dimension

Vertical integration within and beyond the EU

One of the most important ways to 'vertically' integrate different levels of water governance is through integrating European Union policy with the policies of its Member States. The responsibility of Member States for sustainable water management is crucial. When it comes to water policy, the European Union can provide only general principles, guidance on implementation, and some funding. The concrete policy measures to implement this guidance and these principles can only be made by national and regional governments with knowledge of local conditions. Chapter 2 showed the importance of diffuse pollution and hydromorphology as impacts on the status of water in Europe. Measures designed to combat the impact of those pressures can be taken and arranged at different levels, whether national, regional or local. However, the concrete action that most influences the quality of a single water body is always a consequence of a concrete action taken at or close to this water body, such as an application of fertiliser or a hydromorphological alteration. The measures taken on river basin or national level, and reported in the River Basin Management Plans, should reflect the importance of these local conditions, while remaining mindful of the repercussions that water policy can have on other policy areas.

European-level water policy can also be 'vertically' integrated with the national water policies of countries outside the EU. This can be seen in the 'neighbourhood' countries of the EU, where water scarcity is a widespread problem. The southern and eastern countries covered by the European Neighbourhood Policy, as well as central Asia and the west Balkan countries, have severe water scarcity problems. They also have problems with their water supply and sanitation systems. An estimated 120 million people in the pan-European region do not have access to safe drinking water or adequate sanitation, and water management is made more difficult by the absence of reliable data on water use (EEA, 2011b). The EU-27 Member States have long experience in water provision and sanitation, particularly through their implementation of the UWWTD. They can therefore provide considerable support to neighbourhood countries via cooperation projects to advance the basic measures of effective waste water treatment.

In the west Balkan countries, the possibility of future EU membership acts as an incentive to promote the harmonisation of national water legislation with guidance from the Water Framework Directive.

A similar incentive effect can be seen in the five non-EU countries that are members of the European Environment Agency ([10]). For example, Turkey — also a highly arid and water scarce country — has developed a number of policies for water management that are aligned with provisions in the Water Framework Directive (General Directorate of State Hydraulic Works, Turkey, 2009). It has also completed action plans for river basin protection for 13 of its 26 main river basins.

Encouraging 'vertical awareness'

Integrating local water management with broader global trends is not only the preserve of public policy. Consumer attitudes can also form part of a 'vertical awareness', whereby consumers reflect on the global effects of their local decisions. For example, there is a growing awareness of the 'water intensity' of certain industrial and agricultural products. These are products that require large amounts of water to produce, and are also known as products with high levels of 'embedded water'. Often these products are consumed in developed countries, and this consumption of water-intense products contrasts with situations of water scarcity, which often hits regions in developing countries.

One of the ways to think about these products that contain large amounts of embedded water is the concept of a 'water footprint' (Hoekstra et al., 2011). The water footprint concept uses an easy-to-understand measurement of litres of water per product. This can indeed be a useful concept for raising awareness of water scarcity among the general public. However, it risks overlooking the fact that water use is an inherently local issue. Many river basins can safely support the production of products with a large water footprint without threatening water quality or quantity, while for other river basins the production of products with even a small water footprint can cause water scarcity.

Raising awareness of the global effects of local choices must therefore be done with sensitivity to the importance of local context. Although the local context of water use is the main determinant of whether water use is sustainable or not, it is true that a general shift in the diet of European consumers to lower meat consumption would relieve strain on water-stressed river basins, and decrease pollution intensity within Europe. Besides the awareness raising, more direct support to sustainable water management and good water stewardship is needed, both inside and outside the EU.

4.2.2 Water governance — the horizontal dimension

The diversity of pressures and impacts on water from other sectors was outlined in Chapter 3. It suggests that water policy can only be effective if it is implemented in a close 'horizontal' dialogue with the stakeholders who have an interest in the use of clean water and healthy water ecosystems. The most important such stakeholder is the agriculture sector. This means that there needs to be a water-focused dialogue on an EU-level in the CAP. It also means that on a national and regional level, the agriculture sector should be intensely involved in stakeholder dialogue during the development of the River Basin Management Plans and other policy activities. There is a similar need for dialogue with the energy and transport sectors.

In all of these dialogues with the agriculture, energy, and transport sectors, regional development policy will play a critical role. Agriculture, energy and transport all relate to the local features of landscapes and their climatic, biological and cultural diversity across Europe. Therefore there cannot be any one-size-fits-all approach. The right measures and solutions can only be found in a dialogue between the relevant stakeholders on local level. First and foremost, European measures and programmes need to focus on fostering and enabling this dialogue.

In some cases, the formal implementation power of environmental policies is rather weak when set against political and economic powers. This interplay of forces often leads to solutions governed by short-term economic arguments and cost-efficiency calculations that fail to account for the long-term effects of ecosystem degradation. The improvement of environmental accounting methodologies and of methodologies for the valuation of ecosystem services can improve this situation, helping to give greater weight to environmental considerations (EEA, 2011d).

Another dimension of horizontal governance is transnational cooperation in larger transboundary river basins across national borders. In this type of transnational cooperation, important aspects of water allocation or the downstream impacts of water quality and pollution control play a key role. The Water Framework Directive fostered this cooperation in many cases by requiring the establishment of Transboundary River Basin Management Plans. These plans were often developed with the help of previously existing

([10]) Norway, Iceland, Liechtenstein, Switzerland, Turkey.

Photo: © Peter Kristensen

International River Conventions, such as were in place for the Danube and the Rhine.

The Water Framework Directive explicitly requires public participation as part of the implementation process. This requirement provides a powerful tool to engage in dialogue with stakeholders across all policy areas (Box 3.1). Unfortunately, in the first round of River Basin Management Plans, this public participation tool was only made use of in some river basins. Often the public participation process was delayed or restricted to the minimum requirement of simply making the draft River Basin Management Plan publicly available. But the possibility of including other stakeholders in the whole process of planning was only rarely taken advantage of (COM, 2012d).

However, the first round of River Basin Planning was also a learning process in which many new possible coordination structures were newly discovered and established. This new knowledge can be used to lead the way into the second round of River Basin Management Plans, which urgently need to see early and intense integration of sustainable water management and the good status objectives into the implementation of agricultural, energy, and transport management (COM, 2012d).

Some of the important 'horizontal' partners in the public participation process can be the stakeholders that arise from nature legislation in the form of the Habitats and Birds Directives. These directives are responsible for the designation of protected areas and the assessment of the conservation status of species and habitats. Using the stakeholder dialogue to engage citizens and non-governmental nature protection organisations in voluntary actions on restoration and monitoring can provide strong support for sustainable water management. In this respect, the interaction between the Water Framework Directive, nature legislation and biodiversity policy is a process that is ripe with opportunity for the public participation of stakeholders.

4.3 The knowledge base for sustainable water management

Involving different stakeholders and levels of government in implementing water policy is vitally important. But this process of horizontal and vertical

Box 4.1 Stakeholder involvement in the selection of measures: the role of Advisory Groups in Scotland to influence river basin management planning

The Water Framework Directive was transposed into Scottish legislation via the Water Environment and Water Services (Scotland) Act 2003 (WEWS). WEWS requires the creation of river basin district advisory groups as a structure for delivering active involvement in the river basin planning process. A network comprising a National Advisory Group (NAG) and eight Area Advisory Groups (AAGs) with forums was established in 2006.

The overall role of the national advisory group is to oversee the river basin management planning process, to contribute to the preparation of the River Basin Management Plan for the Scotland River Basin District, and to co-ordinate the work of the AAGs.

The main role of the AAGs is to assist and contribute to river basin management planning in the district. They are responsible for producing Area Management Plans; the 'geographic chapters' of the river basin management plan for the district. Amongst other things, the groups advise on and support: the development of river basin management planning in the area; the identification of priorities for environmental improvement and protection; and the measures required to deliver environmental improvement and protection within the area.

Recent research funded by the Scottish Government's Programme on Environment — Land Use and Rural Stewardship (Blackstock et al, 2011) has tracked the process of how government and their agencies worked in partnership with the NAG and the AAGs to develop and implement water policy in Scotland. The study concludes that the level of satisfaction among the different stakeholders involved in the groups was mainly positive. Overall, the study found that members prioritised criteria for success relating to implementation, adaptation and networking. Thus, the process confirmed the expectation that stakeholders engaged for instrumental reasons (to achieve buy-in and deliver environmental improvements) rather than to invigorate deliberative democracy (to challenge existing ideas and empower citizens). The feedback on the final adoption of the plan showed that members were broadly supportive of the final plan, with a large majority seeing their input reflected in either the national plan (where 74 % say they saw their input reflected) or the area plan (where 95 % say they saw their input reflected)(Blackstone et al., 2012). But Blackstone et al. (2012) also note that members were cautious in their assessment as to whether the plans can be implemented, particularly in terms of making funding available for voluntary measures and in aligning the plans' objectives with existing organisational commitments. And whilst the views of wider stakeholders were included in the plans through the public consultation process, only half of the advisory group members felt that the final plans would be accepted by these other stakeholders. These concerns are being considered by SEPA and the Scottish Government through a series of working groups and on-the-ground catchment initiatives.

Source: Blackstock et al., 2011; Blackstock et al., 2012.
http://www.sepa.org.uk/water/idoc.ashx?docid=1f971453-3ffb-4c44-8ba9-3a713842bf64&version=-1.

integration will only be of use if the actors involved have access to accurate information on which to base their decisions. That is why the knowledge base for water policy is so critical. At present the knowledge base for water policy is organised mostly around a series of so-called 'indicators', which monitor individual environmental phenomena. For example, nutrient concentrations in different surface waters might be one indicator, while percentage of river basins affected by hydromorphological pressures might be another. European-level indicators — as developed and used by EEA or Eurostat — inform the wider, European-level picture. These can be used to help guide the development of regional-level indicators on a river-basin level.

The following sections provide more information on the knowledge base for water. They discuss methodological aspects like environmental and water accounts, the EEA's WISE water database, and some thoughts on how best to develop the knowledge base to manage policy implementation in the future.

4.3.1 Knowledge for water resource management — water accounts

The concept of accounting is familiar in business and financial management. But it is also relevant to environmental resource management at large and the management of water in particular. Creating a system of environmental accounts for water can help to inform river basin managers how much water is present in a river basin, and how much of this water is available for abstraction by industry, agriculture or residential homes. Water accounts of this nature allow allocations for the different demands by human use, respecting the boundaries of sustainability, and without jeopardising the good status of the ecosystems in the river basin.

This knowledge of the local hydrological situation is in turn the basis for sound water economics, setting the right price for a more or less scarce resource. Comprehensive water accounts also help inform communication with all water users and assist in the effective implementation of all elements of water policy.

The EEA has developed such a system of water accounts. These water accounts constitute the water component of the much larger System of Environmental-Economic Accounts (SEEA), as proposed by the UN statistics division to integrate environmental and economic evaluations (UNSD, 2007). The concept of environmental accounting refers to the modification of the System of National Accounts (SNA) to incorporate the depletion of natural assets into the framework of national accounts ([11]). In the context of the original SEEA, Eurostat is currently developing methodologies for water accounts as part of National Accounting Matrix with Environmental Accounts (NAMEA).

However, the original UN proposal (Volume 1 of the SEEA) struggled to articulate environmental objectives and targets against which balances of water or carbon could be assessed. Therefore a second volume of SEEA is currently being developed with help from EEA experts. This second volume will develop a system of natural capital accounts that includes these objectives and targets for the maintenance and restoration of our ecosystems. The Water Framework Directive objective of 'good status' — both for water quality and water quantity — should be the central parameter for water in this second SEEA volume (EEA, 2011d). Within this framework the water accounts are understood as a balance calculation of water resources within a specific area (e.g. catchment, administrative river basin). Given the flexibility of the system (spatially and temporarily disaggregated) it can be used in a number of applications (see Section 2.4.2 and EEA, 2013c).

Like water accounts, the Water Exploitation Index (WEI) uses the same basic approach of a balance between water availability and water use. However, it is more static, and in its original format as a Eurostat indicator, WEI does not differentiate for regional or seasonal differences (recorded monthly) in a water catchment. Both approaches have been discussed in the framework of the common implementation strategy of the Water Framework Directive. The water accounts developed at EEA can provide a better approach for reflecting the timely variability in water flows than is provided by the WEI (EEA, 2012n; EEA, 2013b) ([12]). More work also needs to be done to develop the information base and the methodology to create accounts that can be useful for both regional applications as well as for overviews on the EU-level. This work can only be completed in the context of further implementation of the Water Framework Directive and in the follow-up on the Blueprint through the cooperation of both the EU and Member State experts.

4.3.2 Knowledge for improved water ecosystems — WISE

The reporting under the Water Framework Directive provided a large knowledge base on the status of Europe's water ecosystems and the pressures that act on them. This information has been compiled and gathered in the Water Information System for Europe (EEA, 2012p). WISE was created in 2003 as an initiative of the EEA and the Commission services DG Environment, the Joint Research Centre and Eurostat. WISE serves as both a streamlined reporting tool for Member States to report their national data, and as an integrated online portal to access water information at EU level.

A core element of WISE is the Water Data Centre, which the EEA manages. The Water Data Centre

([11]) The SNA is the set of accounts which national governments compile routinely to track the activity of their economies. SNA data are used to calculate major economic indicators including gross domestic product (GDP), gross national product (GNP).

([12]) Referring here to the development of WEI+ as discussed in the WFD Water Scarcity and Drought Expert Network and improved beyond the original WEI.

contains information on water indicators such as nitrate or phosphorous concentrations in rivers, lakes, groundwater and coastal waters. WISE also contains all information gathered under the Urban Wastewater, Bathing Water, Drinking Water and Nitrates Directives.

In the period from 2003 to 2011, much of the data collected and assembled by WISE focused on water quality. Future development of the system needs to take into account recent developments of the knowledge base such as improved information on water quantity and the risk of possible water scarcity as captured by water accounts. Moreover, further work is needed to enable common assessments of information coming from three sources: the information on good ecological status now reported under the Water Framework Directive, the information reported under the Nature Directives, and new information that may emerge from future development of the EU's biodiversity strategy. Information from the Nature Directives is currently also stored at the EEA in the Biodiversity Information System (BISE). Further improved assessments will therefore include the interoperability of WISE with BISE and with the EEA land-use data centre, which holds the Corine Land Cover information.

Recent developments in geographical datasets and system architecture allow for better common assessments to be made between WISE, BISE and Corine Land Cover information, integrating information from the different environmental reporting streams. This will lead to an ecosystem assessment that fully integrates the perspectives of land, water and biodiversity.

4.3.3 Knowledge for effective implementation

Major developments in the organisation of the data held at the EEA will facilitate more flexible reporting mechanisms, better integration between the different strands of information, and better data sharing between Member State and EU level.

Reporting under environmental legislation is supposed not only to enable compliance checks, but also to help policy evaluation and therefore allow for further policy improvement. This process of policy assessment and refinement is greatly helped by a common, EU-level knowledge base like WISE. It is also helped by environmental assessments provided by the EEA. Water policy in the form of the second round of River Basin Management Plans will also be informed by the actions taken in the framework of the national climate change adaptation strategies, accessible via the European climate adaptation platform (Climate-Adapt).

Effective policy requires sharing of the information held by Member States to keep track of national implementation measures, as well as to help Member States' evaluation of their own effectiveness. The Commission issued a *Communication on better implementation* (EC, 2012e) to help improve implementation of environmental policy at Member State level. The Communication focuses on better information exchange between the EU and Member States by means of so-called Structured Information and Implementation Frameworks (SIIF), established for each policy area. For the water-related reporting mechanisms under the Urban Waste Water Treatment Directive, the Nitrates Directive and the Bathing Water Directive, this could entail the fostering of common assessments of the results of these directives using WISE in a more integrated and interoperable infrastructure.

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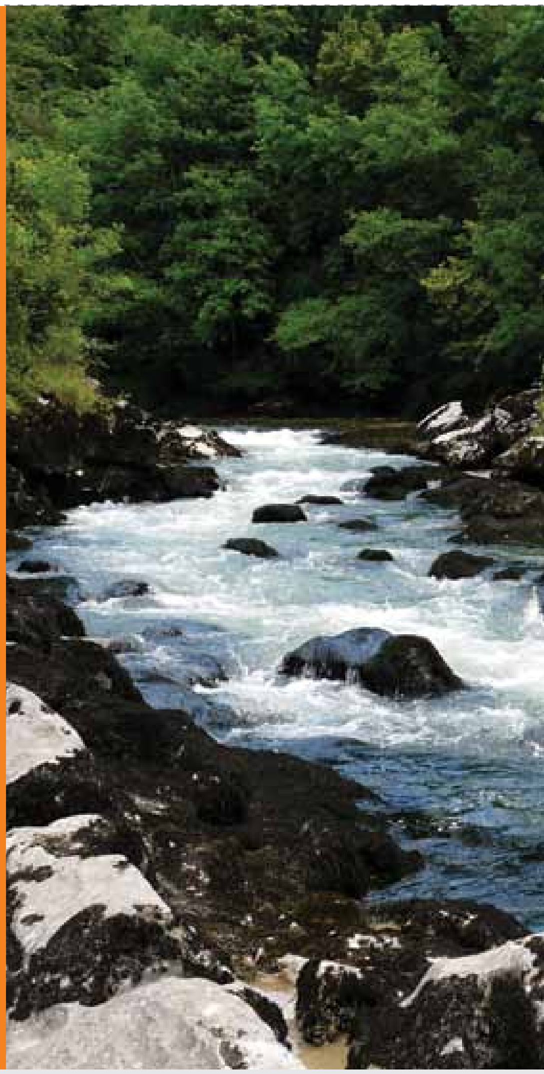

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