

European water policies and human health

Combining reported environmental information

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Contents

Acknowledgements	5
Acronyms and abbreviations	6
Executive summary	7
1 Overview of EU water-related legislation to protect human health and the aquatic environment	8
1.1 Introduction	8
1.1.2 Water management and the water cycle.....	8
1.1.3 Public interest	9
1.2 Scope and management tools of the directives.....	9
1.2.2 Bathing Water Directive	10
1.2.3 Drinking Water Directive.....	11
1.2.4 Water Framework Directive.....	11
1.3 Management measures	11
1.4 Relationships between the water industry directives and the WFD	13
2 Protecting waters from nutrient and organic pollution.....	15
2.1 Introduction	15
2.2 Pressures and status of nutrient pollution	15
2.3 Impacts of nutrient pollution and eutrophication	17
2.3.1 Eutrophication in bathing waters	17
2.3.2 Nitrate and nitrite in drinking water.....	17
2.4 Policies and measures to reduce nutrient pollution.....	18
2.5 Biochemical oxygen demand: a key indicator of water quality.....	19
2.5.1 Background	19
2.5.2 Reduction of BOD in rivers due to urban waste water treatment.....	20
2.6 Storm water overflow from combined sewers.....	20
2.7 Emerging risks	22
3 Protecting drinking water and bathing water from microbiological pollution.....	23
3.1 Introduction	23
3.2 Causes of microbiological pollution.....	23
3.3 Monitoring of microbiological pollution: role of the directives	24
3.4 Microbiological pollution of bathing waters	26

4 Information to the public	28
4.1 Introduction	28
4.2 Reporting obligations.....	28
4.3 Information dissemination.....	28
5 Conclusions	30
5.1 Integrated water management	30
5.2 Water quality and impacts on the environment and human health	30
5.3 Information and public interest	31
5.4 Future challenges	31
References	32
Annex: Results reported under the three water industry directives	35
A1 Bathing Water Directive	36
A1.1 Introduction	36
A1.2 Bathing water quality.....	36
A1.3 Non-compliant and poor bathing water sites.....	38
A1.4 Country comparison	39
A1.5 Short-term pollution and abnormal situations.....	40
A1.6 Measures to improve bathing water quality.....	40
A1.7 Information dissemination.....	41
A2 Drinking Water Directive	43
A2.1 Introduction	43
A2.2 European results	46
A2.3 Country comparison	51
A2.4 Measures to improve drinking water quality.....	54
A2.5 Information dissemination.....	54
A3 Urban Waste Water Treatment Directive	56
A3.1 Legislation	56
A3.2 European results and trends in compliance	57
A3.3 Country comparison	59
A3.4 Measures to improve treatment	61
A3.5 Information dissemination.....	63

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Acronyms and abbreviations

BOD	Biochemical oxygen demand
BWD	Bathing Water Directive
CFU	Colony-forming unit
CSO	Combined sewer overflow
DWD	Drinking Water Directive
EC	European Commission
EEA	European Environment Agency
ETC/ICM	European Topic Centre on Inland, Coastal and Marine Waters
EU-13	Member States of EU having joined since 2004 (2004: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia; 2007: Bulgaria, Romania; 2013: Croatia)
EU-15	Member States of the EU before 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom)
EU-28	EU Member States at the time of publication (sum of EU-13 and EU-15)
NiD	Nitrates Directive
p.e.	Population equivalent
UV	Ultraviolet
UWWTD	Urban Waste Water Treatment Directive
UWWTP	Urban waste water treatment plant
WFD	Water Framework Directive
WHO	World Health Organization
WISE	Water Information System for Europe
WSP	Water safety plan

Executive summary

Society depends on the satisfactory and sustainable management of water. Historically, the primary purpose of water treatment was to protect human health, through reducing disease being transmitted through water. Subsequent measures to address environmental concerns have broadened our expectations of what water and waste water treatment should deliver.

This report considers three pieces of EU water legislation targeted at particular sectors: the Bathing Water Directive (BWD; EEC, 1976; EC, 2006a), the Drinking Water Directive (DWD; EEC, 1980; EC, 1998, 2015a) and the Urban Waste Water Treatment Directive (UWWTD; EEC, 1991a) together termed here as the 'water industry directives'. Their objectives regarding specific issues are considered in the context of the Water Framework Directive (WFD, 2000).

Consideration of the older legislation in the context of the WFD is worthwhile as the European Commission considers a review of water legislation. Meanwhile, the European citizens' initiative 'Right2Water' (EC, 2014b) highlighted the level of interest in water issues. This report looks at areas in common between the water industry directives, and notes where integration under the WFD can identify synergies and allow improved decision-making.

This report builds upon previous reports required by the sectoral legislation, summaries of which are provided in the annex. Common features regarding public health, environmental protection and informing the public are identified and considered in the context of the WFD, which, as a framework directive conceived after much of the sectoral legislation was adopted, brings together many objectives of the water industry directives.

Looking at the water industry directives in general, rates of implementation of the BWD and DWD are

high in all countries. Implementation of the UWWTD tends to be high among the countries that were Member States before 2004 (EU-15). The picture is more mixed among the newer Member States (EU-13), where implementation is advanced or increasing. Reporting under the WFD in the second cycle of river basin management planning is under way and results should become available over 2017–2018. Results of the first river basin management plans of the WFD in 2009 showed that nutrient inputs from waste water treatment plants and agriculture are among the most significant reasons for water bodies failing to be in good status.

Integrating the approaches of water-related directives may help us deal better with current and future challenges, for example, using the WFD river basin management planning process to identify those stakeholders with relevant interests and to implement effective decision-making that takes into account the differing issues, costs and benefits. Integration may require a more detailed understanding of interrelated issues than is needed to meet more linear obligations under sectoral legislation, such as infrastructure improvement. Authorities and water managers need to identify related pressures and impacts to help identify root causes and thereby facilitate more effective implementation.

Significant challenges continue in dealing with point source pollution from storm water overflows, and with diffuse pollution through surface run-off from urban and agricultural land. Diffuse sources are likely to become more significant over time as point sources are tackled. Moreover, emerging risks include micropollutants, microplastics and antimicrobial resistance, where potential risks for both the environment and human health have been identified but their significance is as yet unclear.

1 Overview of EU water-related legislation to protect human health and the aquatic environment

1.1 Introduction

1.1.1 Legislative context

Water is an essential resource. Managing it to provide safe supplies is a fundamental requirement for human civilisation. Accordingly, 'to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing' is an integral part of the EU's environmental policy (EC, 2013a). The Seventh Environment Action Programme (EAP) outlines that in its third objective (1386/2013/EU).

Over the years, the EU has adopted a suite of legislation that aims to protect and manage European waters. This started in 1975 with a directive on surface water quality for drinking water abstraction (75/440/EEC; EEC, 1975) followed by the first Bathing Water Directive (BWD, 76/160/EEC; EEC, 1976), followed by the first Groundwater Directive in 1979 (80/68/EEC; EEC, 1979), and the first Drinking Water Directive (DWD, 80/778/EEC; EEC 1980). In the 1990s, the Nitrates Directive (NiD, 91/676/EEC; EC, 1991b), and the Urban Waste Water Treatment Directive (UWWTD, 91/271/EEC; EC, 1991a) came into force. The UWWTD, BWD and DWD continued to focus on protecting human health, whereas the NiD targeted agriculture as the source of emissions, to protect aquatic resources.

The Water Framework Directive (WFD, 2000/60/EC; EC, 2000) introduced a more holistic approach to ecosystem-based management in 2000. It focuses on the multiple relationships between the many different causes of pollution and their various impacts on water in a river basin. The WFD aims to ensure that human use of water is compatible with the environment's own needs. The WFD uses the 'good status' standard to indicate if there is enough water of sufficient quality to support both ecosystems and human societies. The WFD, as a framework directive, provides a context for more targeted legislation, such as the revised Groundwater Directive (2006/118/EC; EC, 2006b) and Environmental Quality Standards Directive (as revised in 2013/39/EU; EC, 2013b). This established a system for setting water quality standards and introducing measures to prevent or limit pollution of water.

1.1.2 Water management and the water cycle

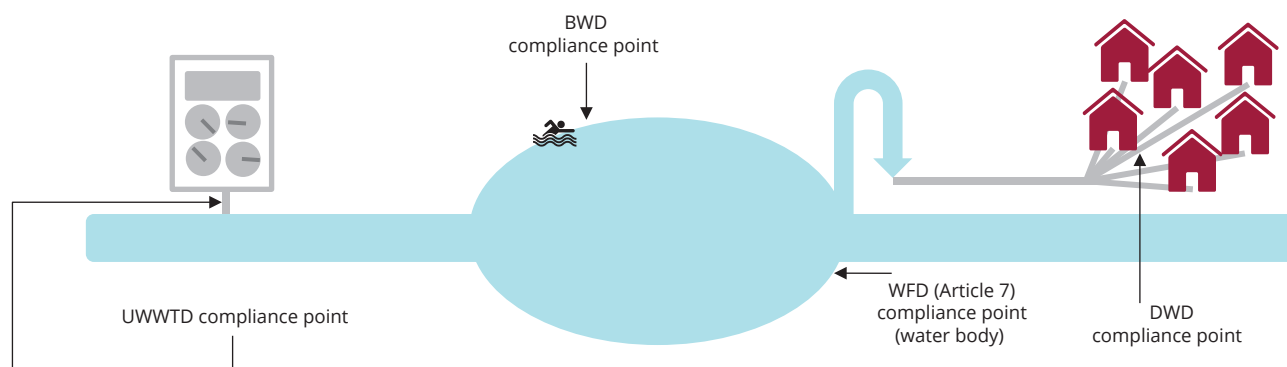
Looking at humans' direct interaction with water, we could consider household and urban water management as a more or less distinct sub-cycle of the natural water cycle: drinking water is abstracted from the groundwater or surface water, treated if necessary, and made available in households and businesses; after use and treatment it is discharged again into the environment.

This human sub-cycle is, of course, part of the wider natural water cycle. Human uses and discharges strongly influence water ecosystems and their status and functionality. This has implications for both society and nature. Water quality can directly affect human health in two ways: if people drink the water or if they come into direct contact with it by swimming. Only where there is sufficient water of sufficient quality for the health of the ecosystem can we ensure human health as well.

The three directives UWWTD, DWD and BWD are sometimes called 'the water industry directives'. Each of them focuses on managing its own part of the human water cycle. Between them, they provide a monitoring framework to document the quality of the water abstracted and used by humans, discharged afterwards, and the quality of the water available for recreational purposes. Member States must report key parameters of water quality and management measures under these directives.

The water industry directives all aim to protect consumers and water users, including the environment, against harmful effects. Management measures are taken in different places, as the compliance points for each of the directives are different, but nevertheless there are complementarities between them, such as improving waste water treatment under the UWWTD and improved bathing water quality under the BWD. The UWWTD ensures that all significant discharges of sewage from domestic and food industry sectors undergo collection and treatment before release into surface water. The BWD defines the water quality suitable for bathing waters and the DWD sets requirements for the quality of drinking water to

Figure 1.1 Relative scopes of the UWWTD, BWD, WFD (Article 7) and DWD — example of river or lake situation



Source: EC, 2014a, modified.

protect human health. They require and facilitate water monitoring and management measures and make information easily and transparently available to the public (EC, 2012).

To help understand the (spatial) scopes of the three different directives, Figure 1.1 shows the points of compliance within a hydrological system in a schematic way. The UWWTD compliance point is at the outlet of the treatment plant, where European water quality standards need to be met. This point complies with the emission principle. Treated waste water, perhaps with a high concentration of nutrients and/or pathogenic microorganisms, reaches a river or lake with a bathing area. This area must comply with the BWD. Under Article 7 of the WFD, the compliance point is the water body used for the abstraction of drinking water. At the compliance point, Member States shall ensure that the treatment regime applied will result in the water meeting the requirements of the DWD. The DWD compliance point is at the point of human consumption.

1.1.3 Public interest

With their focus on the human part of the water cycle, and the quality of water for human consumption and use, the three water industry directives are also at the centre of public interest. The first successful European citizens' initiative, the Right2Water initiative, called on the European Commission (EC) to ensure that all EU citizens enjoy the right to water and sanitation.

In response to the European citizens' initiative, the EC identified a set of priorities and actions at EU or national level to address the concerns motivating this call for action. One focus is to improve information for citizens, by further developing streamlined and more transparent data management and by disseminating information about urban waste water and drinking water. These actions also promote structured dialogue between stakeholders on transparency in the water sector, and aim to improve the transparency and accountability of water services providers by giving citizens access to comparable data on key economic and quality indicators.

1.2 Scope and management tools of the directives

1.2.1 Urban Waste Water Treatment Directive

The UWWTD regulates urban waste water collection, treatment and discharge, as well as treatment and discharge from the agriculture and food sectors. It requires the collection and treatment of waste water in all agglomerations of more than 2 000 population equivalents (p.e.) (see Annex A3.1), and more stringent treatment for agglomerations of more than 10 000 p.e. or in designated sensitive areas ⁽¹⁾ (for more information on the UWWTD, see Annex A3).

To achieve the objectives of the directive, measures need to be taken to increase the population

⁽¹⁾ In case of application of Art. 5(8) and 5(2,3) more stringent treatment is required for all agglomerations over 10 000 p.e. in the entire territory. In case of application of Art. 5(1) and 5(2,3) more stringent treatment is required for all agglomerations over 10 000 p.e. in designated sensitive areas.

connected to waste water collection and urban waste water treatment plants (UWWTPs), and to expand more stringent waste water treatment. To reach these objectives, the directive lays down four main principles: (a) planning, (b) regulation, (c) monitoring and (d) information and reporting. Water managers and responsible authorities need to develop and implement management strategies for each of these principles.

Besides designating sensitive areas and identifying the relevant catchment areas, planning aspects include establishing a technical and financial programme for constructing sewage collection systems, if needed, and identifying needs for more stringent treatment than 'secondary treatment' in larger agglomerations.

The main regulatory tools are the authorisation and regulation of waste water. In addition, the UWWTD requires considering limiting pollution coming from storm water overflows in the design, construction and maintenance of collecting systems, and considering technical requirements for the design, construction, operation and maintenance of plants that treat urban waste water.

Monitoring programmes need to be in place and must correspond to the directive's requirements. Member States must also ensure monitoring of both discharges from UWWTPs and receiving waters (water bodies that receive discharges of waste water). A well-established monitoring system ensures an informed assessment of the sewerage system and its treatment capacity.

Information and reporting are principal management tools. Member States need mechanisms to allow cooperation and exchange of information with each other (e.g. if discharges of waste water have an effect on water quality across a border). National reports and map viewers are also suitable and useful to present ratings and results transparently, both to the EC and to the general public.

1.2.2 Bathing Water Directive

The BWD safeguards public health and protects the aquatic environment in coastal and inland areas from pollution. To manage water quality, Member States monitor bathing water during the bathing season. They take samples of bathing water and analyse them to assess the concentrations of two bacteria, *Escherichia coli* and intestinal enterococci. This has to happen once a month during the bathing season, with a minimum of four samples per season collected at each bathing water site.

Throughout the bathing season, local or national governments publish monitoring results to inform the public about possible health risks when bathing. For all of their bathing water sites, countries also prepare bathing water profiles and ensure they are available to the public. These are descriptions of physical, geographical and hydrological conditions, covering a single site or contiguous sites. They also list potential impacts on water quality and potential threats to it. At the end of each bathing season, Member State authorities send their data to the EC and the European Environment Agency (EEA). Assessment results are then published in national reports, EU reports and interactive viewers, and the BWD data viewer.

A revised BWD (2006/7/EC) was due for implementation by Member States by December 2014. It is fully integrated within the body of measures protecting the quality of EU waters through the WFD, putting greater emphasis on the integrated management of bathing water. The effect is to encourage Member States to implement management measures to improve quality to at least 'sufficient' or even 'excellent' (EEA, 2016a).

Mitigation measures to reduce health risks may include construction of adequate waste water treatment plants. Building sewage collection and treatment systems, ensuring compliance of emission concentrations and removing sediment are very important management actions to improve bathing water quality. Many cases of poor quality and non-compliance are linked to short-term pollution and cases of storm water overflow. Therefore, depending on water status, management measures might also include investigating the sewer network in the vicinity of the bathing water site, together with monitoring surface waters in the vicinity of the bathing water. Bathing water sites subject to such measures might be temporarily closed for part or all of the bathing season.

When extreme events or accidents occur (such as heavy rain, sewage spills or hazardous waste spills) Member States must impose temporary management measures to protect bathers' health. In most cases, this means that local authorities must temporarily close bathing water locations or, at the very least, warn bathers where areas are affected.

The authorities can also close bathing water sites for other reasons, such as dangerous access to the bathing water, damaged infrastructure surrounding it, engineering works at or near the location, or a reduction in the water level of a reservoir. In some cases, the reason might be purely administrative or legal. If a bathing area is temporarily closed for unexpected or uncontrollable reasons, the quality of its water must still be monitored.

1.2.3 Drinking Water Directive

The DWD aims to ensure that water intended for human consumption is safe, with Article 1 stating its objective as being 'to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean' (EC, 1998). The directive applies to all water intended for human consumption, apart from natural mineral waters and waters that are medicinal products.

The directive sets quality standards for drinking water at the tap (microbiological, chemical and indicator parameters) and obliges Member States to monitor drinking water quality regularly, to take remedial action (measures) if the monitoring reveals problems, and to provide consumers with adequate and up-to-date information on their drinking water quality (see Annex A2). Tools for managing drinking water quality are focused on monitoring, measures and information to the public.

Following a revision to the DWD technical annexes II and III (EC, 2015a), there is provision of an option for more flexible monitoring of drinking water, provided a risk assessment is performed to ensure safe quality of drinking water. This means that the directive permits exceptions to monitoring, either by reducing the frequency or by completely removing parameters from the monitoring programme. This is possible if (a) the values of the results obtained from sampling taken during a period of at least 2 successive years are constant and significantly better than the limits, and (b) no factor is likely to cause a deterioration in the quality of the water.

Annex II of the revised DWD brings the water safety planning approach to drinking water management. This approach, developed by the WHO, provides a systematic management tool to assess and mitigate all risks from catchment to consumer. As well as responsibilities for authorities, the approach requires water supply operators to carry out a comprehensive risk assessment for each supply or case and its connected supply system from source to tap, covering all hazards and hazardous events (WHO, 2011).

Measures need to be implemented if the quality of drinking water needs improvement. If the measures are related to treatment or the distribution network, the water supplier is responsible for ensuring high drinking water quality. If pollution comes from the catchment area, this can involve the supplier coordinating with other institutions or stakeholders. Agriculture is the main cause of groundwater and surface water pollution, so water suppliers often engage with farmers to ensure the protection of water sources (Figure 1.2).

Furthermore, the DWD requires that authorities make the results of drinking water quality available to the public. For this, a national triennial report needs to be published. National reports based on the triennial reporting results are available at the Commission website.

1.2.4 Water Framework Directive

The WFD establishes a legal framework to protect and restore clean water across Europe and ensure its long-term, sustainable use. The directive establishes an innovative approach for water management based on river basins, the natural geographical and hydrological units, and sets specific deadlines for Member States to achieve ambitious environmental objectives for water bodies. Under the WFD, Member States should have aimed to achieve good status in all bodies of surface water and groundwater by 2015. Article 10 details the directive's 'combined approach for point and diffuse sources' and refers to several related directives, including the BWD, DWD and UWWTD. The directive regards implementation of these other directives as a minimum requirement (EC, 2008a,b).

River basin management plans were drawn up for extensive river basin districts rather than for individual water bodies. A programme of measures describes the actions that must be taken to bring water bodies into good status. Some key measures are, for example, improving hydromorphology by restoration; removing or scaling back migratory obstacles and transverse structures such as weirs to restore river continuity; optimising sewage treatment plants; and implementing good agricultural practice to reduce chemical inputs into water bodies. All such measures must be commensurate with (a) the nature and scope of the anthropogenic pressures involved and (b) water use modalities.

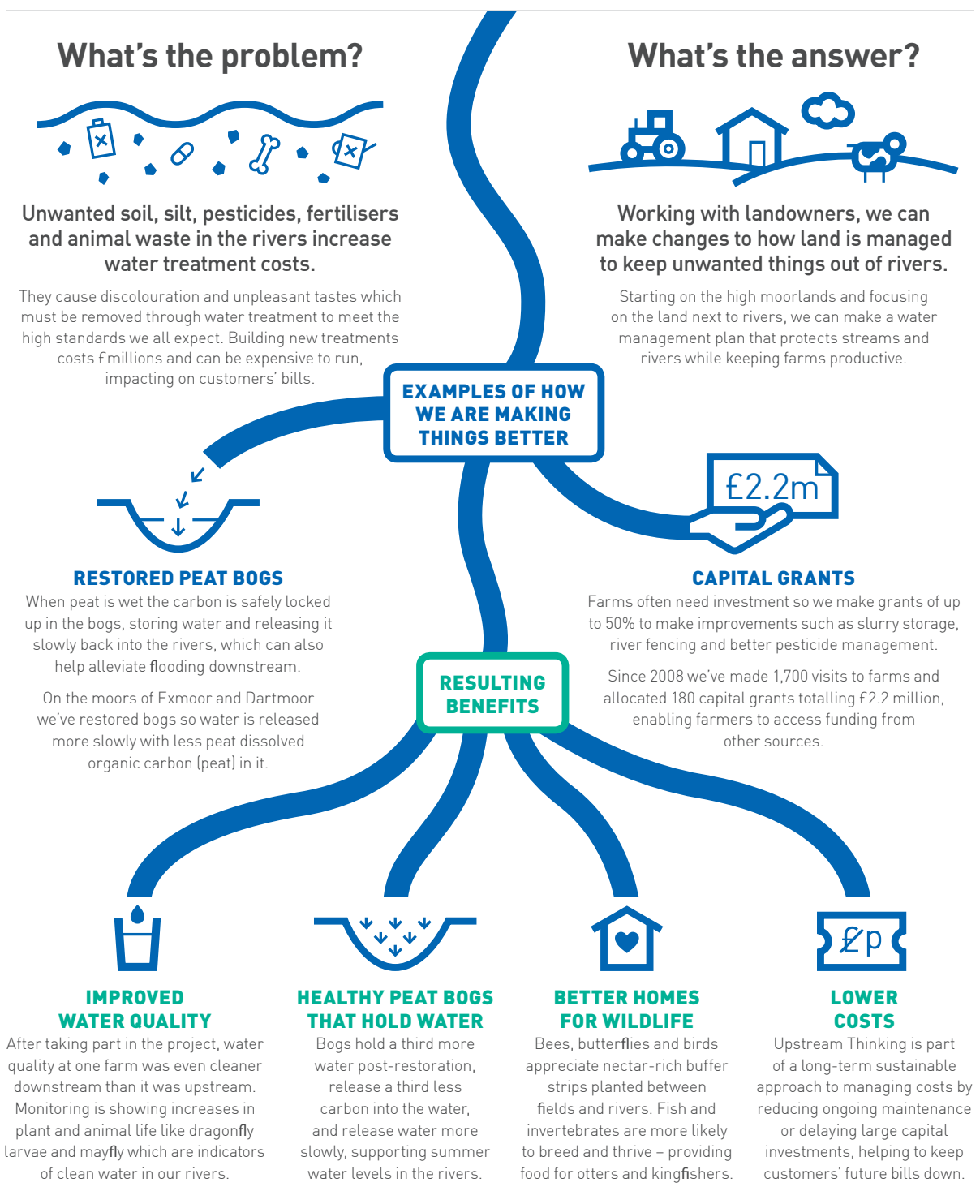
Inasmuch as water protection is a community undertaking, to meet WFD objectives EU Member States will need to coordinate the requirements of the Directive, both in their river basin management plans and in their programmes of measures across borders. Moreover, involving the general public is a key instrument of the WFD. Consultation entails announcing the timeline and work programme; the key water management issues for each river basin district; and the draft river basin management plans.

1.3 Management measures

The most significant reasons for failure of surface waters to achieve good ecological and/or good chemical status under the WFD are hydromorphological pressures,

Figure 1.2 Example of a collaborative approach to water quality improvement from the United Kingdom

Looking after the land to protect our rivers



such as building in riparian areas, canalisation and erection of barriers; diffuse water pollution from agricultural activities; discharges from waste water treatment plants and industries; and overflow of waste water from sewage systems. High inflow of nutrients or chemicals leads to eutrophication, oxygen depletion and accelerated loss of biodiversity, and could result in the loss of viable bathing water and good-quality raw water sources for the drinking water supply. Therefore, the UWWTD has an important link to public health. Furthermore, management under the UWWTD has a strong link with the WFD, for example by upgrading or constructing waste water treatment plants to reach good ecological or chemical status. Therefore, measures of the UWWTD are listed as 'basic measures' tackling the source of surface water pollution under the WFD, which clearly uses its measures to address the point source of pollution. Figure 1.2 shows an example of an approach to integrated management.

Bathing waters are one of the protected areas under the WFD, which means that Member States must achieve compliance with the standards and objectives for each protected area by 2015 (unless otherwise specified in the legislation). The BWD also complements the Marine Strategy Framework Directive (MSFD), in contributing to reaching good environmental status by 2020. All the directives are clearly linked, given that they consider monitoring stations, status assessment and causes of non-compliance. Measures under the WFD could also be adapted to improve bathing water quality in general and to reduce eutrophication on a larger scale.

Measures under the WFD related to drinking water mainly focus on reducing nutrient and pesticide pollution from agricultural activities, and in reducing nutrient and organic substances pollution from human agglomerations in protected areas. These measures could also be implemented from the point of view of the DWD (catchment-related remedial actions). An example of integrated management to ensure high drinking water quality is given in Box 1.1.

1.4 Relationships between the water industry directives and the WFD

The main aim of European water policy is to ensure that sufficient good-quality water is available for people's needs and for the environment.

The WFD promotes sustainable water use based on the long-term protection of water resources. In so doing, it contributes to the provision of sufficient supplies of good-quality bathing water and high-quality sources of drinking water intended for human consumption.

In the legislation, there is no direct link between drinking water quality and surface water or groundwater status under the WFD. The DWD considers the water quality at the tap, after treatment. The river basin management plan under the WFD covers the raw water resources, the catchment and the wider environment within the area of the river basin, including bathing waters as well as point source pollution from domestic or industrial waste water treatment plants. However, discussions to better integrate DWD and WFD, for instance on water safety planning, are on-going (EC, 2014a).

Water resources supply water intended for human consumption and may be treated, if necessary, to protect people from the risks presented by raw water. Common interests between the DWD and the WFD are the protection of the raw water source and its catchment, although the DWD itself does not protect water resources. The consequence of low-quality raw water may be more investment in treatment or water transfers. Such actions potentially result in higher energy use, more carbon emissions and higher prices for consumers. Establishing a closer connection between the DWD and WFD could enable a whole chain approach from catchment to tap, involving all relevant stakeholders.

Under the WFD, full implementation of basic measures is required, which includes compliance with the UWWTD. Going beyond the requirements of the UWWTD to improve waste water treatment may be identified in river basin management plans as necessary for a water body to reach good status (e.g. supplementary measures for more stringent limits of pollutants discharged into water bodies may be established). Meanwhile, the improvements to a waste water treatment plant undertaken to meet the UWWTD could feed into an overall improvement in status under the WFD. So, rather than aiming to meet a particular objective under a water industry directive, considering the synergies between each of the water industry directives and the WFD could lead to more cost-effective measures, as well as improving the status and quality of waters.

Box 1.1 Integrated management: the example of Lake Constance

Lake Constance is a natural lake that spans the borders of Germany, Switzerland and Austria. It is central Europe's third-largest lake, approximately 570 km² in area and with an average depth of 90 m. Over 500 people per square kilometre live along the shoreline of the lake.

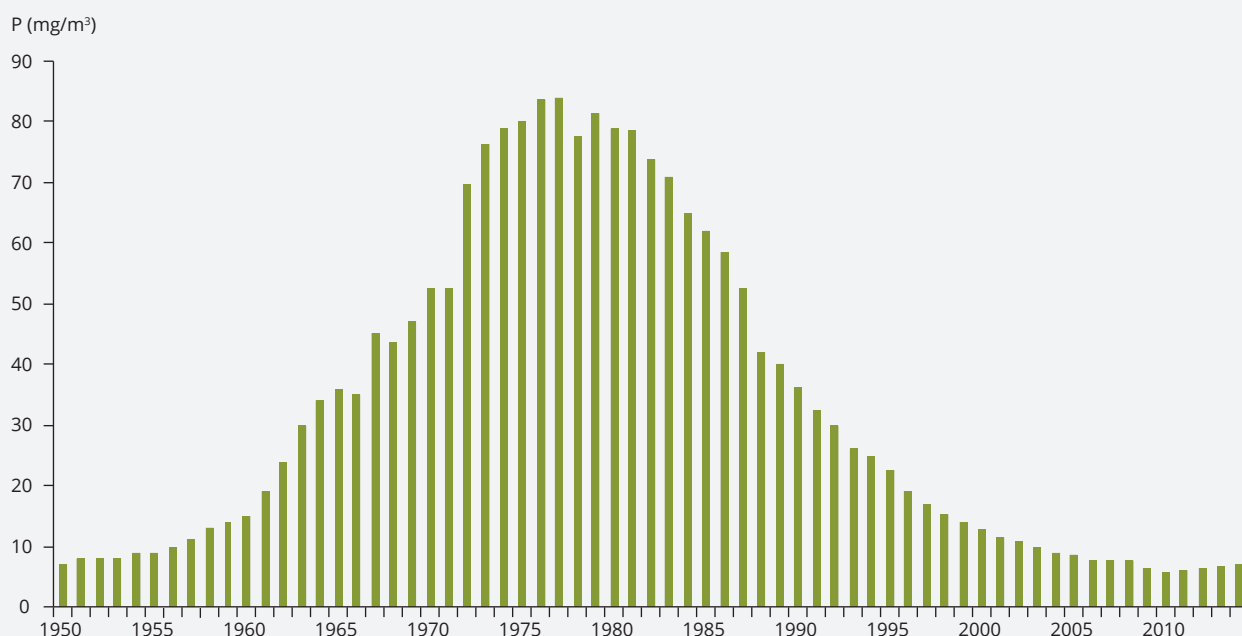
The International Commission for the Protection of Lake Constance, instituted in 1959, is responsible for the target-oriented implementation of measures. The Commission's aims are to supply high-quality drinking water, protect the flora and fauna of the lake and catchment ecosystem, and maintain tourism. It needs to consider all these aims while complying with the DWD, BWD, UWWTD and WFD.

The main uses of the lake and its catchment area are drinking water, fisheries, tourism, agriculture, forestry, habitats for flora and fauna, transport and shipping. The main stressors on the lake are the inflow of polluted water from point and diffuse sources.

Lake Constance provides high-quality drinking water to the northern lake catchment, reaching all the way up to the city of Stuttgart. The Lake Constance Water Supply Company (Bodensee Wasserversorgung), located on the Sipplinger mountain just above the lake, supplies 17 million m³ of drinking water per year to 320 municipalities with a total of approximately 4 million inhabitants. Water demand is also high because of tourism, with approximately 10 million overnight stays and about 27 million day visits per year. Tourism is among the most significant economic factors in the German part of the Lake Constance region (Hammerl and Gattenhoehner, 2003).

The central challenge in this region is to ensure the quality of drinking water. In the 1950s, Lake Constance was in a nutrient-poor ('oligotrophic') state. The phosphorus concentration increased to make the lake highly nutrient rich ('eutrophic'), because of an enormous inflow of untreated urban waste water. This resulted in algal blooms, anoxic conditions in the deeper layers of the lake, and death of fish. The lake threatened to 'tip over'. Thanks to international cooperation and investments totalling over EUR 5 billion in constructing and modernising sewage channels and 220 water treatment plants, the phosphorus level returned to < 10 mg/m³ in 2013 (Figure 1.3).

Figure 1.3 Total phosphorus concentration (annual mean) of Lake Constance



Source: International Commission for the Protection of Lake Constance, 2013.

Besides measures to build up waste water treatment plants, there were, and still are, several measures within the catchment to reduce nutrient input from agriculture or to restore the lake's banks. Furthermore, a drinking water protection area of 8.4 km² near the abstraction points was legally specified in 1987. Future challenges for the integrated management of Lake Constance will be the effects of climate change and micropollutants.

2 Protecting waters from nutrient and organic pollution

2.1 Introduction

From its inception, EU water policy has focused on reduction of pollution to surface waters and groundwater. The UWWTD aims to protect surface waters from pollution to minimise possible impacts on human health and to protect the environment. The BWD, with a primary focus on protecting human health, obliges Member States to achieve certain microbiological standards to avoid people getting infections. With its quality standards to protect human health, the DWD set standards for water intended for human consumption. The WFD serves as an umbrella, integrating most of the requirements of water-related directives and stipulating integrated management of river basins.

For the water industry directives, cross-cutting interests are predominantly around limiting pollutants entering water sources or watercourses. Excess nutrients from waste water treatment plants are addressed by the UWWTD. Organic pollution can be measured by the biochemical oxygen demand (BOD), which is a key determinant under the UWWTD.

Challenges to maintaining and improving water quality remain, for example diffuse pollution from agriculture as well as point source pollution from storm water overflows.

2.2 Pressures and status of nutrient pollution

Excess nutrients can cause eutrophication, a process characterised by increased plant growth, proliferation of algal blooms and an undesirable disturbance to the species composition and abundance of the organisms in the water (EEA, 2012).

In addition, eutrophication can lead to more serious problems, such as low levels of oxygen dissolved in the water. This happens when large amounts of algae die and decay. The process of decay uses up the oxygen in the water. Like the effects of high loads of organic matter in waste water (high BOD, described in Chapter 3), this can kill fish and other aquatic organisms. In rivers and lakes, eutrophication is

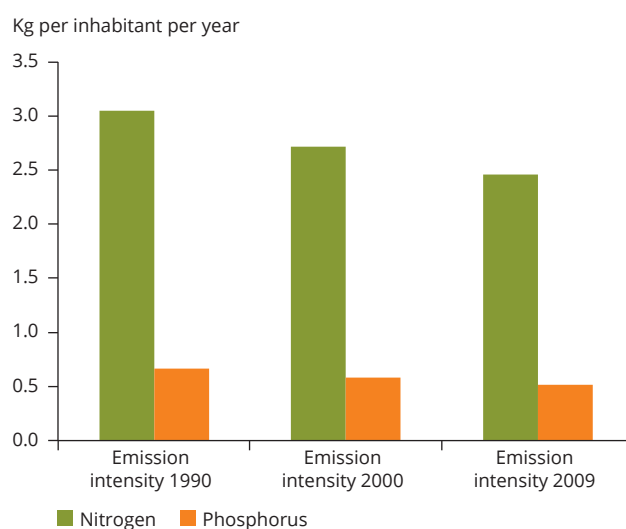
mainly caused by high concentrations of phosphorus, whereas nitrogen enrichment is the main reason for eutrophication in coastal and marine waters (Chislock et al., 2013).

Nutrients in groundwater could also be a source of pollution for surface waters, if rivers or lakes are strongly influenced by groundwater, e.g. where groundwater levels are high, particularly in the lowlands. Groundwater or surface water with high nitrate concentrations may pose a risk to human health.

The main sources of nitrogen and phosphorus are point source emissions from UWWTPs and industry, and diffuse emissions from agriculture such as fertilisers and manure.

Figure 2.1 shows a decline in the nitrogen and phosphorus emissions from the domestic sector in 1990, 2000 and 2009.

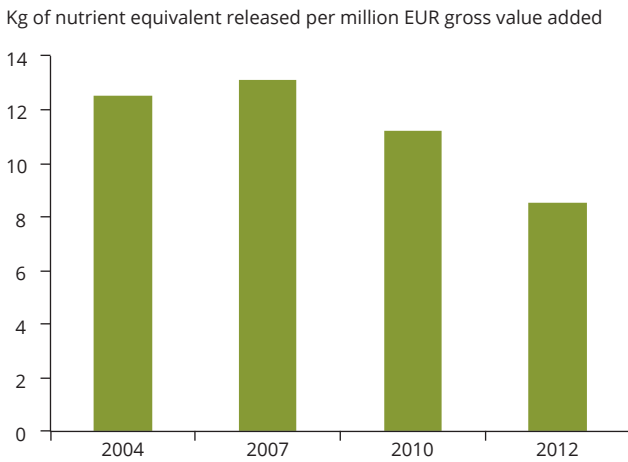
Figure 2.1 Intensity of nitrogen and phosphorus emissions from the domestic sector



Note: The nutrient emission intensity here is expressed in kilograms of nutrient discharged into the environment per inhabitant per year (kg/inhabitant/year).

Source: <http://www.eea.europa.eu/data-and-maps/indicators/emission-intensity-of-domestic-sector/assessment>.

Figure 2.2 Intensity of nutrient emissions from the manufacturing industry



Note: The interpretation of this graph may be biased by the influence of the economic crisis in 2008.

Source: <http://www.eea.europa.eu/data-and-maps/indicators/emission-intensity-of-manufacturing-industries-1/assessment>.

Figure 2.2 shows a decline in the nutrient emission intensity of the manufacturing industry in Europe during 2004, 2007, 2010 and 2012.

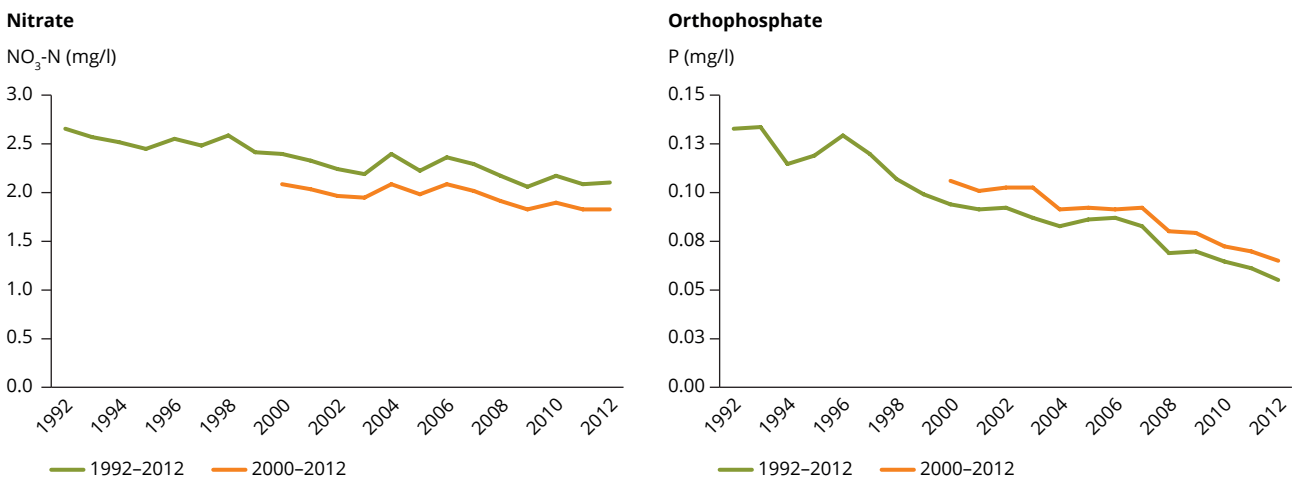
Nutrient emission intensities showed downward trends in the domestic sector and the manufacturing industry during the assessed periods. Similarly, nitrogen (nitrate) and phosphorus (orthophosphate) concentrations in rivers declined (Figure 2.3).

In European rivers, the average concentration of orthophosphate fell by more than half over the period 1992–2012. A significant part of this can be attributed to measures taken under the UWWTD, in particular the removal of nutrients during waste water treatment. In addition, the introduction of phosphate-free detergents has contributed considerably to the reduction of phosphate concentrations in surface waters.

During the past few decades, phosphate concentrations have also gradually reduced in many European lakes. Many discharges from waste water treatment plants have been diverted away from lakes to rivers and this has led to significant phosphate reduction.

The assessments of the first river basin management plans under the WFD showed that diffuse pollution from agriculture constitutes a significant pressure for more than 40 % of Europe's rivers and coastal waters, as well as for one third of Europe's lakes and transitional waters (EEA, 2012). Intensive use of mineral fertilisers and manure leads to high nutrient surpluses, often causing diffuse nutrient pollution of surface waters and groundwater. While phosphate is adsorbed to particles in the soil, limiting its release into water,

Figure 2.3 Nutrient trends in European rivers



Note: 1992–2012: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Liechtenstein, Lithuania, Luxembourg, Norway, Poland, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom.

2000–2012: Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, former Yugoslav Republic of Macedonia, Netherlands, Norway, Poland, Romania, Serbia, Slovakia, Slovenia, Sweden, Switzerland, United Kingdom.

Source: <http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-6>.

Figure 2.4 Nitrate concentration in Europe's groundwater

Note: 1992–2012: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, Germany, Ireland, Liechtenstein, Lithuania, Netherlands, Norway, Portugal, Slovakia, Slovenia.

2000–2012: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Serbia, Slovakia, Slovenia, Spain, Switzerland, United Kingdom.

Source: <http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-6>.

nitrogen compounds, especially nitrate, can dissolve in water and seep through the soil, leaching into groundwater.

Figure 2.4 shows the nitrate concentration in Europe's groundwater from 1992 to 2012. The shorter time series shows a similar pattern, with hardly any trend, although this larger selection of groundwater bodies shows a slightly higher average concentration level.

Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/l NO_3), although this depends on the oxygen concentration, since low oxygen availability favours nitrite over nitrate. Nitrate concentrations greater than natural levels are caused entirely by human activities, such as agriculture, industry and domestic effluents.

2.3 Impacts of nutrient pollution and eutrophication

2.3.1 Eutrophication in bathing waters

Algae (e.g. phytoplankton) are most abundant in the summer. Their abundance is linked to the warmer temperatures and to the availability of nutrients

in the water. Nutrient enrichment/eutrophication may therefore cause excessive growth of plankton algae (i.e. increase in phytoplankton biomass), which increases the concentration of chlorophyll-a. This in turn may result in an increase in the frequency and duration of phytoplankton blooms, which can pose hazards to human health in the case of toxic blue-green algae (EEA, 2012).

In marine and coastal waters, the chlorophyll-a concentration is a proxy for the primary production and indicates the amount of phytoplankton. The higher the concentration, the higher the biomass of algae (Map 2.1).

Chlorophyll-a concentrations are moderate or high in most European seas. According to reported data from between 1985 and 2012 (<http://www.eea.europa.eu/data-and-maps/data/waterbase-transitional-coastal-and-marine-waters-11>), concentrations are decreasing in the Greater North Sea, Bay of Biscay and Adriatic Sea, but increasing in many parts of the Baltic Sea. The species that make up the pelagic food web and how it functions may change in ways that exacerbate the negative effects of excessive phytoplankton growth. Eutrophication in seas can also promote harmful algal blooms that may discolour the water, produce foam, kill off benthic fauna and make fish or shellfish poisonous to humans. Furthermore, excessive algal blooms in coastal waters (as well as in freshwater) could also affect tourism, with immense effects on the economy of the regions concerned.

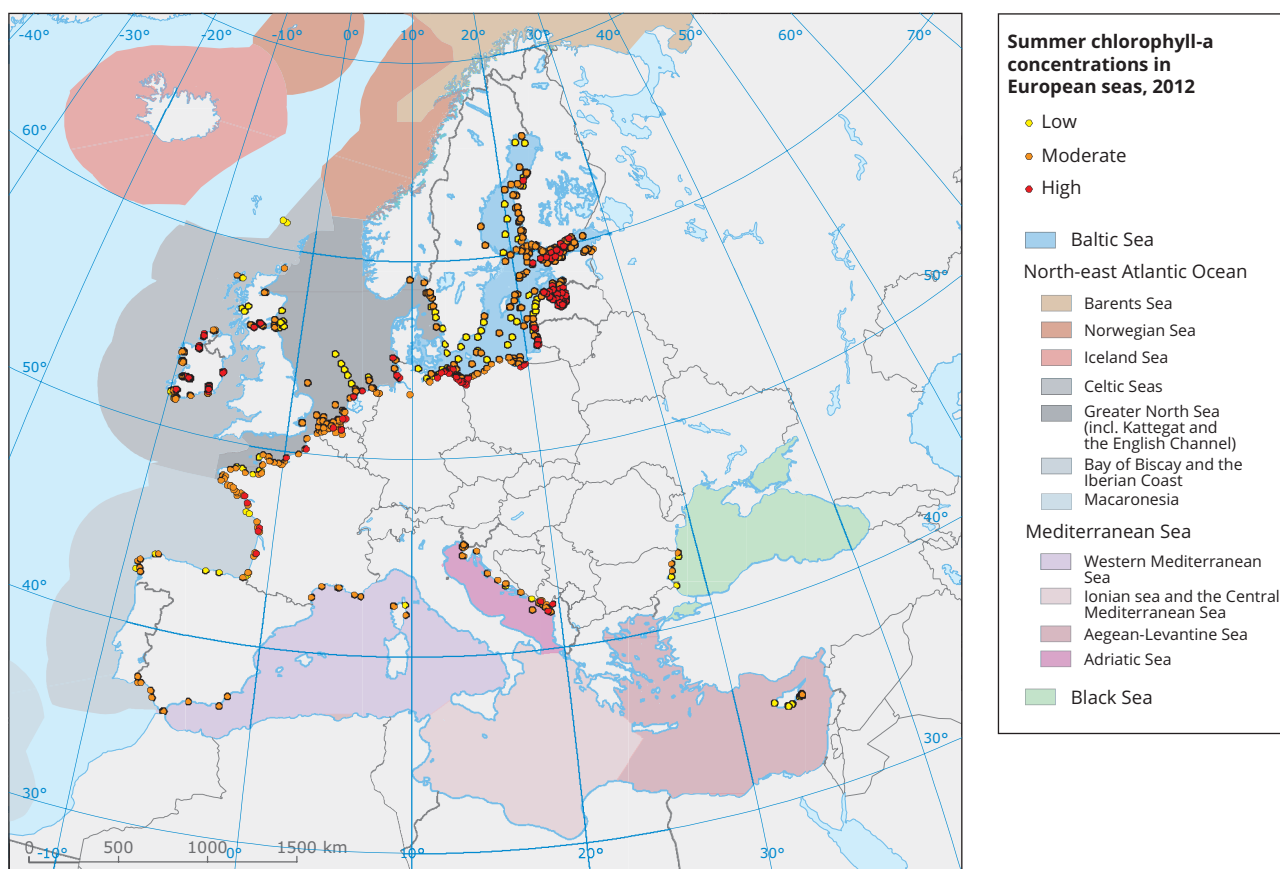
Highly polluted lakes often have harmful blue-green algal blooms in summer. Optimal conditions for blue-green algae include intense radiation, high temperature, high levels of nutrients (phosphorus and nitrogen) and a lack of flow or turbulence. Blooms can endanger human health because of the proliferation of algal toxins. They can cause rashes, skin and eye irritation, allergic reactions and other effects.

Blue-green algae produce microcystin, which is a toxin. The WHO sets standards of 1 $\mu\text{g/l}$ for microcystin in drinking water (WHO, 2003a). If the level exceeds this value, additional treatment is necessary, or drinking water should be taken from a different source (see also Annex A3).

2.3.2 Nitrate and nitrite in drinking water

The DWD sets standards for drinking water of 50 mg/l of nitrate (NO_3) and 0.5 mg/l of nitrite (NO_2), because of nitrate subsequently converting to nitrite in the human body. Nitrite oxidises the iron in the haemoglobin of the red blood cells, forming methaemoglobin, which lacks

Map 2.1 Summer chlorophyll-a concentrations in European seas, 2012



Source: <http://www.eea.europa.eu/data-and-maps/figures/map-of-summer-chlorophyll-a-concentrations-observed-in-2>.

the oxygen-carrying ability of haemoglobin. This can create the condition known as methaemoglobinemia (sometimes referred to as 'blue baby syndrome'), in which blood cannot carry enough oxygen to the cells, so the veins and skin appear blue. The health concern is primarily if infants drink contaminated water (WHO, 2011).

In Europe, about 50 % of drinking water is taken from groundwater and about 40 % from surface water. 10 % of drinking water is used from other sources, like artificial groundwater recharge or bank filtration water (see Annex A2). Many waters in Europe are polluted with nutrients, and the levels of nitrate in groundwater have not decreased over decades. This may affect the cost of supplying of high-quality drinking water in the future, because the purification of highly contaminated raw water is expensive. Protecting drinking water resources to prevent contamination is a way to limit the significance of the issue.

2.4 Policies and measures to reduce nutrient pollution

The WFD is the key instrument for protecting water and setting quality objectives with respect to pressures such as pollution from diffuse sources (e.g. agriculture) or point sources. The UWWTD is one of the most important basic measures alongside the WFD and relates largely to point sources. Implementing the UWWTD has led to an increasing proportion of the EU's population being connected to municipal treatment works via sewer networks. Furthermore, treatment levels have increased, moving from mechanical to biological treatment or to more stringent treatment (nitrogen and phosphorus removal). However, although there are national regulations that set standards for small wastewater treatment plants (fewer than 2 000 p.e.), and the UWWTD requires appropriate treatment at small waste water treatment plants, nevertheless small-scale sanitation poses a potential threat to water quality and public health, particularly in rural areas (EEA, 2015).

Box 2.1 Good practice: two examples

Photos: Blue-green algae bloom in a reservoir, Germany © J. Völker

- Pollution of a reservoir in Hesse, Germany, was found to be caused by significant nutrient discharges from six small-scale UWWTPs on the two tributaries to the lake. The discharges caused blue-green algal blooms and repeated fish kills between 2000 and 2009. Subsequently, bathing was banned in the summer months. This led to a reduction of income from tourism, so the local authorities and other concerned parties developed a common strategy to combat eutrophication of the lake. The following objectives were set: (a) halving the concentration of phosphorus in the discharges from all six waste water treatment plants, (b) merging two treatment plants and in addition diverting waste water to another plant with higher treatment capacity, (c) reducing the percentage of water from external sources and (d) refurbishment of the sewer collection system. These measures have greatly improved the trophic condition in the lake. Since 2010, there have been no further algal blooms.
- The Federal State of Baden-Württemberg, Germany, adopted the 'Protected Areas and Compensatory Regulation' (Schutzgebiets- und Ausgleichsverordnung, SchALVO). It aims to protect the raw drinking water from agricultural nutrient and pesticide contamination. The regulation restricts land use practices in the water protection areas according to different zones: zone I, 'nitrate sanitation areas'; zone II, 'nitrate problem areas'; and zone III, 'normal areas'. The 'water cent' is an additional tax on the consumer price for drinking water to compensate farmers for implementing agri-environmental measures and potential losses in income (Umweltministerium BW, 2001).

Besides urban waste water treatment, cost-effective measures to tackle diffuse agricultural pollution are also triggered through the WFD and its river basin management plans where water bodies are not in good status. The WFD covers the requirements for protected areas under the NiD, the BWD and the UWWTD, which include restrictions on water use, in particular for agriculture.

2.5 Biochemical oxygen demand: a key indicator of water quality

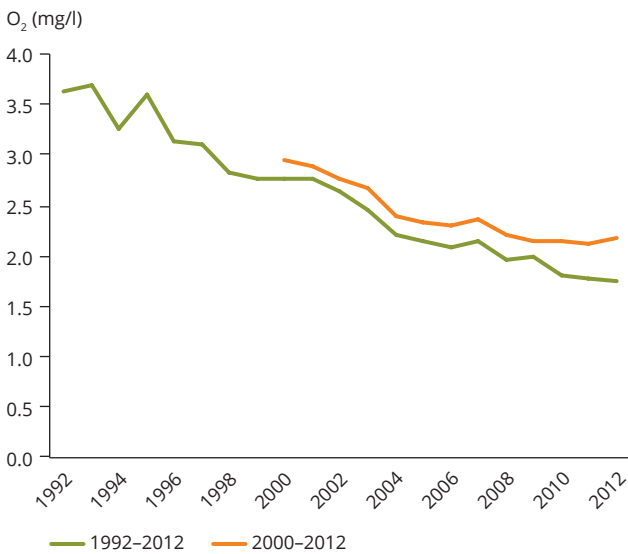
2.5.1 Background

Biochemical oxygen demand is the amount of dissolved oxygen needed by aerobic organisms to break down organic material present in a water sample. It is a common indicator of organic, biodegradable pollution

and is used to assess the effectiveness of waste water treatment plants. Concentrations of BOD can be increased, for example, through discharges from waste water treatment plants and industry, and by agricultural run-off. BOD concentration is influenced by many factors and can change, depending on the receiving water and on how the discharges are distributed. Severe organic pollution may lead to rapid de-oxygenation of river water, and can harm fish and aquatic invertebrates. BOD concentrations therefore provide an insight into the quality of water for aquatic life.

The most important sources contributing to BOD are from domestic waste waters, from certain industries such as paper or food processing, and from agriculture in silage effluents and manure. As outlined in Annex A3, the UWWTD regulates waste water discharges from domestic sources and food processing. The directive

Figure 2.5 Trend of 5-day BOD in European rivers (a)



Note: Figure 2.5 depicts two time series: the longer time series has fewer stations (539) and the shorter time series has more (1 235).

1992-2012: Austria, Belgium, Bulgaria, Denmark, Estonia, Finland, France, Ireland, Latvia, Lithuania, Luxembourg, former Yugoslav Republic of Macedonia, Slovakia, Slovenia, United Kingdom.

2000-2012: Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Denmark, Estonia, Finland, France, Ireland, Italy, Latvia, Lithuania, Luxembourg, former Yugoslav Republic of Macedonia, Poland, Romania, Slovakia, Slovenia, United Kingdom.

(a) BOD can be measured over 5 days or, less commonly, over 7 days: in Figure 2.5, BOD7 data have been recalculated into BOD5 data.

Source: <http://www.eea.europa.eu/data-and-maps/indicators/oxygen-consuming-substances-in-rivers/oxygen-consuming-substances-in-rivers-7>.

explicitly specifies which kind of treatment must be applied. Biological waste water treatment ('secondary treatment') significantly reduces biodegradable pollution in waste water and therefore has a direct influence on the surface water quality, in particular the organic pollution expressed as BOD.

2.5.2 Reduction of BOD in rivers due to urban waste water treatment

Industrial and agricultural production increased in most European countries after the 1940s. Because a greater proportion of the population was connected to sewage collection and treatment systems, the discharge of organic waste into surface water increased. Over the past 15 to 30 years, however, more waste water treatment plants have introduced biological treatment

(secondary treatment) and organic discharges have subsequently decreased throughout Europe.

In European rivers, biological oxygen demand (BOD) decreased by 1.6 mg/l between 1992 and 2012 (Figure 2.5).

Figure 2.6 charts the changes in BOD concentration in rivers from 2000 to 2012 and the related percentages of the population connected to at least secondary treatment of municipal waste water in 2010. There is a clear relation between BOD concentration in 2012 (red squares) and the percentage of inhabitants with secondary or more stringent treatment. However, Italy (94 % of inhabitants with adequate treatment), Belgium (73 %) and Poland (66 %) have BOD concentrations above 2 mg/l, which can be regarded as the cut-off point between slightly and moderately polluted rivers (e.g. LAWA, 1998).

The largest decreases in BOD concentrations between 2000 and 2012 were in the former Yugoslav Republic of Macedonia, Luxembourg, Bulgaria and France. Concentrations there fell by 54 %. Almost all countries with low concentrations of BOD (except Ireland, Latvia and Slovenia) have high proportions of the population (above 80 %) with at least secondary treatment. In all countries with high percentages of the population connected to at least some treatment, BOD concentrations in rivers are low or water quality is gradually improving.

2.6 Storm water overflow from combined sewers

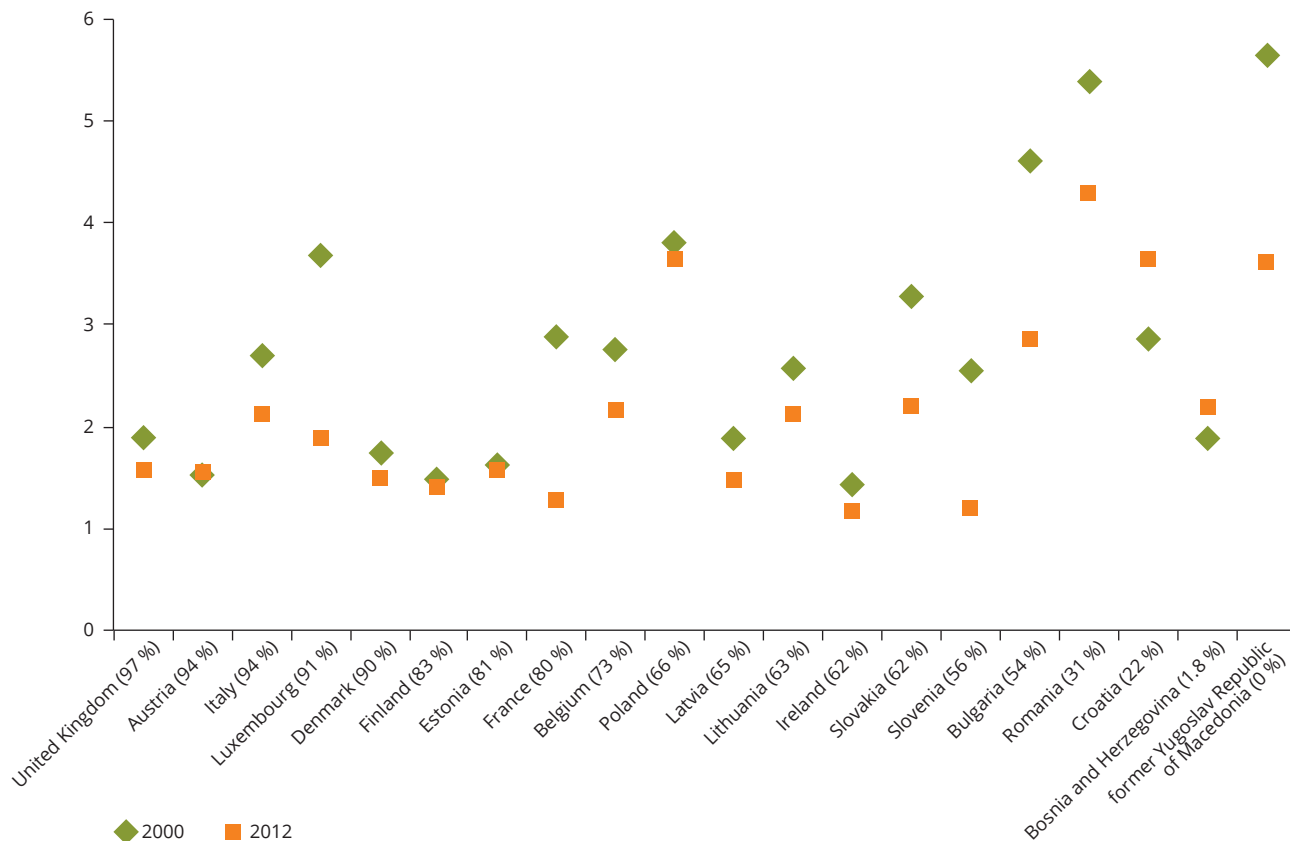
Some waste water collecting systems have separate pipes for storm water and waste water ('separate systems'), whereas other collecting systems combine both storm water and waste water in the same system of pipes ('combined systems'). Large amounts of rainfall in a short period can exceed the design capacity of the combined sewer, leading to a combined sewer overflow (CSO). If the retention capacity of the sewers or the waste water treatment plant is exceeded, the excess water can cause flooding and untreated waste water is released.

Organic substances, hydrocarbons, chemicals, heavy metals, litter and pathogens (e.g. bacteria, viruses, parasites) in the released wastewater can adversely affect water quality and aquatic life, and impair bathing or the use of drinking water from nearby drinking water supply zones. CSOs lead to multiple, uncontrolled, point sources of pathogens and pollutants to surface waters. They are one of the major threats for the quality of bathing waters (see Chapter 3), and therefore

Figure 2.6 Changes of BOD concentrations in rivers between 2000 and 2012, and proportion of population with at least secondary treatment in 2010

BOD concentrations in rivers

mg O₂/l



Note: Percentages in parentheses are of inhabitants with secondary or more stringent treatment of urban waste water, 2010.

Sources: <http://www.eea.europa.eu/data-and-maps/indicators/freshwater-quality/freshwater-quality-assessment-published-may-2>;
<http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=ten00020&plugin=1>.

for human health (Cools et al., 2016). Chemicals in such overflows may cause oxygen depletion, nutrient enrichment/eutrophication and toxic effects for aquatic organisms. These can result from pesticides, herbicides, fertilisers and other substances commonly applied to urbanised areas, farmlands and suburban gardens.

There are no EU-wide statistics on the actual number of CSOs at the agglomeration or national level. Ten EU Member States (Austria, Bulgaria, the Czech Republic, Finland, France, Germany, the Netherlands, Slovakia, Sweden and the United Kingdom) reported in 2010, under WFD reporting, that CSOs exerted significant pressure on the ecological status of surface waters in their river basin districts.

As the implementation of the UWWTD is now quite advanced, it seems likely that efforts to improve ecological status under the WFD will bring more focus

on the management of storm water overflows. By nature it will not be possible or economically feasible to design sewers to cope with all extreme events, but management measures can try to optimise the retention capacity of sewer systems. Management solutions need to control how often and how much untreated water is discharged into receiving waters.

In the future, the impacts of storm water overflows could also be influenced by climate change, as changes in precipitation can influence the frequency and volume of discharges. In the future, more intense rainfall events are expected particularly in northern and central Europe, and these might cause more frequent overflows with larger volumes. In addition, urban developments and increased sealing of ground surfaces could exacerbate the problem and result in even more run-off and greater risk of storm water overflows (Moreira et al., 2016).

2.7 Emerging risks

In addition to nutrient and organic pollution there are a number of emerging issues, some of which are as yet poorly understood with regard to their potential impacts on public health and the integrity of aquatic ecosystems.

Emerging pollutants are typically chemicals present in low concentrations but which may have harmful effects on aquatic organisms or those that feed on them. They are not necessarily new chemicals. Emerging pollutants can be defined as pollutants that are currently not included in routine monitoring programmes at the European level. They may be candidates for future regulation, depending on research into their (eco) toxicity, potential health effects and public perception, and on monitoring data regarding their occurrence in the various environmental compartments. The NORMAN network (<http://www.norman-network.net>) lists examples of emerging substances which included surfactants, flame retardants, pharmaceuticals and personal care products, petroleum additives and their degradation products, other degradation products, and various proven or suspected endocrine-disrupting compounds. Such pollutants are not currently covered by EU legislation ^(?) but the WFD provides a mechanism by which concentrations in the aquatic environment can be controlled.

Plastic in the environment is another emerging issue, especially the potential impacts of microplastics. These are pieces of plastic that have been scoured and degraded and are generally defined as being less than 5 mm in size. They have been recognised as a widespread contaminant in the marine environment (GESAMP, 2015) but their relevance is being increasingly discussed for freshwater. Research into the impacts of microplastics is under way. As yet, European water legislation does not control the sources of microplastics or their pathways from land through waste water treatment plants or from diffuse sources.

Antimicrobial resistance is highly relevant to human health. It is the acquired resistance of a microorganism to an antimicrobial drug that was originally effective for treatment of infections caused by it. Resistant microorganisms are able to withstand attack by antimicrobial drugs (e.g. antibiotics), so that standard treatments become ineffective and infections persist, increasing the risk of spreading to others (WHO, 2016). This novel risk in the aquatic environment is at an early stage of research, but some recent work shows that increases in the number of antimicrobial resistant bacteria could be associated with proximity to waste water treatment plants (Amos et al., 2014, 2015).

^(?) The European Commission is currently undertaking a regulatory fitness check relating to chemicals legislation (excluding EU regulation REACH — Registration, Evaluation, Authorisation and Restriction of Chemicals).

3 Protecting drinking water and bathing water from microbiological pollution

3.1 Introduction

Protection of human health from microbiological risks is a key aim of EU water legislation. Both the DWD and the BWD set microbiological standards to protect humans from possible infections resulting from water-based human or animal faeces.

3.2 Causes of microbiological pollution

Microbiological pollution is caused by microorganisms such as bacteria, viruses and protozoa. Microorganisms can cause severe health problems when ingested, including gastrointestinal diseases, cholera, typhoid and hepatitis. Possible risks are generally well under control and infections are rarely lethal in Europe. Humans can catch water-based infections of humans can be transmitted by drinking polluted water, by breathing

pathogen-containing droplets (e.g. legionella) or through body contact e.g. bathing in contaminated water.

Microbiological pollution of natural waters can be assessed using certain faecal indicators which show the presence of human or animal faeces in waste water. Concentrations of coliphages (viruses of the bacterium *Escherichia coli*) and intestinal enterococci are monitored to assess health risks (EPA, 2015), although they themselves are not directly harmful to humans. The threat to human health comes from the ingestion of water contaminated by pathogenic or microbiological organisms such as noroviruses or campylobacteria.

Such microorganisms are typically found in sewage water, or washouts from fields from livestock grazing, manure spreading and other farming activities. In addition, wildlife and domestic animals as well as

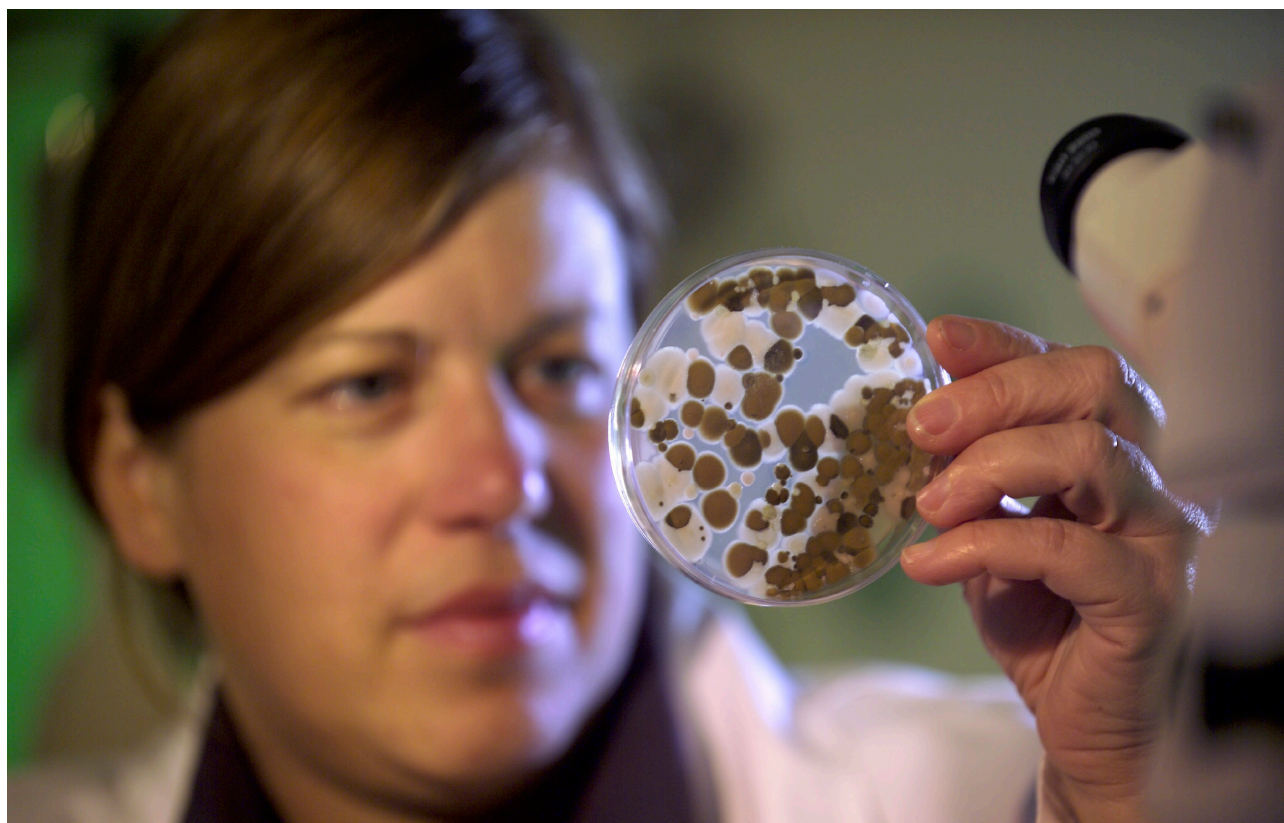


Photo: © André Künzelmann, UFZ

humans bathing or sporting in surface waters can be a source of microbiological pollution. Furthermore, some naturally occurring microorganisms can be harmful to human health (WHO, 2003b).

The most frequent causes of microbiological pollution reported under the BWD are pollution from sewage water as a result of sewer system failures or activation of storm water overflows, water draining from farms and farmland, and animals and birds on or near beaches (EEA, 2016).

Studies on the influence of effluents from waste water treatment plants and storm water overflows upon the microbiological quality of surface water usually show an increase of faecal contamination following heavy storms (WHO, 2003b). The impact might be especially large in small river catchments, where the concentrations of microorganisms downstream from storm water overflows may be 100 times greater after a storm than in dry weather. However, the actual impact of storm water overflows also depends on numerous environmental factors, so an assessment needs to be site specific.

The principal problems, combined with the specific characteristics of each bathing area, lead to a complex combination of pressures and impacts. For example, heavy rain may cause flooding of nearby pastures, resulting in washout of significant microbiological pollution into the bathing area. In Germany, authorities reported that two bathing areas in Lake Constance had to be closed for this reason in 2014. In other regions such events occur much more frequently, e.g. in the Walloon Region, where grazing of livestock on the meadows along the rivers was prohibited to stop microbiological pollution of the bathing sites. Other sources of microbiological pollution, e.g. public infrastructure, abandoned facilities or landfills near bathing water sites, may further complicate tracking the relevant source of pollution. An incident at one bathing site in Portugal in 2013 was probably caused by a malfunction at an urban waste water treatment plant (EEA, 2015). However, bathers themselves, when they gather in large numbers for extended periods, can also increase microbiological pollution of the water. In the Mediterranean this happens quite often throughout the bathing season (Saliba and Helmer, 1990).

The BWD obliges the national authorities to monitor and report on bathing water quality. Regular monitoring and assessment have led to a better understanding of the causes of microbiological water pollution. This has encouraged the development of targeted measures to reduce the microbiological

pollution in designated bathing sites. For example, Sweden has recently introduced a law that forbids all recreational ships and boats to discharge sewage into its territorial waters.

3.3 Monitoring of microbiological pollution: role of the directives

The core principle is to identify faecal pollution sources and potential entry points into the aquatic environment, and to take action to reduce the presence of, or exposure to, hazards until they reach acceptable levels. Targeted measures can include emission reductions at municipal sewage discharge points, treatment works and combined sewer overflows, and prosecutions for illegal connections to sewers (WHO, 2003b).

The EU water industry directives prescribe monitoring of bacterial groups that are essential for assessing water quality for human use. The UWWTD does not directly require monitoring of specific bacteria, but instead prescribes monitoring of BOD, phosphorus and nitrogen. These indicate levels of nutrients that are able to support bacterial life (see also Chapter 2 and Annex A3). Depending on the use of the water (bathing or drinking), different bacteria must be monitored.

Drinking Water Directive:

- *E.coli*
- Enterococci
- *Pseudomonas aeruginosa* (if water is offered for sale in bottles or containers)
- *Clostridium perfringens*, including spores (if water originates from or is influenced by surface water)
- Colony count 22°C
- Colony count 37°C (if water is offered for sale in bottles or containers)
- Coliform bacteria.

Bathing Water Directive:

- *E. coli*
- Intestinal enterococci
- Cyanobacteria.



Photo: © André Künzelmann, UFZ

The European database on bathing water quality contains almost 1.1 million samples, composing a time series of 8 years (2008–2015). The data on bacterial concentrations cover the bathing season, which is generally from June to September.

Bathing sites are located in different categories of waters, each having their own geographical, physico-chemical and hydromorphological characteristics: coastal waters, lakes, rivers and transitional waters (typically estuaries and lagoons) (Table 3.1). Twenty-seven Member States plus Albania and Switzerland reported bathing water results for 2015 (EEA, 2016). Almost three quarters of the designated bathing waters are on sea coasts; these are followed by lakes, which account for 21 % of all

samples. The BWD defines quality classification limits depending on the surface water type. Therefore, unlike other water industry directives, the BWD provides data on microbiological pollution for each water category but does not go into as much detail as the WFD, which stipulates the definition of surface water types within water categories. Reporting under the DWD provides data on the microbiological state of the tap water. Member State reporting according to the UWWTD provides monitoring data on the water discharged directly from the waste water treatment plant. Unless disinfection treatment is applied, for instance where the discharge affects a bathing water, the UWWTP discharge will still be contaminated with microorganisms (Wakelin et al., 2008).

Table 3.1 BWD samples by water category in the time period 2008–2015

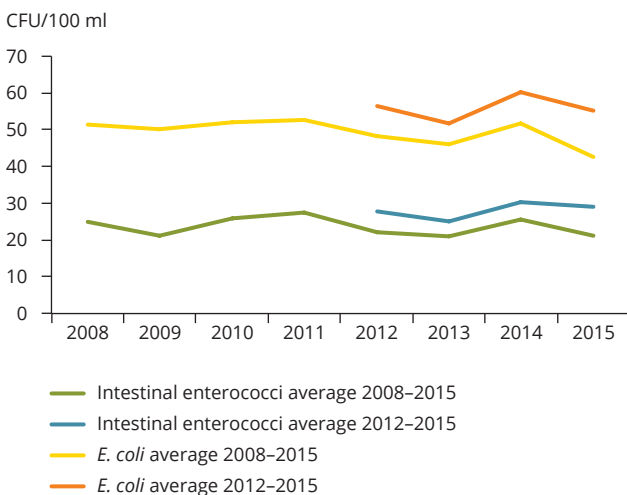
Type	BWD quality classification group	Number	% of total
Coastal	Coastal and transitional	944 530	74
Transitional		18 274	1.5
Lake	Inland	272 340	21
River		42 983	3.5
Total		1 278 127	100

Source: WISE bathing water quality database, <http://www.eea.europa.eu/data-and-maps/data/bathing-water-directive-status-of-bathing-water-8>.

3.4 Microbiological pollution of bathing waters

According to the BWD, good bathing water quality is achieved if the 95th percentile of all samples at the site in the most recent assessment period is lower than defined limits of intestinal enterococci and *E. coli*. Limits for coastal and transitional waters are 200 colony-forming units (CFU) per 100 ml of intestinal enterococci and 500 CFU per 100 ml for *E. coli*. For inland waters the limits are higher: 400 CFU per 100 ml for intestinal enterococci and 1 000 CFU per 100 ml for *E. coli*. For coastal and transitional waters, 2.2 % of all samples exceeded the limits, and likewise 2.2 % of all samples exceeded the limits for good bathing water quality in inland waters ⁽³⁾.

Figure 3.1 Overall European trends in intestinal enterococci and *E. coli* concentrations in bathing waters



Source: EEA, 2016.

Figure 3.1 shows bacterial concentrations in European bathing waters. The data since 2008 show no clear trend in bacterial concentrations, although in the 2015 bathing season a decrease in bacterial concentrations, especially for *E. coli*, can be noted.

The shorter term time series (2012–2015) cover a larger number of European bathing water sites and generally show higher, average, bacterial concentrations. This indicates that bathing waters added to the monitoring programme more recently are of lower quality.

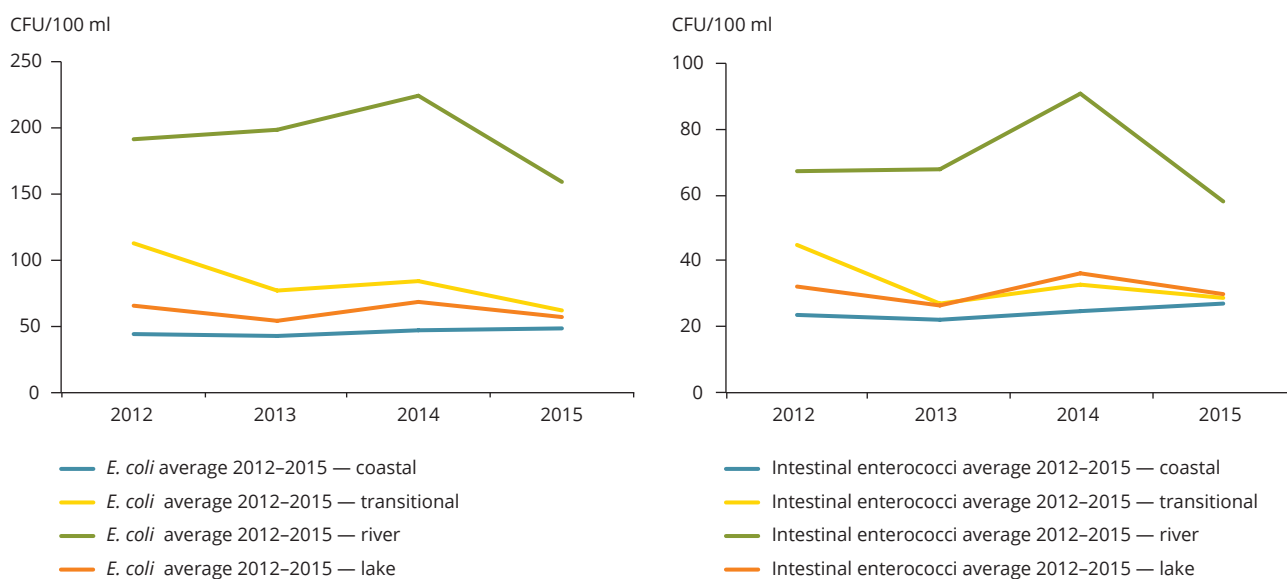
Figure 3.2 depicts bacterial concentrations for each water category: coastal, transitional, lake and river. As expected, coastal bathing waters are of better quality than other categories. They have fewer bacteria of both types because salt water provides harsher living conditions than freshwater. Coastal water bacterial concentrations are rather stable. *E. coli* concentrations are around 49 CFU per 100 ml and intestinal enterococci concentrations around 27 CFU per 100 ml. The BWD classifies transitional waters according to the same standards. However, average bacterial concentrations are higher there than in coastal water, especially concentrations of *E. coli* (rising to 62 CFU per 100 ml in the 2015 season).

Bacterial concentrations in lake bathing waters were at their lowest in the 2013 season and rose again in 2014. *E. coli* reached 57 CFU per 100 ml and intestinal enterococci reached 30 CFU per 100 ml in the 2015 season.

Riverine bathing waters are the most polluted. They have exceptionally high concentrations of both *E. coli* (159 CFU per 100 ml) and intestinal enterococci (58 CFU per 100 ml) compared with other water categories, but with averages changing over the years.

⁽³⁾ Note that national authorities can report samples as having been taken in short-term pollution periods, and yearly assessments exclude those if replacement samples are provided. This review of sample statistics, however, uses all samples for its calculations. It includes those taken during short-term pollution events because these are typical examples of microbiological pollution.

Figure 3.2 Overall European trends in *E. coli* (left) and intestinal enterococci (right) concentrations for bathing waters, by water categories



Source: EEA, 2016.



Photo: © André Künzelmann, UFZ

4 Information to the public

4.1 Introduction

As water is an essential resource for life, it is important that the public have up-to-date information on drinking and bathing water quality and about urban waste water treatment. The European citizens' initiative 'Right2Water' highlighted the level of interest in these issues. In response to this initiative, the European Commission committed itself to several actions to increase transparency with regard to water quality, supply and treatment (EC, 2014b).

4.2 Reporting obligations

Member States report to the European Commission on the implementation of each of the water industry directives in regular reporting cycles, although the reporting frequencies differ between directives. The BWD requires annual reporting of monitoring data and significant management measures implemented or planned. For the UWWTD, monitoring and spatial data must be reported within 6 months of data requests (typically biannual) and on measures to be implemented, every 2 years. Under the DWD, reports on the quality of water intended for human consumption have to be submitted every 3 years. All data are submitted in digital format into the Water Information System for Europe (WISE). This dataset is used by the EEA for assessments and thematic reports on the environment. The EC checks the compliance of the data reported by Member States against the standards and requirements set out in the directives.

Data reported under the BWD include results of monitoring of bathing water as well as information about the duration of the bathing season, abnormal situations, short-term pollution incidents and bathing water locations. UWWTD data include information on the size of the agglomerations, UWWTPs, the type of treatment, emission loads of pollutants, discharge points and spatial data on sensitive areas. The triennial DWD reports consist of general information on the number of water supply zones, number of residents and water sources, and the volume of drinking water supplied. Furthermore, Member States report on drinking water quality, and give information on

non-compliance and exceedances of standards. If water does not comply with the standards, Member States need to report remedial actions (measures) as well as time-frames for the implementation of the measures.

Under the WFD, river basin management plans need to be reported every 6 years, with 3-yearly interim reports on programmes of measures. The reported data include, for example, information on significant pressures and impacts, the status of surface water and groundwater bodies, a dedicated programme of measures for those water bodies not yet achieving good status, justification of exemptions, and information on coordination within the river basin district and public participation. Hence, the river basin management plans constitute a monitoring instrument for river basin managers, stakeholders and the European Commission.

Currently, the timetables for reporting are quite different but there are efforts under way to streamline reporting; for example, reporting for the WFD and the Floods Directive has already been aligned.

4.3 Information dissemination

Each of the water industry directives requires the public to be informed of the results. The BWD describes the requirements for dissemination of information in Article 12. The EEA produces an annual report that publishes the results of the bathing water assessments. Article 13 of the DWD covers information and reporting about water intended for human consumption. According to these articles, Member States have to ensure that the public has adequate and up-to-date information on the quality of bathing and drinking water. The UWWTD obliges the Member States to publish periodic reports about the disposal of waste water and sludge under Article 16.

The interlinkage between the EU-level information and the national information platforms is important. EU-level information provides an overview at a broader scale, enabling citizens and other stakeholders to compare the situation across the EU according

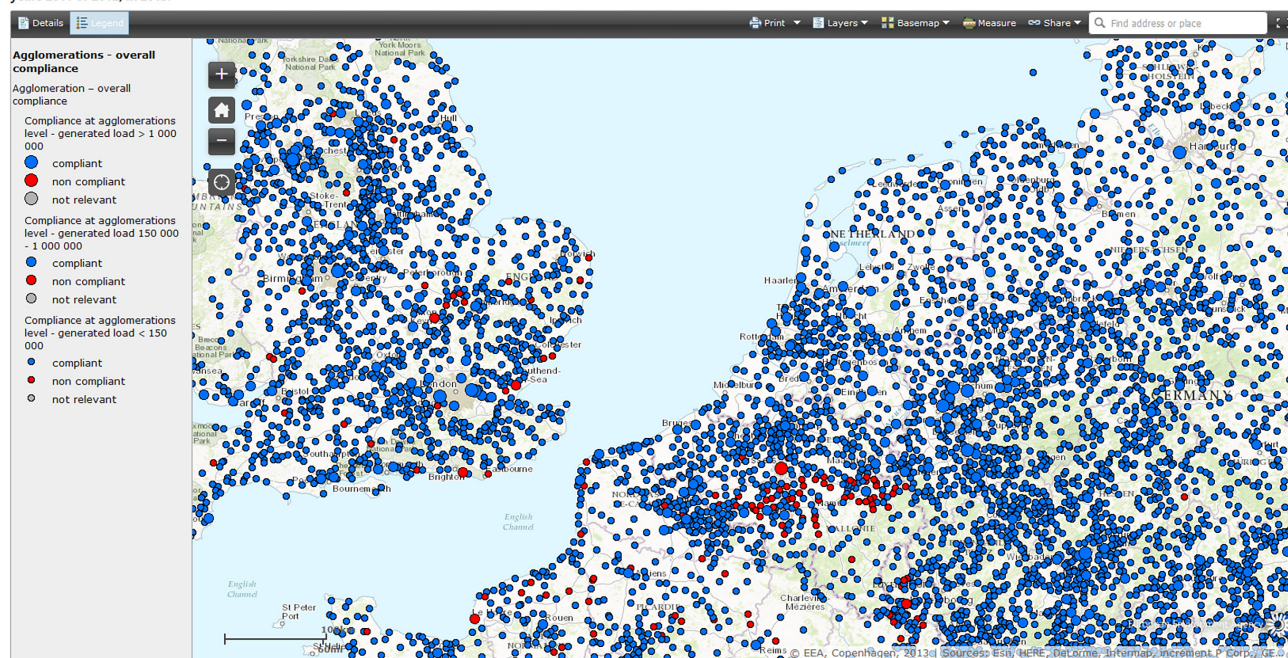
to legislative reporting requirements. National information platforms can cater more directly to a Member State's own needs and be updated more readily with the latest available information.

WISE is one of the main ways of making water information available to the public at the European level. It comprises a wide range of data and information collected by the EU institutions, and presents them through a set of map viewers and data viewers.

The viewers are accessible through the EEA's bathing water and UWWTD websites. They allow users to examine bathing water quality as well as UWWTD data across Europe. Users can check bathing water quality on an interactive map, download data for a selected country or region and make comparisons with previous years. They can examine various UWWTD data (agglomerations, discharge points, sensitive areas, treatment plants, etc.) on the UWWTD map viewer.

Figure 4.1 Urban waste water map viewer

The map reflects the most recent available information at the EU-level on implementation of the Urban Waste Water Treatment Directive (UWWTD) in EU 27 based on data reported by the Member States (for reference years 2011 or 2012) in 2013.



Source: <http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps-1>.

5 Conclusions

5.1 Integrated water management

This report has considered the aims of the Bathing Water Directive, the Drinking Water Directive and the Urban Waste Water Treatment Directive in the context of the Water Framework Directive. The different water industry directives have specific roles in delivering their respective objectives. Rather than aiming to meet a particular objective under a water industry directive in isolation, consideration of the synergies between each of the water industry directives and the WFD can lead to benefits, such as better integration of needs in the design of cost-effective measures to improve the status and quality of our waters. The WFD in combination with river basin management plans provides a powerful framework for achieving integrated water management and stakeholder dialogue across all relevant sectors.

Water of good quality for human consumption and recreation is intrinsically linked with water that is good for the environment, and all are affected by similar pressures. For example, water from the environment supplies drinking water. Drinking water is treated, if necessary, to protect people from the risks posed by raw water. Common interests between the DWD and the WFD are the protection of the raw water source and its catchment, although the DWD itself does not protect water resources. The consequence of lower raw water quality may be a higher investment in treatment or water transfers, leading to higher water prices for consumers. Discussions to better integrate DWD and WFD, for instance on water safety planning, are on-going (EC, 2014a). Considering sustainability on a broad scale, an improved understanding of the relationships and synergies between the DWD and the WFD would help integrated decision-making.

Under the WFD regime, full implementation of basic measures is required, including compliance with the UWWTD. Going beyond the requirements of the UWWTD to improve waste water treatment may be identified in river basin management plans as a necessary measure for the water body to reach good status. Meanwhile, the improvements to a waste water treatment plant undertaken to meet the UWWTD could feed into an overall improvement in status under the WFD. Focusing on the desired outcome and thinking

more broadly than sector-specific solutions can provide better information for decision-makers.

5.2 Water quality and impacts on the environment and human health

The main quality parameters of cross-cutting interest considered in this report are nutrient enrichment, organic pollution and microbiological contamination.

Increased nutrient inputs can present risks to surface and ground waters. Excess nutrients can lead to eutrophication in surface waters, a process characterised by increased plant growth, problem algal blooms, loss of life in bottom water and an undesirable disturbance to the balance of organisms present in the water. Nutrients in groundwater may be a source of pollution for surface waters if rivers or lakes are influenced by groundwater. If polluted groundwater is used for drinking, it could also pose a risk to human health, requiring additional, often energy-intensive, treatment or mixing with less-polluted, raw water.

The main sources of nitrogen and phosphorus are point source emissions from UWWTPs and industry, and diffuse emissions from agricultural production. The integrated management under the WFD provides more instruments for the reduction of these pollutants at source; it is the key instrument to set quality objectives for pressures, such as pollution, from these diffuse or point sources. Alongside the WFD, the UWWTD is one of the most important basic measures related to point sources. It has led to an increasing proportion of the EU's population being connected to urban waste water treatment, and to overall increased water treatment levels. However, reporting on small-scale sanitation is not required by the UWWTD or any other EU legislation, and its inadequacy in some locations poses a potential threat to water quality and public health.

Microbiological pollution of water intended for consumption or recreation is of primary interest for public health. Microbiological pollution originates from both point sources (discharges from waste-water treatment or even direct from sewerage systems) and diffuse surface sources (especially manure run-off

from livestock farming). The most frequent causes of microbiological pollution reported under the BWD are sewage as a result of system failures or overflows from sewage works; water draining from farms and farmland; and animals and birds on or near beaches.

5.3 Information and public interest

With their focus on the human part of the water cycle, and the quality of water for human consumption and use, the three water industry directives are of significant public interest.

The BWD, in particular, considers the public interest obliging the responsible public authorities to provide information on each bathing water site to the public in an easily accessible format during the bathing season. The EEA publishes annual reports of European bathing water quality and provides information on the EEA website, including links to national websites.

While up-to-date bathing water information is available to the public at bathing sites, availability of timely information on regional and local drinking water quality is more variable and frequently rather scarce.

For the UWWTD, the EC publishes regular implementation reports on improvements in waste water treatment. In addition, the information reported by the Member States can be found in WISE on the EEA website (<http://water.europa.eu/>) and the water data centre.

5.4 Future challenges

Existing EU water legislation has made a significant contribution towards ensuring public health and

environmental protection across Europe. However, as measures to reduce point source pollution improve, the significance of diffuse inputs will increase. Such inputs are typically more difficult to address and manage.

Surface water bodies can be affected by intermittent discharges of untreated waste water from CSOs. This will occur where there is no overflow retention capacity or capacity is exceeded. Often, the nearby watercourse (usually the surface water) receives the waste water and water quality is affected as a consequence. Multiple, point source storm water overflows represent an uncontrolled source of pathogens and pollutants to the environment. They are one of the major threats to good bathing water quality (see Chapter 2), and consequently to human health.

Diffuse pollution from agriculture can affect raw water supplies for drinking water, for example leading to the need for increased treatment or dilution with less contaminated sources. It can affect water quality, where surface runoff transports nutrients, harmful chemicals and microbiological contaminants from manure into watercourses, where there may be impacts on bathing water quality.

The long-term effects of climate change, with higher intensity rainfall, may also influence the degree of environmental impacts caused by intermittent discharges and runoff events. Pollution events may become more frequent, spilling greater volumes.

Emerging issues for water quality, which represent potential but as yet poorly understood risks, include newly identified micropollutants, microplastics and antimicrobial resistance. Improving the understanding of these topics, particularly the risk they might present to public health and water quality, presents new challenges.

References

- Amos, G. C. A., Hawkey, P. M., Gaze, W. H. and Wellington, E. M., 2014, 'Waste water effluent contributes to the dissemination of CTX-M-15 in the natural environment', *Journal of Antimicrobial Chemotherapy*, (69) 1 785–1 791 doi:10.1093/jac/dku079.
- Amos, G. C. A., Gozzard, E., Carter, C. E., Mead, A., Bowes, M. J., Hawkey, P. M., Zhang, L., Singer, A. C., Gaze, W. H. and Wellington, E. M., 2015, 'Validated predictive modelling of the environmental resistome', *ISME Journal* 1–10.
- Castiglioni, S., Bagnati, R., Fanelli, R., Pomati, F., Calamari, D. and Zuccato, E., 2006, 'Removal of pharmaceuticals in sewage treatment plants in Italy', *Environmental Science & Technology*, (40) 357–363.
- Chislock, M. F., Doster, E., Zitomer, R. A. & Wilson, A. E., 2013, 'Eutrophication: Causes, Consequences and Controls in Aquatic Ecosystems. *Nature Education Knowledge*, 4(4):10.
- Cools, J., Cavaco, Y. K., Emonts, M. and Boelee, E., 2016, *Assessment of impact of storm water overflows from combined and separate waste water collecting systems on water bodies (including the marine environment) in the 28 EU Member States.*, Final Report for Task 1.4., Specific Contract No. 070201/2014/SFRA/693725/ENV/C.2. (<https://circabc.europa.eu/sd/a/8e7b4f1d-f1b7-4bf8-a54e-ac9795ebeb50/Task%204%20Health%20impact>) accessed 17 October 2016.
- EC, 1991a, Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1991L0271:20081211:EN:PDF>) accessed 19 October 2016.
- EC, 1991b, Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0676:EN:HTML>) accessed 17 October 2016.
- EC, 1998, Council Directive 98/83/EC of November 1998 on the quality of water intended for human consumption (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:EN:PDF>) accessed 17 October 2016.
- EC, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>) accessed 19 October 2016.
- EC, 2002–2013, 'The European Commission synthesis reports on the implementation of Council Directive concerning Urban Waste Water Treatment' (http://ec.europa.eu/environment/water/water-urbanwaste/implementation/implementationreports_en.htm) accessed 17 October 2016.
- EC, 2006a, Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:064:0037:0051:EN:PDF>) accessed 19 October 2016.
- EC, 2006b, Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:372:0019:0031:EN:PDF>) accessed 19 October 2016.
- EC, 2008a, Water Notes on the Implementation of the Water Framework Directive. Water Note 2., *Cleaning up Europe's waters: Identifying and assessing surface water bodies at risk*, Water Note 2, Brussels (http://ec.europa.eu/environment/water/participation/pdf/waternotes/water_note2_cleaning_up.pdf) accessed 17 October 2016.
- EC, 2008b, Water Notes on the Implementation of the Water Framework Directive. *Integrating water policy: Linking all EU water legislation within a single framework*, Water Note 9, Brussels (http://ec.europa.eu/environment/water/participation/pdf/waternotes/water_note9_other_water_legislation.pdf) accessed 17 October 2016.

- EC, 2012, *Sustainable water ecosystems management in Europe — Bridging the knowledge of citizens, scientists and policy makers*, Editor: C. Sassa, C. (ed.), IWA Publishing, London.
- EC, 2013a, Decision 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN>) accessed 17 October 2016.
- EC, 2013b, Directive 2013/39/ of the European Parliament and of the Council of 12 August 2013 amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:226:0001:0017:EN:PDF>) accessed 19 October 2016.
- EC, 2014a, Joint Workshop on Better Integration of Drinking Water Resources Protection Considerations into River Basin Management Planning 1–2 October 2014 ([https://circabc.europa.eu/d/a/workspace/SpacesStore/cd635f66-6dd7-4813-b27e-2af1abf24c6c/SummaryReport%20on%20DWD~WFD%20Rome%20workshop\(rev\).doc](https://circabc.europa.eu/d/a/workspace/SpacesStore/cd635f66-6dd7-4813-b27e-2af1abf24c6c/SummaryReport%20on%20DWD~WFD%20Rome%20workshop(rev).doc)) accessed 19 October 2016.
- EC, 2014b, 177 final COMMUNICATION FROM THE COMMISSION on the European Citizens'Citizens' Initiative "Water and sanitation are a human right! Water is a public good, not a commodity!", Brussels (<http://ec.europa.eu/transparency/regdoc/rep/1/2014/EN/1-2014-177-EN-F1-1.Pdf>) accessed 17 October 2016.
- EC, 2014c, Synthesis Report on the Quality of Drinking Water in the EU examining the Member States' reports for the period 2008–2010 under Directive 98/83/EC. (http://ec.europa.eu/environment/water/water-drink/pdf/report2014/1_EN_ACT_part1_v3.pdf) accessed 23/11/16.
- EC, 2015a, COMMISSION DIRECTIVE (EU) 2015/1787 of 6 October 2015 amending Annexes II and III to Council Directive 98/83/EC on the quality of water intended for human consumption. (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L1787&from=EN>) accessed 19 October 2016.
- EC, 2015b, *Technical assessment of the implementation of Council Directive concerning Urban Waste Water Treatment (91/271/EEC)*, Final version 25 March 2015 ') (http://ec.europa.eu/environment/water/water-urbanwaste/implementation/implem_report_2016/8th%20Technical%20assessment%20of%20information%20on%20the%20implementation%20of%20Council%20Directive%2091-271-EEC.pdf) accessed 18 October 2016.
- EC, 2016, Eighth Report on the Implementation Status and the Programmes for Implementation (as required by Article 17) of Council Directive 91/271/EEC concerning urban waste water treatment (<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52016DC0105>) accessed 18 October 2016.
- EEA, 2012, *European waters — Assessment of status and pressures*, EEA Report No 8/2012, European Environment Agency (<http://www.eea.europa.eu/publications/european-waters-assessment-2012>) accessed 18 October 2016.
- EEA, 2015, *European bathing water quality in 2014*, EEA Report No 1/2015, European Environment Agency (<http://www.eea.europa.eu/publications/european-bathing-water-quality-in-2014>) accessed 18 October 2016.
- EEA, 2016, *European bathing water quality in 2015*, EEA Report No 9/2016, European Environment Agency (<http://www.eea.europa.eu/publications/european-bathing-water-quality-in-2015>) accessed 18 October 2016.
- EEC, 1975, Council Directive of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (75/440/ EEC) (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31975L0440&from=en>) accessed 19 October 2016.
- EEC, 1976, Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1980L0778:19950101:EN:PDF>) accessed 18 October 2016.
- EEC, 1979, Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances. (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31980L0068&from=EN>) accessed 19 October 2016.
- EEC, 1980, Council Directive of 15 July 1980 relating to the quality of water intended for human consumption (80/778/EEC) (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1980L0778:19950101:EN:PDF>) accessed 19 October 2016.

- EPA, 2015, 'Basic information about pathogens and indicators in drinking water' (<https://assets.documentcloud.org/documents/2462002/basic-information-about-pathogens-and-indicators.pdf>) accessed 18 October 2016.
- Gadipelly, C., Pérez-González, A., Yadav, G. D., Ortiz, I., Ibáñez, R., Rathod, V. K. and Marathe, K. V., 2014, 'Pharmaceutical industry waste water: review of the technologies for water treatment and reuse', *Industrial & Engineering Chemistry Research*, (53) 11 571–11 592 (doi:10.1021/ie501210j).
- GESAMP, 2015, 'Sources, fate and effects of microplastics in the marine environment: a global assessment' (Kershaw, P. J., ed.). (IMO/FAO/UNESCO-IOC/ UNIDO/ WMO/ IAEA/UN/ UNEP/ UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud.), 2015, *Sources, fate and effects of microplastics in the marine environment: A global assessment*, Kershaw, P. J. (ed.), GESAMP Reports and Studies No. 90, 96 p.
- Hammerl, M. and Gattenhoehner, U., 2003, 'Lake Basin Management Initiative — Experience and lessons learned brief. Lake Constance/Bodensee. PaperBodensee', paper presented at the Lake Basin Management Initiative Regional Workshop for Europe, Central Asia and the Americas in June 2003, Vermont, USA, June.
- Holländer, R., Zenker, C., Pielen, B., Geyler, S. and Lautenschläger, S., 2008, *Trinkwasserpreise in Deutschland — Welche Faktoren begründen regionale Unterschiede?*, Report for Verband Kommunaler Unternehmen (VKU), Leipzig.
- Hulsmann, A., Klaassens, E., Kros, H., Römkens, P. and de Vries, W., 2015, *Background document for stakeholder meeting on the evaluation of the Drinking Water Directive 98/83/EC — Tuesday, 26 May 2015, Brussels* (<http://www.safe2drink.eu/wp-content/uploads/2015/05/DWD-Stakeholder-meeting-May-2015-Background-document.pdf>) accessed 19 October 2016.
- International Commission for the Protection of Lake Constance, 2013, *Faktenblatt 'Phosphor im Bodensee'* (http://www.igkb.org/fileadmin/user_upload/dokumente/aktuelles/IGKB_Faktenblatt_P_im_BS.pdf) accessed 18 October 2016.
- Kraemer, R. A., Pielen, B. and de Roo, C., 2007, 'Regulation of water supply in Germany', *CESifo DICE Report*, Vol. (5, No 2,) 21–26.
- KWR, 2011, The quality of drinking water in the European Union 2005–2007. (<https://circabc.europa.eu/d/a/workspace/SpacesStore/b580866d-8eb7-4937-9a97-d3d3485d046e/2005-2007%20SynthesisReport.pdf>) accessed 23 November 2016.
- LAWA (Länderarbeitsgemeinschaft Wasser) 1998, *Beurteilung der Wasserbeschaffenheit von Fließgewässern in der Bundesrepublik Deutschland — Chemische Gewässergüteklassifikation*, Länderarbeitsgemeinschaft Wasser, Berlin.
- Moreira, G., Cools, J., Jurkiewicz, K., DamirKuipers, Y.K., Petrović, D. and Zamparutti, T., 2016, *Assessment of impact of storm water overflows from combined waste water collecting systems on water bodies (including the marine environment) in the 28 EU Member States*. Final, final report. Specific Contract No. 070201/2014/SFRA/693725/ENV/C.2 (<https://circabc.europa.eu/sd/a/c57243c9-adeb-40ce-b9db-a2066b9692a4/Final%20Report>) accessed 18 October 2016.
- Saliba, L. and Helmer, J. R., 1990, 'Health risks associated with pollution of coastal bathing waters', *World Health Statistics Quarterly*, (43) 177–187.
- Umweltministerium BW, 2001, 'Verordnung des Umweltministeriums über Schutzbestimmungen und die Gewährung von Ausgleichsleistungen in Wasser- und Quellenschutzgebieten' (Schutzgebiets- und Ausgleichs-Verordnung — SchALVO) vom 20. Februar 2001, letzte Änderung Dezember 2013 (<http://www.landesrecht-bw.de/jportal/?quelle=jlink&query=WasSchAusgIV+BW&psml=bsbawueprod.psml&max=true>) accessed 18 October 2016.
- Wakelin, S. A., Colloff, M. J. and Kookanal, R. S., 2008, 'Effect of wastewater treatment plant effluent on microbial function and community structure in the sediment of a freshwater stream with variable seasonal flow', *Applied and Environmental Microbiology*, (74) 2659–2668 (<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2394891>) accessed 19 October 2016.
- WHO, 2003a, *Cyanobacterial toxins — Microcystin-LR in drinking-water*, Background document for development of WHO Guidelines for Drinking-water Quality, World Health Organization, Geneva.
- WHO, 2003b, *Guidelines for safe recreational water environments — Coastal and fresh waters*, World Health Organization, Geneva.
- WHO, 2011, *Guidelines for drinking-water quality*, 4th Ed., World Health Organization, Geneva.
- WHO, 2016, *Antimicrobial resistance fact sheet*, World Health Organization, Geneva. (<http://www.who.int/mediacentre/factsheets/fs194/en>) accessed 17 October 2016.

Annex Results reported under the three water industry directives

The reporting cycles of the three water industry directives are different: the BWD reports every year, the UWWTD every two years and the DWD every three years. The European Commission together with the

EEA and consultancies developed assessments based on UWWTD in 2013–14 and DWD water quality data in 2011–2013 and we can now present them together with the bathing water data from 2015 (EEA, 2016).

A1 Bathing Water Directive



Photo: © UFZ, Norma Neuhaus

A1.1 Introduction

The BWD safeguards public health and protects the aquatic environment in coastal and inland areas from pollution. To manage water quality, Member States monitor bathing water during the bathing season. They take samples of bathing water and analyse them to assess the concentrations of two bacteria, *E. coli* and intestinal enterococci. This has to happen once a month during the bathing season, with a minimum of four samples per season collected at each bathing water site.

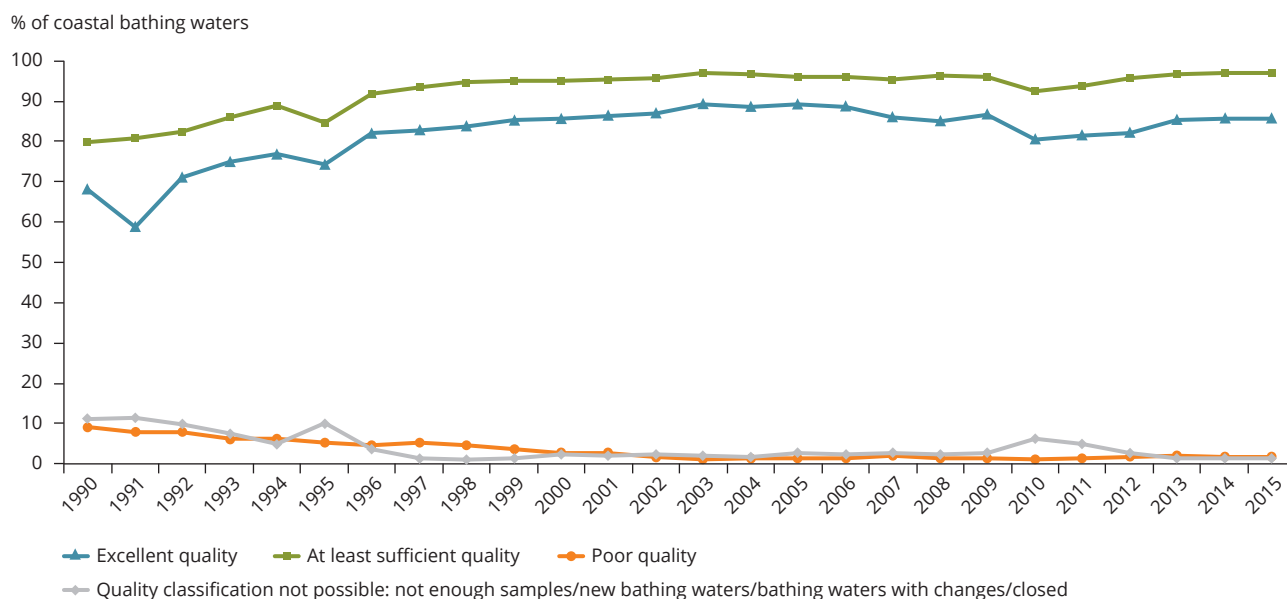
Throughout the bathing season, local or national governments publish monitoring results to inform the public about possible health risks when bathing. For all of their bathing water sites, countries also prepare bathing water profiles and ensure those are available to the public. These descriptions of physical, geographical and hydrological conditions cover a single site or contiguous sites. They also list potential impacts on water quality and potential threats to it. At the end of each bathing season, Member State authorities send their data to the EC and the EEA. Assessment results are then published in national reports, EU reports and interactive viewers, and the BWD data viewer.

The number of European bathing water sites varies from year to year, between 21 000 and 22 000. Two thirds of them are coastal; the remainder are inland, in rivers and lakes. By the end of the 2015 bathing season, all monitored bathing water sites should have reached at least 'sufficient' quality. Therefore, those with poor quality will have to take improvement measures or be closed for bathing.

A1.2 Bathing water quality

Bathing water in Europe continues to be of high quality. The percentage of bathing water sites meeting the minimum water quality standards (i.e. of at least 'sufficient' quality) increased from 92 % in 2010 to 96.1 % in 2015. The proportion assessed as 'excellent' in 2015 reached 84.4 %, an increase of 9.7 percentage points from 2010. Fewer than 2 % of bathing water sites were assessed as being of 'poor' quality (i.e. failing to meet the BWD's minimum standards) in 2015.

For some sites, quality cannot be assessed because the required number of samples is not available. The number of such sites has significantly decreased over the years. In 2010, 6.5 % could not be assessed; by 2015 this proportion had fallen to 2.3 % of all bathing water sites.

Figure A1.1 Percentage of EU coastal bathing water sites in each compliance category

Source: EEA, 2016.

Coastal bathing water sites in the EU

The majority of reported EU coastal bathing water locations are in France, Italy and Spain. Of all coastal waters in the EU, 97 % achieved the minimum quality standards established by the EU directives and 86 % were of excellent quality in 2015.

The proportion of coastal bathing water sites that achieved at least 'sufficient' quality (i.e. were compliant with mandatory values) increased from just under 80 % in 1990 to over 96 % in 2003. Since then, it has remained fairly stable (Figure A1.1). A minor drop in the percentage of 'at least sufficient' bathing waters happened between 2009 and 2012 as an effect of implementing the revised BWD. The proportion of coastal bathing water sites of excellent quality



Photo: © UFZ

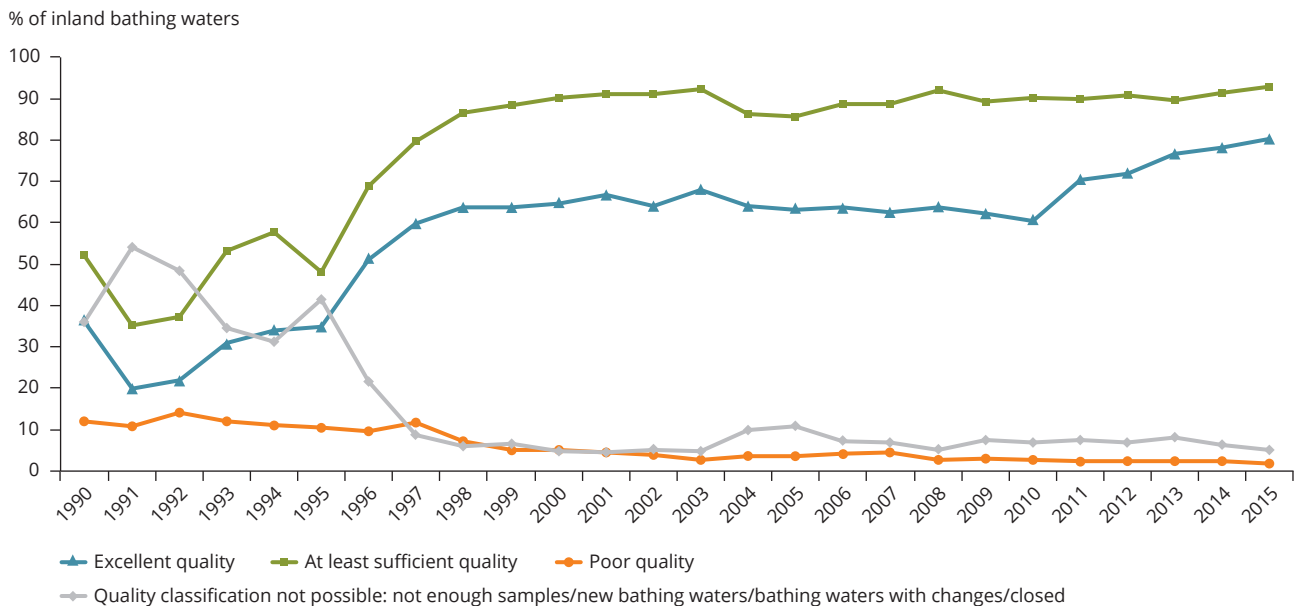
(compliant with guide values) also increased from 1990 to 2000, before reaching a plateau. For the last 5 years, the trend has been positive again.

Very few coastal bathing water sites (1.6 %) were of poor quality and did not comply with mandatory values. This represents a slight decrease from 2014. It also represents a change in direction from the trend of the previous years, which saw the proportion of poor-quality sites increase between 2010 (1.1 %) and 2013 (1.9 %).

Inland bathing water sites in the EU

In 2015, Member States monitored more than 6 000 bathing sites on rivers and lakes across Europe. The vast majority (80 %) of inland bathing water locations are on lakes. In 2015, 93 % of inland bathing waters in the EU were of at least sufficient quality, and the percentage of inland sites of poor quality dropped below 2 % for the first time since 1990.

The proportion of inland bathing water sites of excellent quality has been constantly growing (Figure A1.2). In 1995, fewer than 40 % of inland sites were excellent. In 1998, this proportion exceeded 60 %, and it remained more or less stable until 2011. The proportion of inland bathing water sites that achieved excellent quality (i.e. complied with the guide values) has increased significantly from 1995, reaching 80 % in 2015.

Figure A1.2 Percentage of EU inland bathing water sites in each compliance category

Source: EEA, 2016.

A1.3 Non-compliant and poor bathing water sites

Bathing water sites that do not comply with monitoring provisions

The BWD contains a number of requirements related to bathing water management and monitoring. The basic monitoring requirements consist of taking a pre-season sample, a minimum of four samples per season and a minimum of one sample per month. These conditions must be met for all reported bathing water sites. Bathing water sites that do not meet the criteria are categorised as 'sampling frequency not satisfied'. However, most Member States take more samples than required, to ensure that the results are reliable and minimise any potential risks. Sometimes Member States do not fulfil the monitoring requirements because the sampling starts too late, they do not take not enough samples or sampling is not possible as a result of abnormal situations such as floods or droughts.

In 2015, more than 400 bathing water locations in Europe had insufficient sampling frequencies. Nevertheless, their monitoring data that are available show that many of these non-compliant bathing water sites were of sufficient, good or even excellent quality.

Poor-quality bathing water sites

Many human activities result in water pollution. Pollution gets into the water from many sources and takes many forms. During the 20th century, increased population growth led to increased waste water production from urban areas and industry, resulting in a marked increase in water pollution. Many years of investment in the sewerage system, combined with better waste water treatment, have led to Europe's bathing water being much cleaner today than 30 years ago, when large quantities of untreated or partially treated urban and industrial waste water were discharged into bathing water areas. Nevertheless, there are still some major sources that prevent the quality of some bathing water sites from improving. Faecal contamination is a cause of concern for public health; raw sewage and animal waste have high levels of bacteria and viruses. Swimming at contaminated beaches or bathing lakes can result in illness.

The major sources of pollution responsible for faecal bacteria in bathing water are:

- Sewage: bacteria from sewage can enter our waters as a result of system failures or overflows from

sewerage works. Insufficiently treated waste water of this sort finding its way into freshwater and the sea continues to be a pollution problem at some beaches.

- Farms and farmland: poorly stored slurry or manure from livestock can wash into streams, resulting in the pollution of downstream bathing water. Scattered houses with misconnected drains and poorly located or poorly maintained septic tanks can also cause pollution. Pollution from farmlands and from sewage increases during heavy rain, which washes more pollution into the rivers and seas and can cause sewerage systems to overflow.
- Animals and birds on or near beaches: bathing water can be affected by dog, bird and other animal faeces, as they often contain high levels of bacteria. Crowded beaches with many swimmers may also result in poor quality, although it helps if people use the toilet and shower before swimming (EEA, 2016).

The highest rates of bathing water sites of poor quality in 2015, with over 3 % of sites, were in the United Kingdom (31 sites, 4.9 %), Ireland (6 sites, 4.4 %), the Netherlands (24 sites, 3.4 %) and Bulgaria (3 sites, 3.2 %).

Member States are encouraged to report reasons for poor water quality at each of these bathing water sites. Ideally, along with reasons, they should report management measures to improve water quality.

Water policy integration

Efficient bathing water management often goes well with implementation of other water policies such as the UWWTD (adequate collection, treatment and discharge of urban waste water and waste water from certain industrial sectors) or the WFD (achieving good chemical and ecological water body status). Box A1.1 illustrates an example of how adequate implementation of one policy brought a positive result in implementing another policy and vice versa.

A1.4 Country comparison

There is a huge diversity of beaches within Europe, from the warm Mediterranean Sea to the colder Baltic Sea and North Atlantic Ocean. Lakes and rivers also have a great variety of bathing locations. The geographical coverage for the whole bathing water data set is wide and relatively dense, with sampling points

Box A1.1 Successful water policy integration: the case of Ardmore Beach (Ireland)

Ardmore Beach is a sandy beach on the south coast of Ireland near Ardmore village. During the bathing season, approximately 500 people per day visit the bathing water site. Surfing, body-boarding and kayaking are popular activities, as well as swimming. Besides recreational value, biodiversity on and near the beach is relatively high. Between the beach and the boat harbour, low tide gives access to numerous rock pools, which are home to a variety of plants and animals such as shrimps, crabs, small fish and anemones. There are areas of natural heritage conservation interest both east and west of Ardmore Beach. It includes good examples of coastal dry heather and vegetated sea cliffs (both listed in the Habitats Directive) and is of great ornithological importance. The Blackwater estuary, west of Ardmore Beach, is an internationally important wetland site because of the population of black-tailed godwits it supports.



Photo: Bathing water at Ardmore Beach © Paul Carroll

The bathing water is sampled at least every 30 days. During the 2014 bathing season, southerly tidal and wind conditions interfered with the normal dispersion and dilution of screened sewage from the nearest waste water treatment plant. As a consequence, bacterial levels in the bathing water rose. To mitigate these, measures were taken at the treatment plant, which included chlorinating the discharged waters during the bathing season. During operational testing, increased chlorine dosage levels were used to reduce the amount of faecal organisms in the bathing water. Samples taken after the application confirmed that bacterial levels were lower, allowing the bathing water advisory notice to be removed.

Screening and chlorination of sewage discharge during bathing season mitigated bacterial levels. The national authorities also plan to build a new treatment plant.

on marine, transitional and fresh waters throughout the continent.

Every country has its own specifics when implementing the BWD and managing bathing water. These depend on physical characteristics as well as economic, political and social constraints. Nevertheless, all Member States are making an effort to improve the quality of bathing water and provide up-to-date information to the public about monitoring results, potential risks and other issues. Many of them face problems that affect bathing water quality. Such problems can result from natural phenomena such as floods and droughts, as well as human activities (e.g. pollution from sewage and water draining from farms and farmland).

All Member States had started implementing the revised BWD by 2012, some of them already in 2007. Albania and Switzerland, non-Member States, also report their data on bathing water quality to the EC and EEA.

The EEA bathing water viewer (<http://www.eea.europa.eu/themes/water/interactive/bathing/state-of-bathing-waters>) shows results in more detail. In 2015, Austria, Croatia, Cyprus, Germany, Greece, Italy, Luxembourg and Malta reported that at least 90 % of bathing water sites were of excellent quality. In spite of these good results, even these countries also had some poor-quality sites. For example, there were 5 in Germany (0.2 %) and 95 in Italy (1.7 %).

A1.5 Short-term pollution and abnormal situations

When the cause of pollution is clearly identifiable, it is normally expected to affect the bathing water quality for not more than approximately three days (EC, 2006). This can be reported as 'short-term pollution'. The competent authorities should have established procedures to predict and deal with consequences of such events.

In 2015, 722 short-term pollution events were reported at 587 bathing water sites. This is a decrease from 739 (at 608 sites) in 2014. The countries that reported the largest numbers of short-term pollution events were Italy (156 sites, 2.9 % of the total), France (115, 3.4 %) and Spain (114, 5.2 %).

Short-term pollution is clearly distinguished from the general poor quality of some bathing water sites. If bathing water is classified as 'poor' for 5 consecutive years, bathing is banned permanently or permanent advice against bathing is introduced.

An abnormal situation is an event or combination of events affecting bathing water quality at the location concerned and not expected to occur on average more than once every 4 years (EC, 2006). An example is the flooding that happened in central Europe in late May and early June 2013. The floods primarily affected regions along the Elbe and Danube rivers, affecting bathing water sites in the region, as well as the monitoring and management of water quality. During the 2013 season, 313 abnormal situations caused by flooding were reported to affect European bathing water sites. At least 223 of them can be attributed to the central European floods. Monitoring took place after the floods and adequate quality assessment samples were available for some affected bathing water sites.

A1.6 Measures to improve bathing water quality

The BWD requires large-scale measures to manage bathing water sites of persistently poor quality. It strongly encourages Member States to introduce management measures to improve quality to at least 'sufficient', or even to 'good' or 'excellent', status.

When unexpected or uncontrollable conditions occur (heavy rain, sewage spills, hazardous waste spills, floods, etc.), Member States must impose temporary management measures. Such measures can include informing the public, implementing effective modelling and warning systems, prohibiting bathing, and various measures to prevent, reduce or eliminate causes of pollution. They might temporarily close bathing water that requires such measures, for part or all of the bathing season.

To improve water quality and safeguard public health, Member States are also implementing long-term management measures. These include building adequate waste water treatment plants, limiting pollution from agriculture, surveillance, early warning systems and other measures taken as part of river basin management planning under the WFD (see also Chapter 3).

Management measures are primarily implemented at those bathing water sites that have only sufficient or poor water quality. Such measures can include reducing the frequency of storm water overflows, construction of waste water treatment plants, reducing the pollution from farms and farmland, and measures to restrict the number of animals (when bathing water is affected by large number of resting birds or dogs) (EEA, 2016).

Between 2014 and 2015, 125 bathing water sites improved status from poor to sufficient or better (Map A1.1). However, in the same period, 76 sites changed their status from sufficient or better to poor.

A1.7 Information dissemination

For all of their bathing water sites, countries prepare descriptions of physical, geographical and hydrological conditions and ensure those are available to the public. Member States are obliged to encourage participation by the public concerned. They must provide information on how to participate and guidance on formulating suggestions, remarks or complaints. This particularly relates to setting up, reviewing and updating lists of bathing water sites. Competent authorities should take due account of any information obtained. Bathing water authorities must provide information that becomes available during the bathing season actively and promptly to the public concerned, in an easily accessible place near each bathing area. Short-term pollution should also be noted, along with its reasons and expected duration, as well as notes on similar events in previous bathing seasons. If

permanent advice against bathing is introduced, the area must be removed from the list of bathing water sites. All this information is also reported to the EC and the EEA, so the reports can give a comprehensive European overview each year. The reports give adequate up-to-date information on how effectively the BWD is implemented.

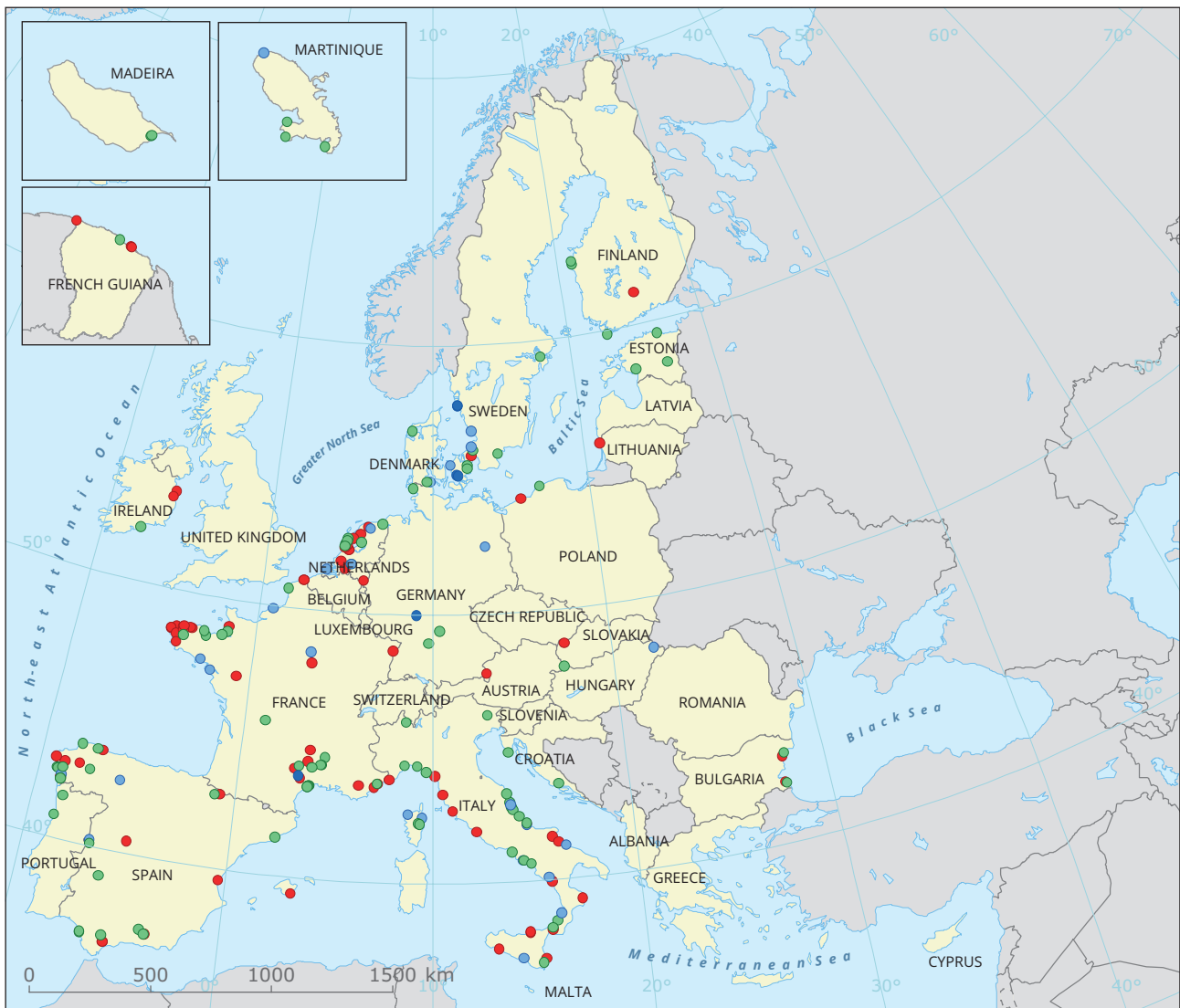
Besides national reports, Member States also use the media, including the internet, to disseminate information about bathing waters. To provide comprehensive information to the public, all Member States have established national or local websites. Most of them have linked web pages for individual bathing sites. These web pages generally include a map search function and allow public access to the monitoring results, both in real time and for previous seasons, as well as additional descriptions of water quality, management measures and legislative backgrounds. Other ways of disseminating information about bathing water quality include press conferences before the bathing season, public information broadcasts on television and especially local radio, and printed leaflets for people who do not use digital media.

Box A1.2 Measures to reduce diffuse water pollution from agricultural and urban sources in the United Kingdom

Authorities in the United Kingdom are working with farmers and others to develop measures to reduce diffuse water pollution from agricultural and urban sources, and to provide information and advice to achieve the goals of the BWD and WFD. Different mechanisms are used in different parts of the United Kingdom:

- In England, the Environment Agency collects evidence of diffuse pollution from agriculture. The Rural Development Programme for England (RDPE) uses this to implement measures in the water bodies where they will deliver the greatest benefit. A key project in this programme is Catchment Sensitive Farming (CSF), which provides advice and capital grants to reduce diffuse pollution from agriculture.
- In Wales, the Flood and Water Management Act 2010 provides a framework for implementing sustainable drainage systems (SuDS) for new developments. The works planned by Schedule 3 of this act are under way in 2016. In addition, following consultation early in the year, voluntary standards and guidance for the construction of SuDS for new developments were published in December 2015. The Natural Resources Wales continues to undertake investigations to identify sources of contamination where they affect bathing water quality.
- The Scottish Environment Protection Agency is working with land managers, organising events and workshops to raise awareness and discuss actions. The Scotland Rural Development Programme 2014–2020 also offers funding to land managers towards the cost of certain measures to reduce diffuse pollution.
- In Northern Ireland, 12 000 farmers are participating in agri-environment schemes involving over 450 000 hectares of land. The Northern Ireland Rural Development Programme manages the projects. Countryside Management Scheme (NICMS) participants must prepare and implement a plan for managing farm nutrients and waste.

Map A1.1 Improvements and deteriorations in bathing water quality



Bathing water sites where quality improved from poor in 2014 to sufficient, good, or excellent in 2015; and bathing water sites where quality deteriorated from excellent, sufficient, or good in 2014 to poor in 2015

- EU Member States and other countries with results
- Outside coverage

Bathing water sites where quality improved from poor in 2014 to sufficient, good, or excellent in 2015

- Excellent water quality
- Good water quality
- Sufficient water quality

Bathing water sites where quality deteriorated from sufficient, good, or excellent in 2014 to poor in 2015

- Poor water quality

Source: EEA, 2016, <http://www.eea.europa.eu/data-and-maps/figures/bathing-water-sites-that-were-2>.

A2 Drinking Water Directive



Photo: © Robert Owen-Wahl freeimages.com

A2.1 Introduction

Legislation

The DWD aims to ensure that water intended for human consumption is safe. The objective of this Directive is to protect human health from the adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean. It applies to all water intended for human consumption apart from natural mineral waters and waters that are medicinal products.

The directive came into force in 1998 and replaced Directive 80/778/EEC and was amended in 2015 (EC, 2015a). Twenty-seven Member States of the EU have enacted it in their national legislation and have to comply with its requirements (Croatia does not yet have to comply with the DWD).

The directive:

- sets the general obligation that drinking water must be wholesome and clean, and sets quality standards for drinking water quality parameters (microbiological, chemical, indicator parameters and radioactivity) ;

- obliges Member States to monitor drinking water quality regularly, to take remedial action if the monitoring reveals problems and to provide consumers with adequate and up-to-date information on the quality of their drinking water;
- allows Member States to exempt water supplies serving fewer than 50 persons or providing less than 10 m³ of drinking water per day on average.

Drinking water quality parameters

The directive sets standards for the most common organisms and substances that can be found in drinking water. A total of 48 parameters must be monitored and tested regularly. In general, the basis for the standards is the WHO's guidelines for drinking water and the opinion of the EC's Scientific Advisory Committee.

Annex I of the directive divides the parameters into microbiological parameters, chemical parameters, indicator parameters and radioactivity.

The two *microbiological parameters* are *E. coli* and enterococci. Their parametric value is a substitute for zero. In other words, these organisms should be absent from drinking water to guarantee its quality.



Photo: © André Künzelmann, UFZ

The *indicator parameters* indicate that something has changed in the source, the treatment or the distribution of the water. This needs to be investigated and may require urgent action. Most indicator parameters do not pose a direct threat to human health, but they might have an indirect impact through the appearance, taste or odour of the water, making it less acceptable to the consumer, or they might interfere with proper treatment. For example, organic matter may make disinfection inadequate.

The *chemical parameters* were selected for their potential impact on human health, and they do not closely match the list of priority substances for surface waters under the WFD. Apart from accidents, chemicals are almost never present in drinking water in concentrations that cause acute health effects. They include trace elements, such as arsenic, nickel or lead, and other substances, such as cyanide, polycyclic aromatic hydrocarbons or nitrogen compounds (nitrate and nitrite). In particular, these parameters cause 'blue baby syndrome' (see Chapter 5). Furthermore, the impact of these chemicals depends on how they affect the human body. Mostly, the parametric values are based on lifelong exposure and an average intake of 2 l of drinking water per person per day.

Member States may, for a limited time, deviate from the chemical quality standards specified in Annex I of the directive. This process is called 'derogation'. A derogation can be granted if it does not constitute a potential danger to human health and if there is no other reasonable means of maintaining the supply of water intended for human consumption in the area concerned.

For the case of water supplied from a distribution network, the DWD requires that the drinking water quality parametric values should be met in at the point within premises or an establishment, at which water emerges from the taps that are normally used for human consumption.

Water supply zones and dependency on environmental pressures

Assessing drinking water quality is based on the spatial scale of a water supply zone. A water supply zone is 'a geographically defined area within which water intended for human consumption comes from one or more sources and within which water quality may be considered as being approximately uniform' (Annex II, DWD). This means that a water supply zone could be a waterworks that collects and processes raw water from two drinking water reservoirs; or it could also be an elevated tank that supplies a district with drinking water.

The directive makes a distinction between large and small water supply zones. Large water supply zones supply more than 1 000 m³ of drinking water per day, on average, or serve more than 5 000 persons. Small water supply zones are sub-divided into three further categories: category 1 supplies 10–100 m³ per day; category 2 supplies 100–400 m³ per day; and category 3 supplies 400–1 000 m³ per day.

From a water manager's perspective, the level of treatment required in a particular water supply zone depends on the quality of water it receives from its sources. Water efficiency measures are worth exploring if there are shortages of raw water or if polluted sources require costly treatment. The option to transfer water from another basin with abundant



Photo: © Kris Van den Belt

resources would need to be assessed, with the financial and environmental costs of transfer against the costs of treatment and possibility to reduce pollution at source (for costs of transport see also, for example, Kraemer et al., 2007; Holländer et al., 2008). Measures to reduce demand and clean up pollution should be explored before considering the need to transfer water between basins. The DWD itself does not request any information about the quality of raw water, its source (in terms of transfers from other water bodies) or the intensity of treatment necessary. Integrated approaches to evaluate the most appropriate solution, taking source water quality into account, should be implemented in an integrated way under the WFD.

Information to the public

Large and small supply zones have the same minimum water quality requirements. However, monitoring requirements differ. Reporting to the EC is mandatory for large water supply zones. Member States are also obliged to report the water quality of small water supply zones if data are available.

Every 3 years, Member States must digitally report drinking water quality to the EC. They are also obliged to publish a national report to the public. Table A2.1 lists links to the national drinking water quality reports or information about the reporting period 2011–2013.

Table A2.1 Links to national drinking water reports and information for 2011–2013

Member State	Report location
Austria	http://bmg.gov.at/home/Schwerpunkte/VerbraucherInnengesundheit/Lebensmittel/Trinkwasser
Belgium	http://www.leefmilieu.brussels/themas/water
Bulgaria	http://eea.government.bg/bg/output/soe-report/index.html
Cyprus	http://www.moh.gov.cy/moh/mphs/phs.nsf/DMLwater2_archive_gr?OpenForm&Start=1&Count=1000&Expand=1&Seq=1
Czech Republic	http://www.szu.cz/tema/zivotni-prostredi/pitna-voda
Denmark	http://cdr.eionet.europa.eu/dk/eu/dwd/envvnnugw/National%20report%20on%20drinking%20water%202011-2013.pdf
Estonia	http://cdr.eionet.europa.eu/ee/eu/dwd/refvlizg
Finland	http://cdr.eionet.europa.eu/fi/eu/dwd/envvlix7g
France	http://www.sante.gouv.fr/IMG/pdf/Rapport_qualite_eau_du_robinet_2012_DGS.pdf
Germany	http://www.umweltbundesamt.de/themen/wasser/trinkwasser/trinkwasserqualitaet
Greece	http://www.moh.gov.gr
Hungary	http://oki.antsz.hu/files/dokumentumtar/lvovizminoszeg2011.pdf
Ireland	http://www.epa.ie
Italy	http://www.cheacquabeviamo.it/main.htm
Latvia	http://cdr.eionet.europa.eu/lv/eu/dwd/envvpbw_w
Lithuania	http://vmvt.lt/maisto-sauga/kontrolė/valstybine-maisto-kontrolė/geriamojo-vandens-kontrolė
Luxembourg	http://www.eau.public.lu/publications/index.html
Malta	http://cdr.eionet.europa.eu/mt/eu/dwd/envvowj9q/index_html?&page=3
Netherlands	https://www.rijksoverheid.nl/documenten/rapporten/2014/12/08/de-kwaliteit-van-het-drinkwater-in-nederland-in-2013
Poland	http://www.gis.gov.pl/?lang=pl&go=content&id=30
Portugal	http://www.ersar.pt/website/ViewContent.aspx?SubFolderPath=%5cRoot%5cContents%5cSito%5cMenuPrincipal%5cDocumentacao%5cPublicacoesIRAR&Section=MenuPrincipal&FolderPath=%5cRoot%5cContents%5cSito%5cMenuPrincipal%5cDocumentacao&BookTypeID=3&BookCategoryID=1
Romania	https://www.insp.gov.ro/cnrmrc/images/rapoarte/Raport-sintetic-2013.pdf
Slovakia	http://www.uvzsr.sk/index.php?option=com_content&view=category&layout=blog&id=156&Itemid=65
Slovenia	http://www.mpv.si/porocila
Spain	http://www.msssi.gob.es/profesionales/saludPublica/saludAmbLaboral/calidadAguas/publicaciones.htm
Sweden	http://www.livsmedelsverket.se
United Kingdom	http://www.dwi.gov.uk

Furthermore, national country reports show drinking water quality in the reporting period 2011–2013 in a nutshell (map viewer on dwd.etcicm.cenia.cz). All reported data are available in the WISE databases.

A2.2 European results

General information

According to the drinking water quality data for the reporting period 2011–2013 in the EU, the volume of water supplied divided by the number of resident population is about 220 l. This is much more than the mean water consumption per person and day, because drinking water supply for industry or other uses than human consumption is included. The water consumption varies between Member States; for example, it is about 81 l in Slovakia, 150 l or less in Denmark and Hungary, and more than 200 l in Austria, Bulgaria, Cyprus, Finland, France, Greece, Ireland, Italy, Luxembourg, Portugal, Romania, Sweden and the United Kingdom. The high consumption level also includes water for agriculture and/or industry in many cases. In the EU's Member States, the major sources for drinking water are groundwater, which provides 50 % of the total resource use, and surface water (37 %), such as lakes or rivers. Bank filtration or artificial groundwater recharge as modified water systems play a minor role in drinking water sources. Other water sources are coastal water, or a mixture of groundwater and surface water reservoirs (Figure A2.1).

Figure A2.1 Sources of drinking water in the EU, 2011–2013

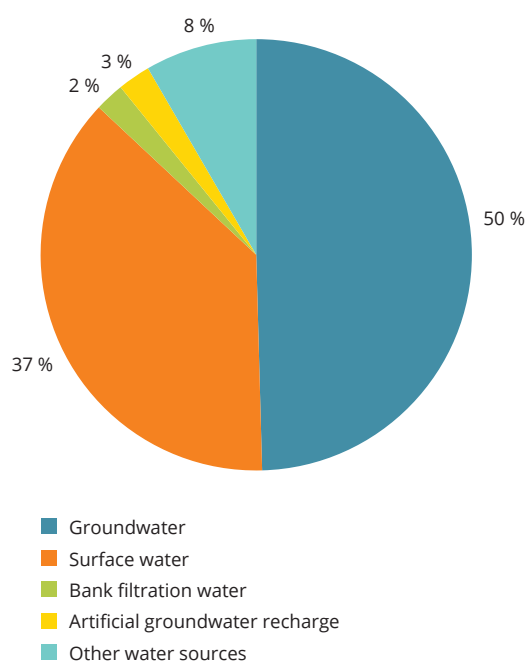


Figure A2.2 shows the percentage of resident population in large water supply zones (> 1 000 m³ per day and/or supplying more than 5 000 people). Some countries also reported the resident population of small water supply zones in 2011–2013. If we add those, the total proportions of residents supplied are 100 % in Bulgaria, France, Hungary, Malta, Portugal and Slovakia; 96 % in Belgium; 95 % in Cyprus; 93 % in Spain; 90 % in Slovenia; 85 % in Ireland; and 66 % in Romania.

Drinking water quality

To assess drinking water quality in water supply zones, Member States carried out a huge number of analyses in the reporting period 2011–2013: microbiological parameters (4.1 million analyses), chemical parameters (7.1 million analyses) and indicator parameters (17.5 million analyses).

For each parameter, information on compliance was available. Percentage of compliance reflects the ratio between the number of analyses and the number of exceedances. Compliance with the directive means that more than 99 % of all analyses meet the given standard. Exceeding indicator parameters does not necessarily mean non-compliance with the directive, for the reasons mentioned in section A3.1, but only if there is no direct threat to human health.

Figure A2.3 shows the percentage of compliance for the parameter groups: microbiological, chemical and indicator parameters. The results show high compliance rates for microbiological and chemical parameters. Indicator parameters reached almost 99 % compliance in the reporting years 2011–2013. The indicator parameters covered exclude colour, odour, taste and turbidity, which do not have numerical values.

Figure A2.4 shows information on compliance for the chemical parameters in the EU.

At 98.83 %, arsenic shows the lowest compliance rate. This is mainly caused by geological background concentrations in the catchment areas.

Figure A2.5 shows information on exceedances for indicator parameters. The figure just gives an overview of the exceedances. It does not reflect non-compliance with the directive, because a number of indicator parameters do not have a numerical value, such as colour, taste, odour or turbidity.

The most frequent exceedances in the indicator parameter group are for total organic carbon, iron, sulphate and manganese.

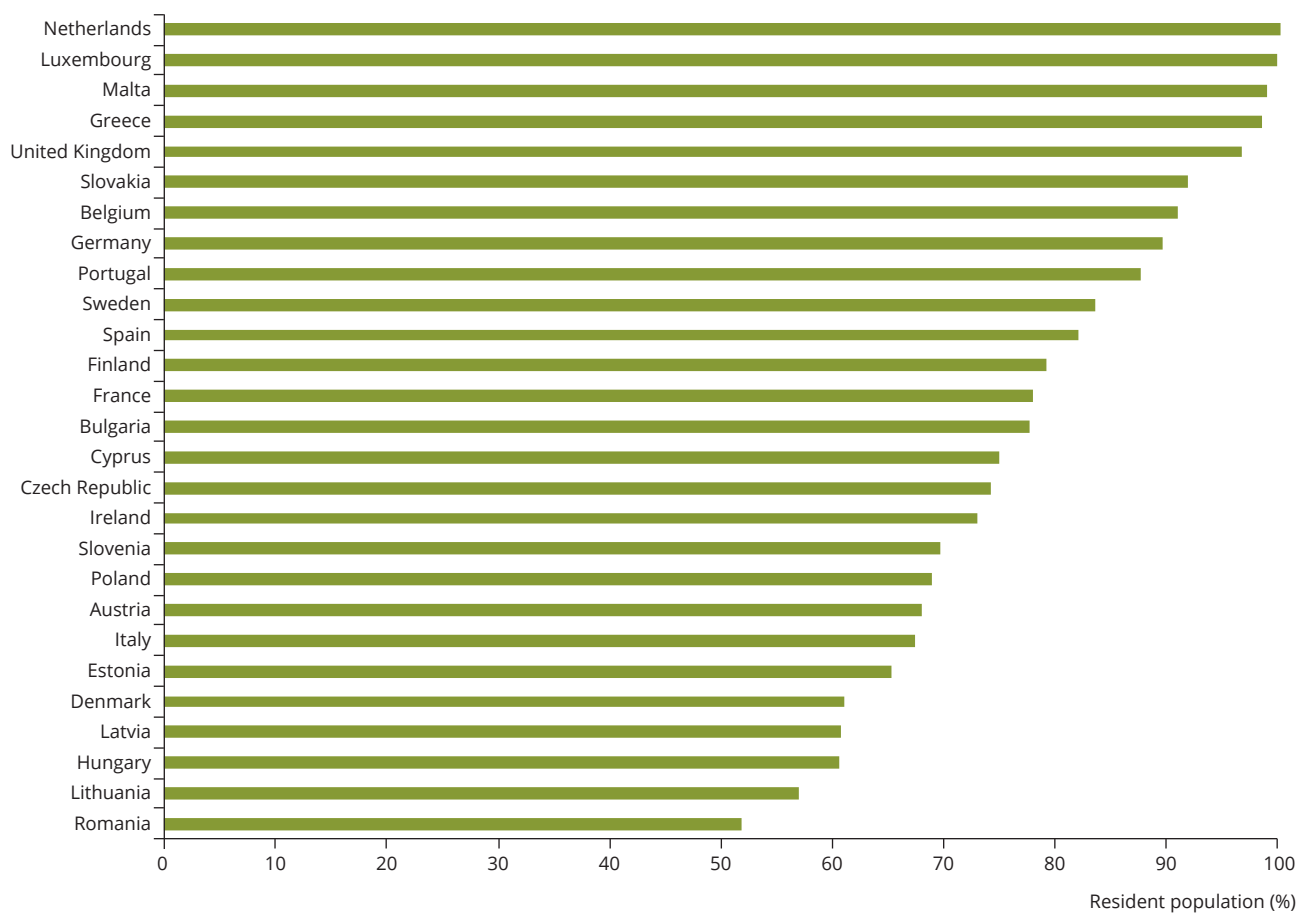
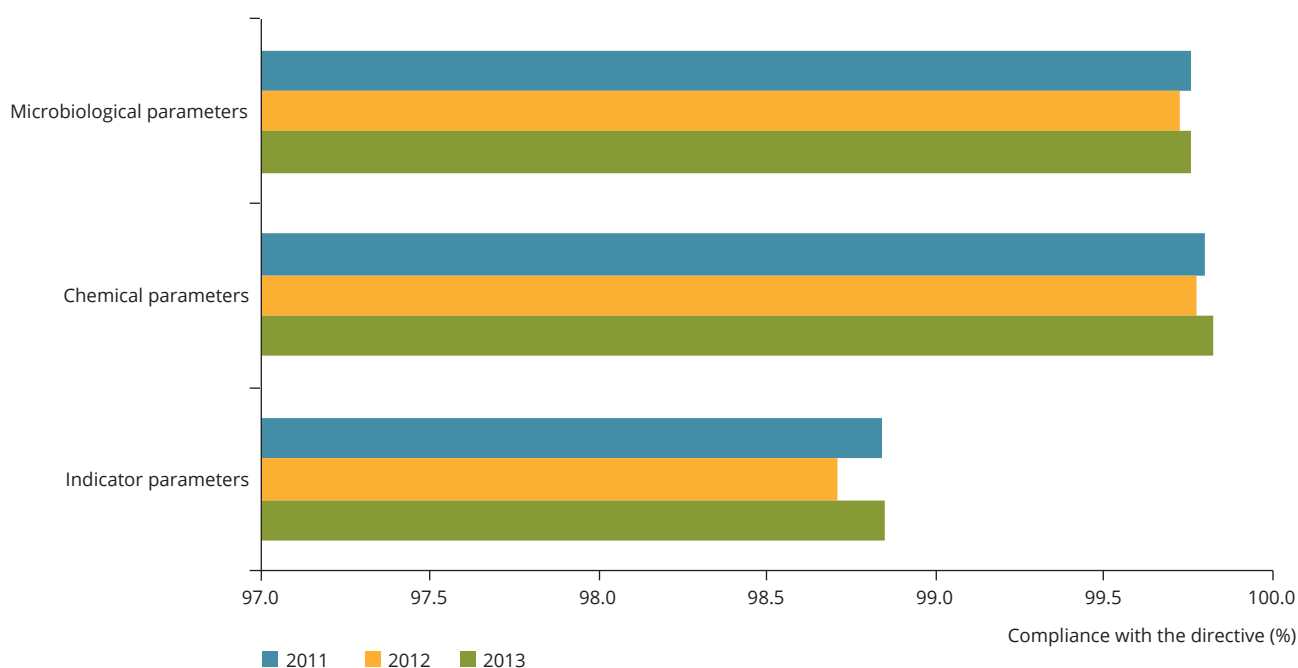
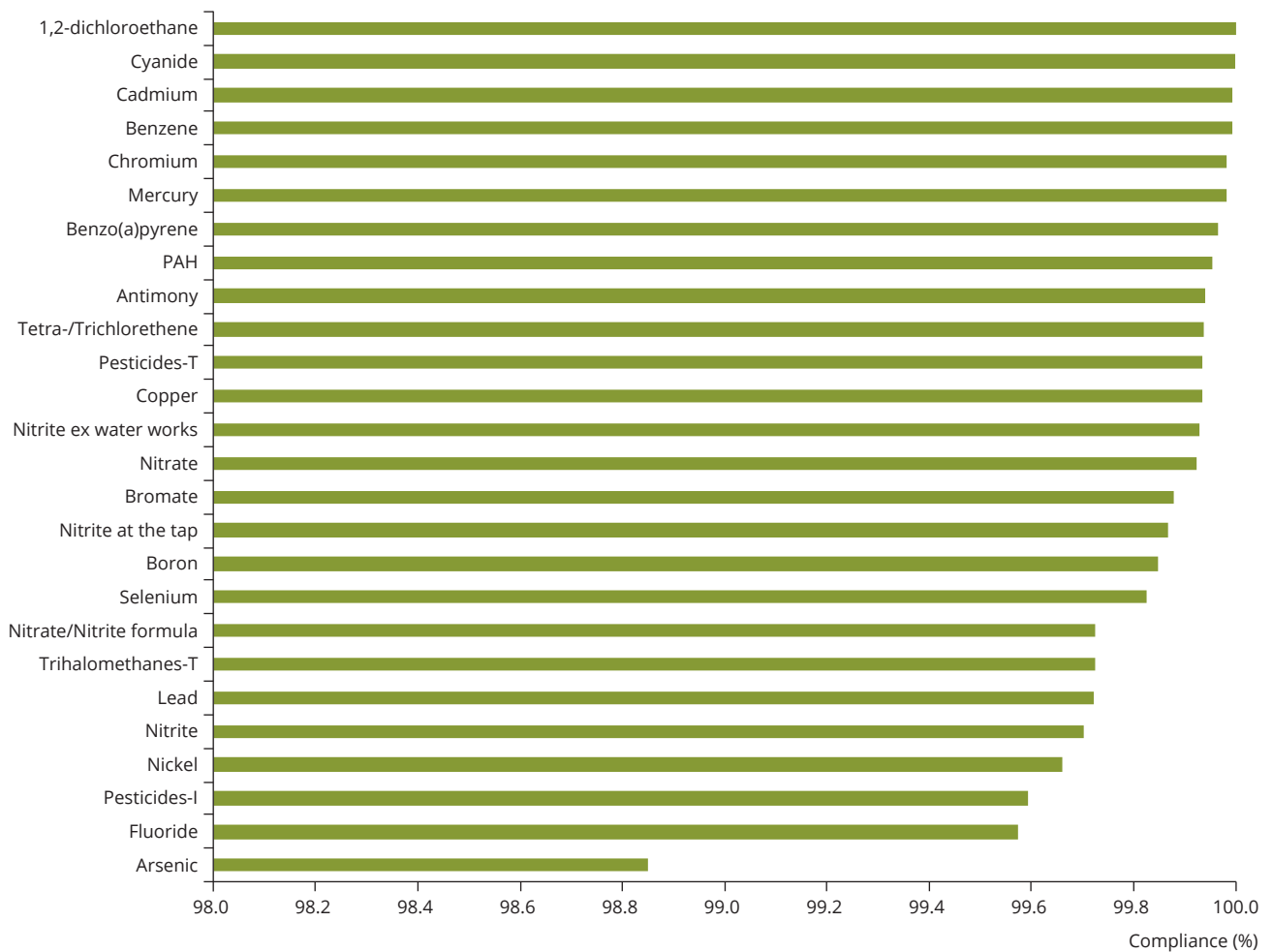
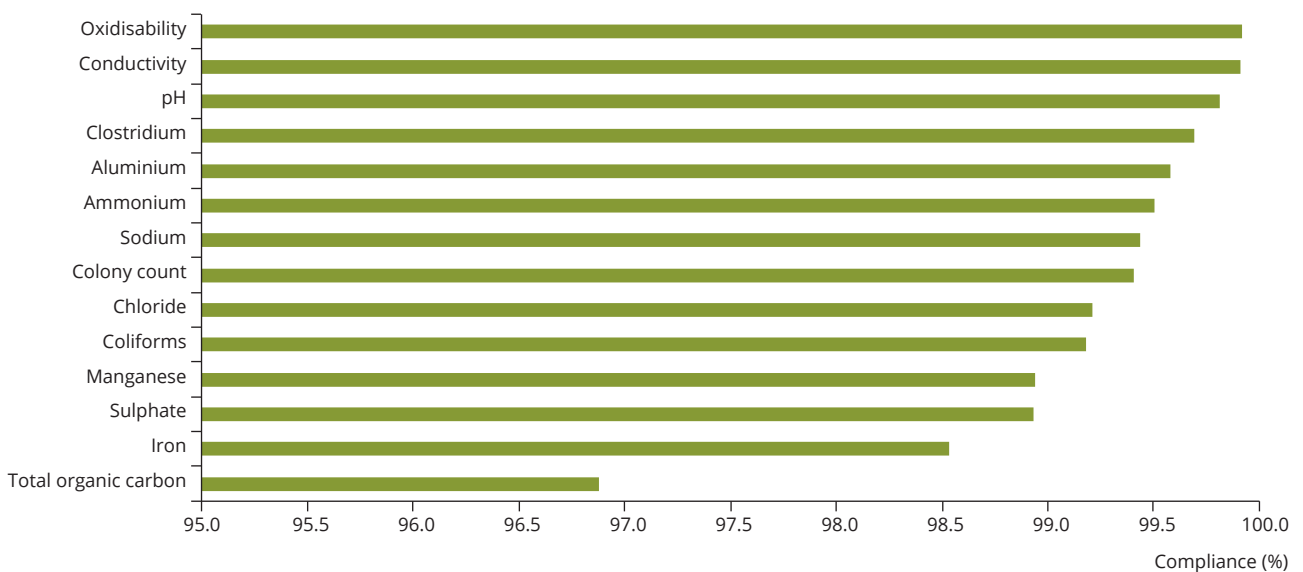
Figure A2.2 Population with access to large water supply zones in the EU, 2011-2013**Figure A2.3 Percentage of compliance for microbiology, chemicals and indicator parameters in the EU**

Figure A2.4 Compliance rates for the chemical parameters in the EU, 2011–2013**Figure A2.5 Percentage of indicator parameters with no exceedances in the EU, 2011–2013, excluding colour, taste, odour and turbidity**

Box A2.1 reflects the importance of pesticides as a potential risk for drinking water quality.

Causes of non-compliance

The reporting obligations mean that, if a water supply zone does not comply, Member States need to report

causes and remedial actions. The number of causes depends on the number of non-compliant analyses.

Failures suspected of being caused by contamination of the source water are defined as 'catchment related'. These causes include discharges from waste water treatment plants or storm water overflow (see also Chapters 3 and 6), agricultural activities (use of

Box A2.1 Pesticides in drinking water

Pesticides can be 'contaminants of concern' for aquifer recharge, and mainly reach aquifers from agricultural run-off.

Much effort has been put into standards for pesticide levels in drinking water. The standards use an indicator approach and do not really reflect acceptable concentrations for health. The DWD sets a concentration limit of 0.1 µg/l for individual pesticides, and the sum of the pesticides must not exceed 0.5 µg/l. Because pesticides are present on a regular basis and in low concentrations, exposure to these chemicals is generally chronic. The health risk is difficult to assess, because data on acceptable doses for chronic exposure are scarce and the low concentrations involved are difficult to monitor.

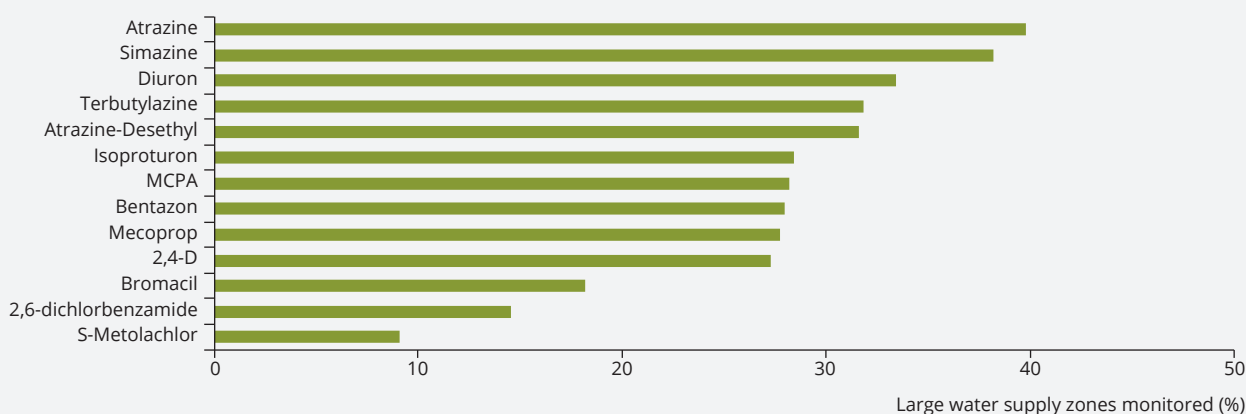


Photo: © André Künzelmann, UFZ

Member States monitor a huge number of national specific pesticides and metabolites in drinking water. However, the EC and Member States agreed a short list of 13 pesticides for which the Member States reported monitoring frequency and non-compliance in 2011–2013. The short list is a harmonised approach and makes reporting comparable, but does not show the full picture of all pesticides and all relevant metabolites in a country.

Figure A2.6 shows the percentage of large water supply zones in the EU where monitoring of the listed pesticides have been carried out in the reporting period 2011–2013.

Figure A2.6 Percentage of a selection of monitored pesticides in large water supply zones in the EU, 2011–2013



Admitting that monitoring is low, compliance rates are consistently high. The compliance rate is more than 99.9 % for pesticides in total, but 99.6 % for individual pesticides (see Figure A2.4). These include the region-specific substances and all relevant metabolites.

Protecting raw water is particularly important. Critical groundwater bodies need special attention from specific measures for drinking water. That cannot be the task of the competent authority or water suppliers alone. Rather, various stakeholders need to cooperate closely to plan and implement measures in the catchment area. To protect drinking water against pollution from the catchment area, there must be well-integrated links between the DWD, the implementation of the water safety plan approach and the WFD.

fertiliser and pesticides) and industrial activities. Treatment-related causes are mainly associated with the treatment processes at the plant, such as chemical dosing regimens, coagulation and clarification procedures, filter operation or disinfection. Within the distribution network, causes of contamination could be flow reversals and pressure changes, changes in the flushing or scouring regime, or leakages. Failures associated with the domestic distribution network can be identified only at the consumer's tap. Non-compliances with the standards for copper, lead and nickel at the consumer's tap may be associated with the consumer's pipes and fittings.

Figure A2.7 shows the main parameters that exceeded the parametric value and that had causes reported. During the reporting period 2011–2013, most of the reported causes of exceedances were for coliform bacteria. A number of causes were also reported for iron, microbiological parameters other than coliform bacteria, total organic carbon, ammonium and

manganese. Most of these are indicator parameters that pose no direct threat to human health.

Figure A2.8 shows the different causes for the most frequently-reported parameters. Causes of exceedances due to biological parameters (coliform bacteria, colony count, *E. coli*, enterococci, clostridium) and iron cannot be exactly specified, exceedances of ammonium, manganese, pH, chloride, sulphate, arsenic and nitrite are mainly related to the catchment. Total organic carbon and aluminium mainly come from treatment, whereas lead is clearly associated with problems in domestic distribution networks.

The problem of nitrite and the nitrate/nitrite formula is widely discussed. The figure shows a rather small number of reported causes. They are obviously related to the catchment and are less prone to sudden impacts within the source area. Pre-selection and combination of higher-quality raw waters usually mitigate them.

Figure A2.7 Number of analyses with reported causes of exceedances for the parameters of the DWD in the EU, 2011–2013

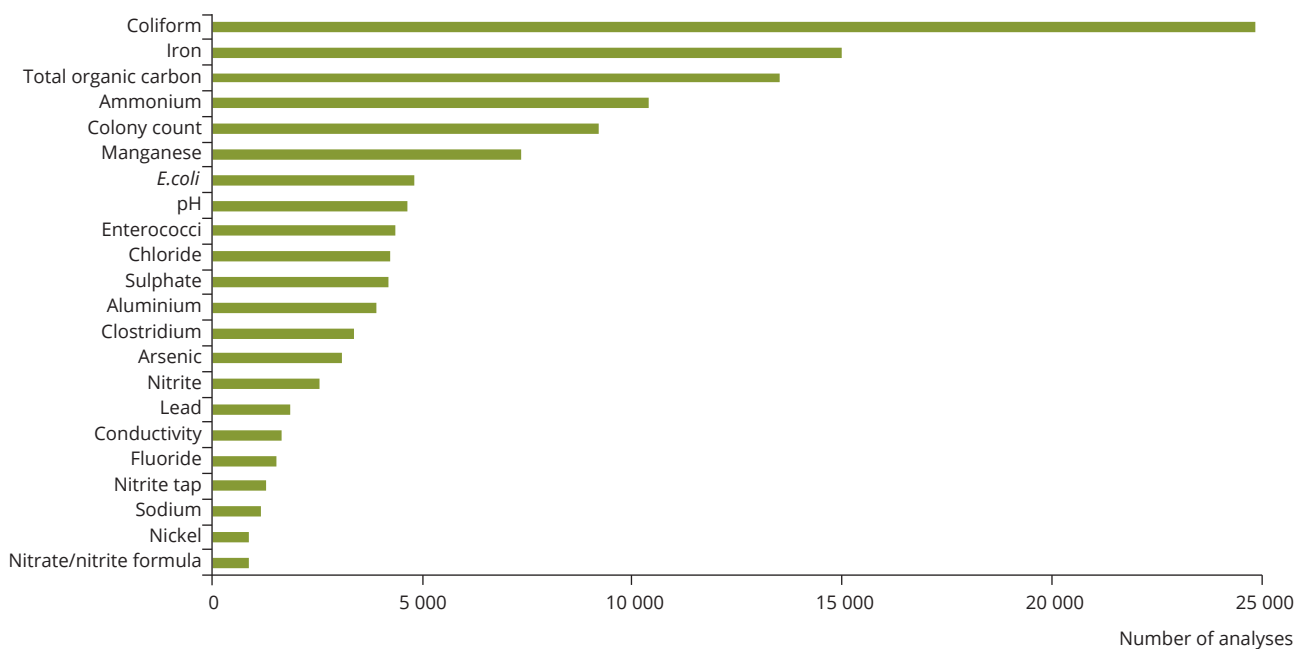
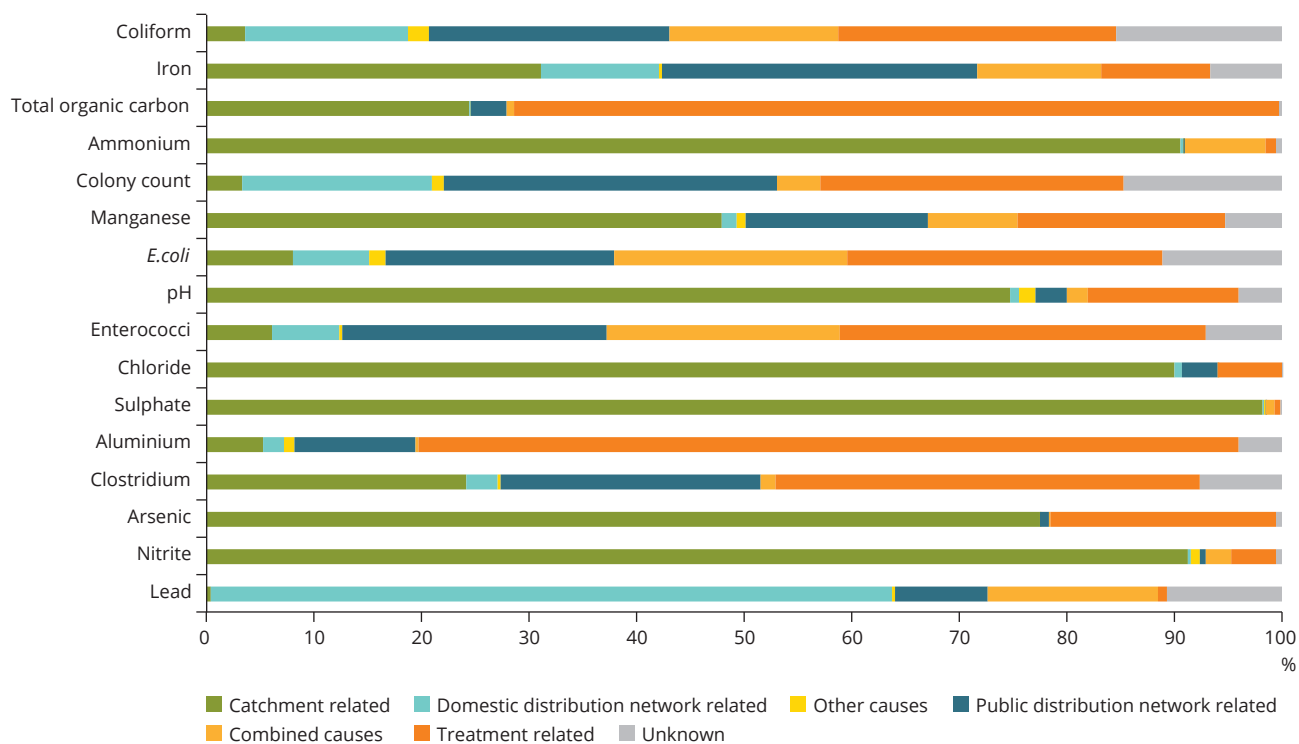


Figure A2.8 Causes of non-compliance for the most reported parameters of the DWD in the EU, 2011-2013

A2.3 Country comparison

Table A2.2 presents compliance of parameter groups for each EU Member State (before Croatia's accession). The percentages are the mean compliance rate for each parameter group in 2011–2013.

For the microbiological parameters, all Member States reported between 99 % and 100 % compliance. For the chemical parameters, 26 Member States

reported compliance between 99 % and 100 %, and only Hungary reported between 98 % and 100 % compliance.

For the indicator parameters, three Member States had compliance rates of less than 98 %, three had compliance rates between 98 % and 100 %, and 21 had compliance rates of 99 % to 100 %. Malta reported a mean compliance rate of less than 98 % because of very low compliance rates for chloride.

Table A2.2 Compliance rates in 2011–2013 (%)

Member State	Microbiological parameters	Chemical parameters	Indicator parameters ^(a)
Austria	99.84	99.9	99.6
Belgium	99.75	99.9	99.1
Bulgaria	99.25	99.5	99.3
Cyprus	99.01	99.9	96.3
Czech Republic	99.91	99.9	99.2
Denmark	99.80	99.8	98.6
Estonia	99.99	99.8	99.1
Finland	100.00	99.9	99.6
France	99.84	99.8	99.4
Germany	99.88	99.9	99.7
Greece	99.64	99.9	99.5
Hungary	99.71	98.6	97.1
Ireland	99.97	99.5	99.3
Italy	99.20	99.6	99.6
Latvia	99.92	100.0	98.7
Lithuania	100.00	99.3	99.0
Luxembourg	99.77	100.0	99.5
Malta	100.00	99.9	90.1
Netherlands	99.97	100.0	100.0
Poland	100.00	100.0	99.8
Portugal	99.57	99.9	99.3
Romania	99.69	99.7	99.2
Slovakia	99.52	100.0	99.4
Slovenia	99.25	100.0	98.7
Spain	99.62	99.8	99.4
Sweden	99.94	100.0	99.1
United Kingdom	99.98	99.9	99.9

99–100 % rate of compliance

98–99 % rate of compliance

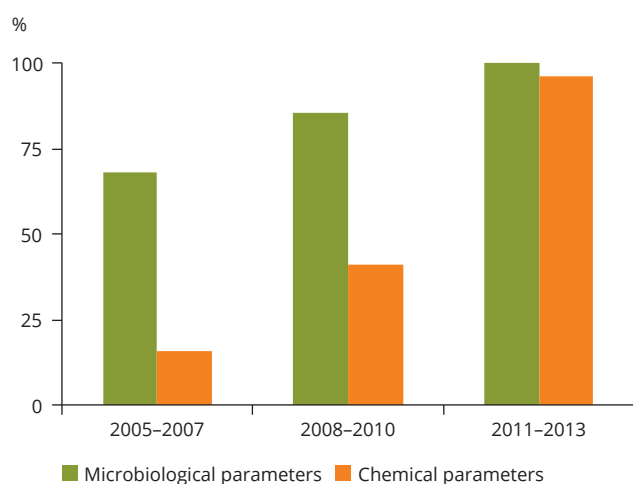
< 98 % rate of compliance

Note: ^(a) Excluding odour, taste, colour and turbidity.

These high standards are the result of improvements in Member States. During the reporting period 2011 to 2013, all Member States had a compliance rate of between 99–100 % in microbiological parameters. However, results from DWD reporting in 2005 to 2007 showed that only 17 of 25 (68 %) of Member States (without Italy and Sweden) had the same compliance rate (KWR, 2011), and 23 (85 %) in the reporting period 2008 to 2010 (EC, 2014c).

The improvement of chemical parameters is also clearly visible. In reporting period 2005–2007, only 4 (16 %) showed 99–100 % compliance rate, 11 (41 %) in 2008–2010 and a high value of 26 out of 27 (96 %) in the reporting period 2011–2013 (Figure A2.9).

Fig A2.9 Percentage of Member States with compliance rates between 99–100 % for the microbiological and chemical parameters in three different reporting periods in the EU



Sources: EC, 2014c, and KWR, 2011.



Photo: © André Künzelmann, UFZ

A2.4 Measures to improve drinking water quality

Where the quality of drinking water needs further improvement, the action to take depends on the parameter and the cause.

Some parameters, such as nitrate or pesticides, relate to human activity in the catchment area. In these cases, measures need to be taken to improve site-specific source protection over a long time. For example, authorities could improve waste water treatment plants or restrict the use of fertiliser and pesticides within the catchment. They also need to liaise with the teams implementing the river basin management plan under the WFD. Short-term remedial actions could be additional treatment or changing the source of raw water; however, that might require longer water transfers.

For treatment-related parameters, remedial actions include changes in chemical dosing regime, coagulation, clarification procedures, filter operation (backwashing arrangements) or disinfection. Remedial actions related to distribution networks are, include flushing/scouring the mains or replacing/refurbishing corroded/leaking pipes. The selection of techniques to be applied is dependent upon the local situation.

If loss of drinking water quality is linked to the use of materials such as lead, copper and nickel, problems are often related to the domestic distribution network and in-house installation. Where materials are in contact with drinking water, the property owner should use appropriate materials and products. This might require, for example, the replacement of lead pipes.

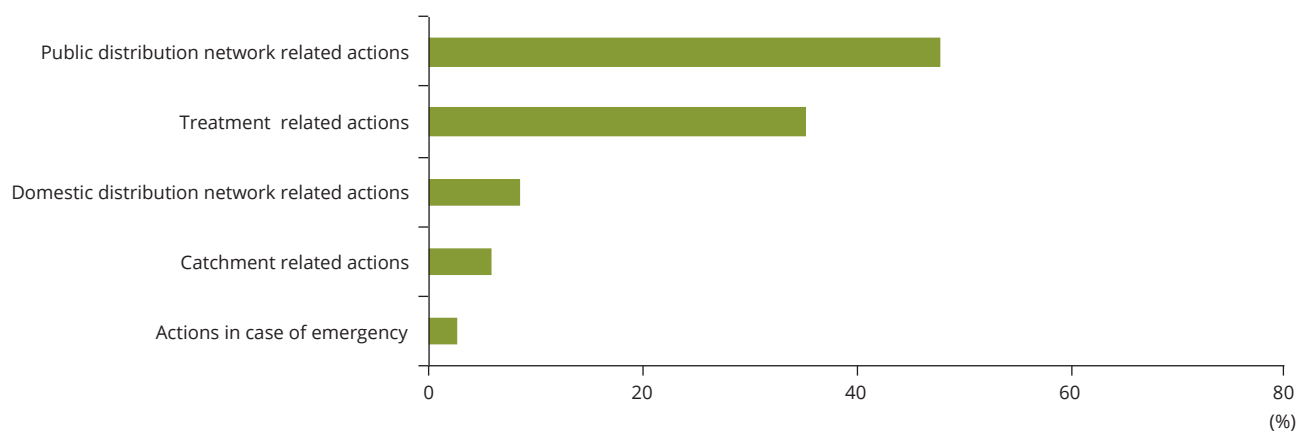
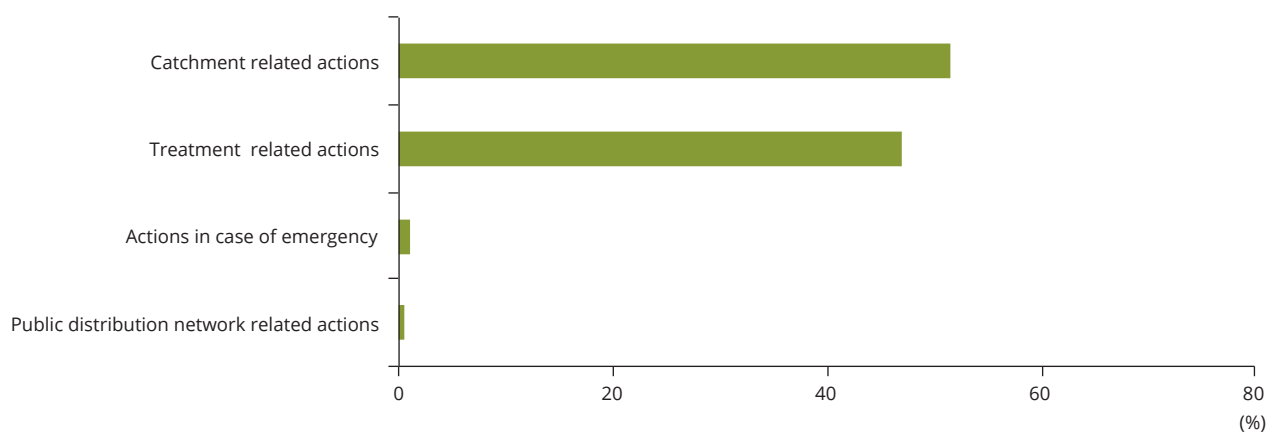
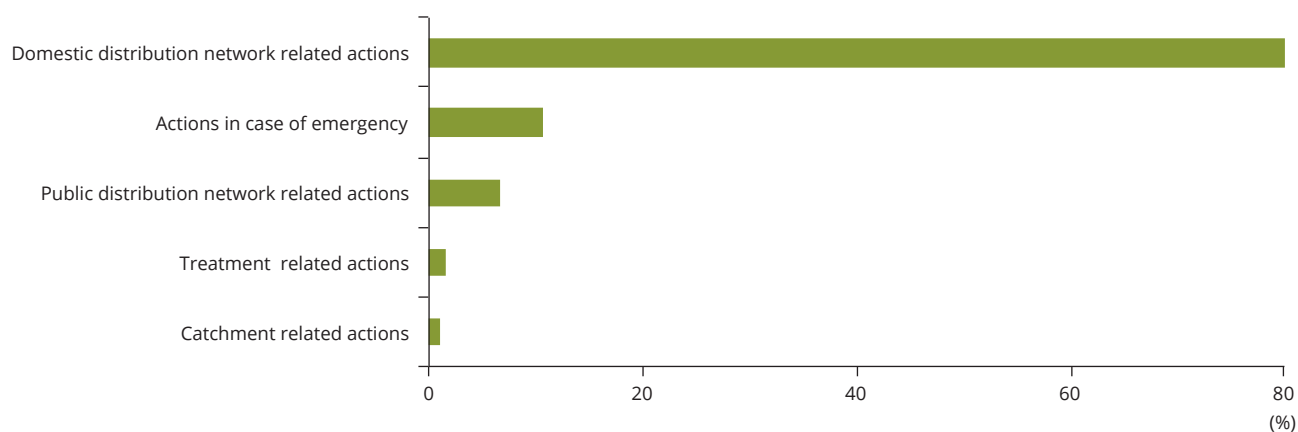
Figure A2.9 shows the percentages of different kinds of remedial actions for three parameters that cause non-compliance or had a higher number of exceedances in 2011–2013: coliform bacteria, arsenic and lead.

Remedial actions for coliform bacteria contamination mainly affect the public distribution network (47.7 %) or treatment (35.2 %). Remedial actions to minimise high concentrations of arsenic in drinking water are related to catchment (51.5 %) or treatment (47 %). For concentrations of lead exceeding the standards, 80 % of all reported remedial actions were replacing or disconnecting lead pipes in the domestic distribution network.

To summarise, specific drinking water quality parameters or groups of parameters can cause problems at different points along the supply chain: water source, treatment, distribution and end of pipe — the consumer. That makes it difficult to develop transparent and useful monitoring, to identify the causes of non-compliance and to implement measures to maintain a healthy supply of drinking water in the EU.

A2.5 Information dissemination

Whereas up-to-date information about bathing water is available to the public at the bathing sites, through the media, in reports and through data viewers, data on drinking water are frequently not up to date. Most Member States do not use comprehensive maps or other published public reports, except a yearly report on national drinking water quality. This makes it difficult to provide the public with updated EU-wide information on drinking water policy and quality on a regular basis. In addition, countries monitor, process and report data in different ways across the EU. That makes it difficult to compare the performance of different Member States and their compliance with the directive. An update of the monitoring requirements and methods of analysing drinking water quality parameters (Annexes II and III; DWD) has been undertaken (EU/2015/1787, EC, 2015a). Furthermore, the digital reporting is planned to be further revised and harmonised, based on the lessons learned from the reporting exercise for 2011–2013.

Figure A2.10 Remedial actions for selected water quality parameters in the EU, 2011–2013**Coliform bacteria****Arsenic****Lead**

A3 Urban Waste Water Treatment Directive



Photo: © Annabel

A3.1 Legislation

The UWWTD is one of the core elements of EU water policy. Adopted in 1991, it regulates discharges of municipal waste water from cities, towns and larger villages (called agglomerations) and explicitly specifies what kind of treatment must be applied.

Every second year, Member States report their national data on compliance with the UWWTD to the European Commission. The EEA, consultants and the Commission take different parts in checking these data for good quality and subsequently analysing them for compliance with the UWWTD. The data and results are visible within a map viewer (<http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps-1>), while the EC publishes a report summarising compliance (EC, 2015b).

The directive requires the following:

- **Article 3:** All European agglomerations with a size of more than 2 000 p.e. are equipped with collecting systems for their waste waters. The UWWTD uses the term 'population equivalent' to measure the size of agglomerations. It is calculated on the basis that the average 5-day BOD per person is 60 g of oxygen a day.

- **Article 4:** Urban waste water from agglomerations above 2 000 p.e. that enters collecting systems needs to be subjected to secondary treatment. Waste water treatment should significantly reduce biodegradable pollution, mainly BOD and chemical oxygen demand, in waste water.
- **Article 5:** 'Sensitive areas' are those areas suffering from the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, resulting in eutrophication. They and their catchments require more stringent treatment to eliminate nutrients before the waste water is discharged from agglomerations of more than 10 000 p.e.

Compliance with the requirements of the UWWTD is assessed at the national level as well as at the level of the individual agglomeration. An agglomeration is considered to be in compliance with the UWWTD if it collects all the waste water it generated and sends it to treatment plants, and all the plants serving the agglomeration comply with the required treatment (treatment type and discharge waste water concentrations or percentage reduction). However, the EC allows a certain margin of flexibility to Member States when assessing compliance with Article 3

(2 % of the generated load or 2 000 p.e.), Article 4 and Article 5 (1 % of the collected load or 2 000 p.e.).

A3.2 European results and trends in compliance

European results

The eighth report on implementation of the UWWTD assessed the situation in about 19 000 towns and cities (agglomerations) of more than 2 000 inhabitants (generating pollution corresponding to a population of 495 million) during 2011 or 2012 (EC, 2015b).

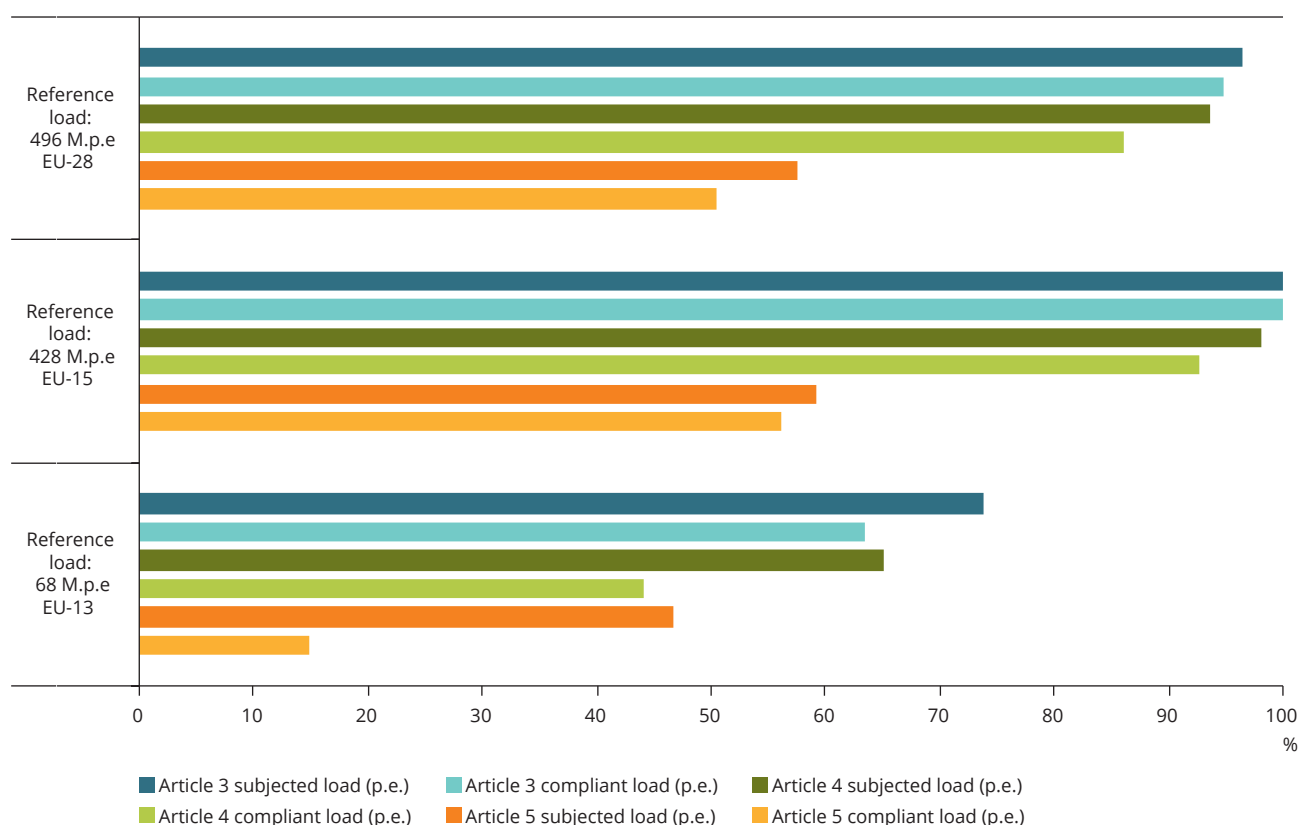
Almost 15 000 towns and cities, or 86 % of the pollution load, are in the 15 Member States that joined the EU before 2004 (EU-15). The remainder are in the

13 Member States that joined the EU in 2004, 2007 and 2014 (EU-13). The compliance assessment was carried out for 25 Member States. Data from Italy and Poland were of insufficient quality to include, while for Croatia no compliance obligation was applicable as of 2012.

Figure A3.1 presents the status of the implementation of the UWWTD across the EU for the reference year (2011 or 2012). It shows the share of the total generated load that requires compliance with the UWWTD (darker bars) and the share of the load for which compliance has been achieved (lighter bars), both in relation to the total generated load.

Of the total load to be collected (496 million p.e. (M.p.e.)), obligations for collecting sewage (Article 3) were met for 471 M.p.e. of the 479 M.p.e. required (i.e. 98.3 %).

Figure A3.1 Average compliance rates in relation to the total generated load



Note: Darker bars indicate load that should be collected and/or treated; lighter bars indicate load for which the collection or treatment provided complies with the provisions in the directive. Data exclude Poland, Italy and Croatia.

Article 3: waste water collection from agglomerations of more than 2 000 p.e.

Article 4: waste water with biological treatment.

Article 5: waste water with more stringent treatment in sensitive areas.

M.p.e: million population equivalent.

Source: EC, 2015b.

Article 4 deals with biological (or 'secondary') treatment. These obligations were met for 427 M.p.e. of the 464 M.p.e. required (i.e. 92.0 %).

Article 5 requires more stringent treatment in sensitive areas with agglomerations over 10 000 p.e. These obligations were met for 251 M.p.e. out of the 285 million p.e. identified as needing more stringent treatment (88.1 %).

Compliance rates in the EU-15 are, in general, very high. They are lower in the EU-13, especially in sensitive areas (Article 5). Results for all current Member States (EU-28) overall, however, are still very high because the EU-13 treats most of its wastewater to the required standard.

Trends in compliance

The EC publishes regular implementation reports. Comparing the compliance rates in them, a positive pattern appears: compliance increases over time (Table A3.1).

UWWTP indicator: proportion of inhabitants connected to UWWTPs during last 20 years

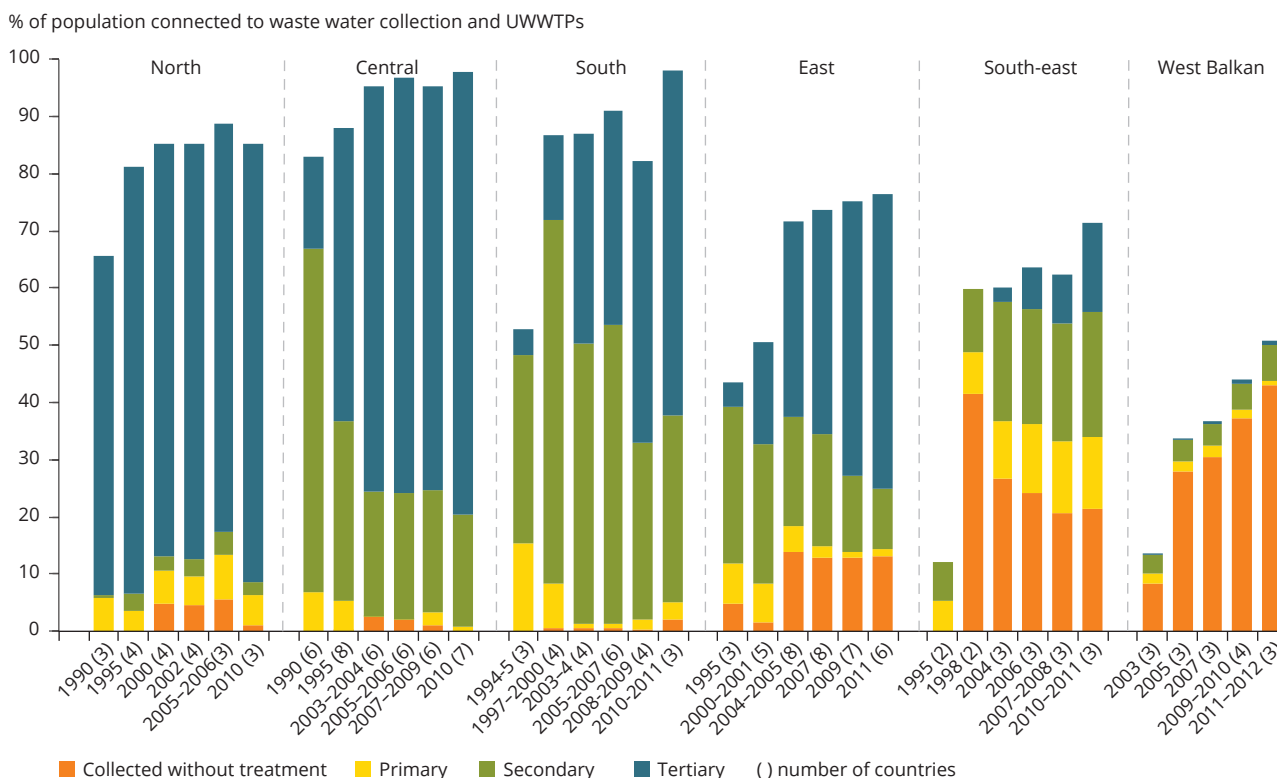
The percentage of the population connected to primary, secondary and more stringent waste water treatment in southern, south-eastern and eastern Europe has increased over the last 10 years. The latest proportions of the population connected to waste water treatment in the southern countries are comparable to those in the central and northern countries, whereas those in eastern and south-eastern Europe are still relatively low. The percentage of more stringent, also called tertiary, treatment is far lower in the southern than in the northern countries. The overall treatment level in central Europe is also fairly high. In eastern and south-eastern Europe, the total number of the population connected to waste water treatment has increased over the last 2 years, but the proportion of untreated waste water is still relatively high. In the non-EU western Balkan countries, an increasing proportion of waste water is treated, but still most of it is not (Figure A3.2).

Table A3.1 European compliance rates for Articles 3, 4 and 5

Report	Reference year	Compliance rate (%)		
		Collection	Biological treatment	More stringent treatment
2	1998	-	-	9
3	2000/2001	83	69	14
4	2001/2002	-	79	84
5	2005/2006	99	86	85
6	2007/2008	93	78	75
7	2009/2010	94	82	77
8	2011/2012	98	92	88

Note: Nine EU Member States (Bulgaria, Czech Republic, Greece, Ireland, Italy, Malta, Poland, Spain, United Kingdom) are missing from the presentation of the fifth report. The sixth report does not include a data set for the United Kingdom and the eighth report does not include data for Italy and Poland.

Source: EC, 2002–2013.

Figure A3.2 Changes in waste water treatment in regions of Europe between 1990 and 2012

Note: North: Finland, Iceland, Norway, Sweden. Central: Austria, Denmark, England and Wales, Scotland, Germany, Ireland, Luxembourg, Netherlands, Switzerland.
 South: Cyprus, France, Greece, Malta, Portugal, Spain.
 East: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia.
 South-east: Bulgaria, Romania, Turkey.
 West Balkan: Albania, Bosnia and Herzegovina, former Yugoslav Republic of Macedonia, Serbia.

Source: EEA, Urban Waste Water Treatment Indicator (CSI 024, last update 2015), <http://www.eea.europa.eu/data-and-maps/indicators/urban-waste-water-treatment/urban-waste-water-treatment-assessment-3>.

Only countries with data from (almost) all periods included (number of countries in parentheses).

The chart is based on the Eurostat data set, which includes information on all waste water treatment plants reported, regardless of the size of agglomeration they serve. Thus the number may differ (in some countries) from the number of waste water treatment plants reported under the UWWTD, which reports only those serving agglomerations of more than 2 000 p.e.

A3.3 Country comparison

For more stringent treatment (removal of nutrients in sensitive areas), the overall compliance rate was 88 %. However, EU-13 Member States showed delays in implementing more stringent treatment. They treated only 32 % of waste waters appropriately. On the positive side, 11 countries reached 90–100 % compliance.

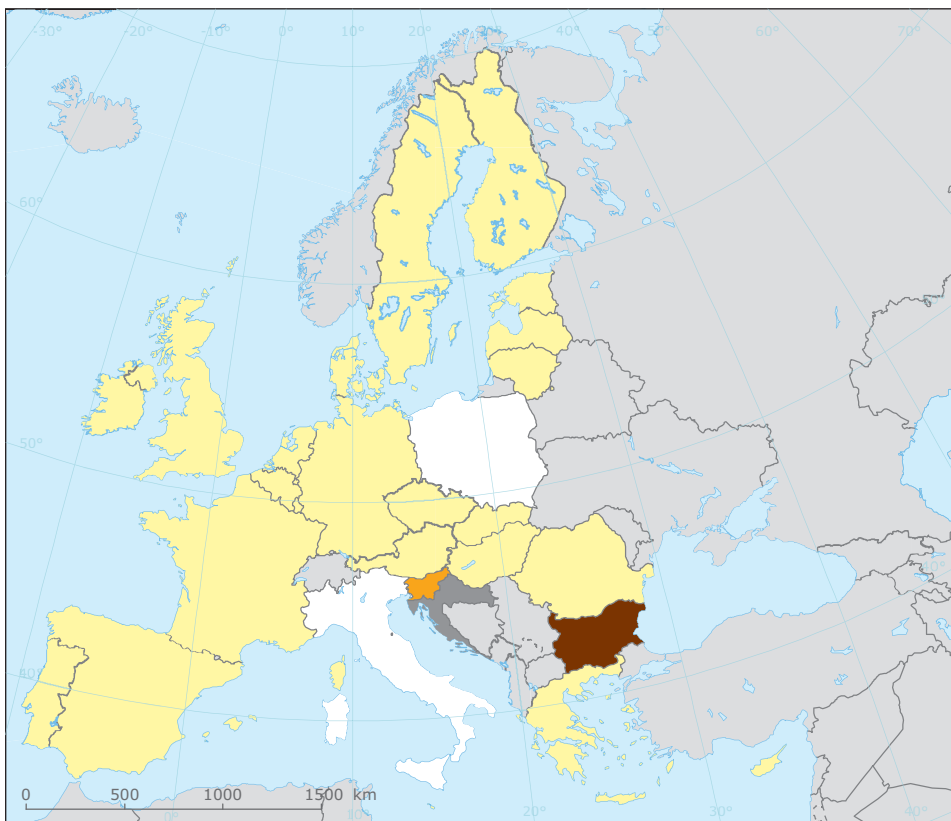
The maps in Figure A3.3 show compliance rates for collecting systems (Article 3), secondary treatment (Article 4) and more stringent treatment (Article 5) in Member States as a percentage of the load subject to compliance (reference years 2011–2012).

For Article 3 (collecting systems), 20 EU Member States are completely compliant: they collect 100 % of the waste water load. Belgium has a compliance rate of 98 %, Estonia 94 % and Romania 99 %. Only two EU Member States collect less than 60 % of the load that should be collected (Bulgaria 12 % and Slovenia 57 %).

For Article 4 (secondary treatment), 16 EU Member States reach a level of compliance between 90 % and 100 %. Five (Cyprus, the Czech Republic, France, Portugal and Spain) have compliance rates between 60 % and 90 %. Romania's is 48 %. Low compliance rates can be seen in Bulgaria (11 %) and Slovenia (14 %). Malta shows no compliance with Article 4.

Map A3.1 Share of generated load compliant with Articles 3, 4 and 5 in the EU-28

a)



Share of generated load compliant with Article 3 of the Urban Waste Water Treatment Directive in EU-28 Member States (*)

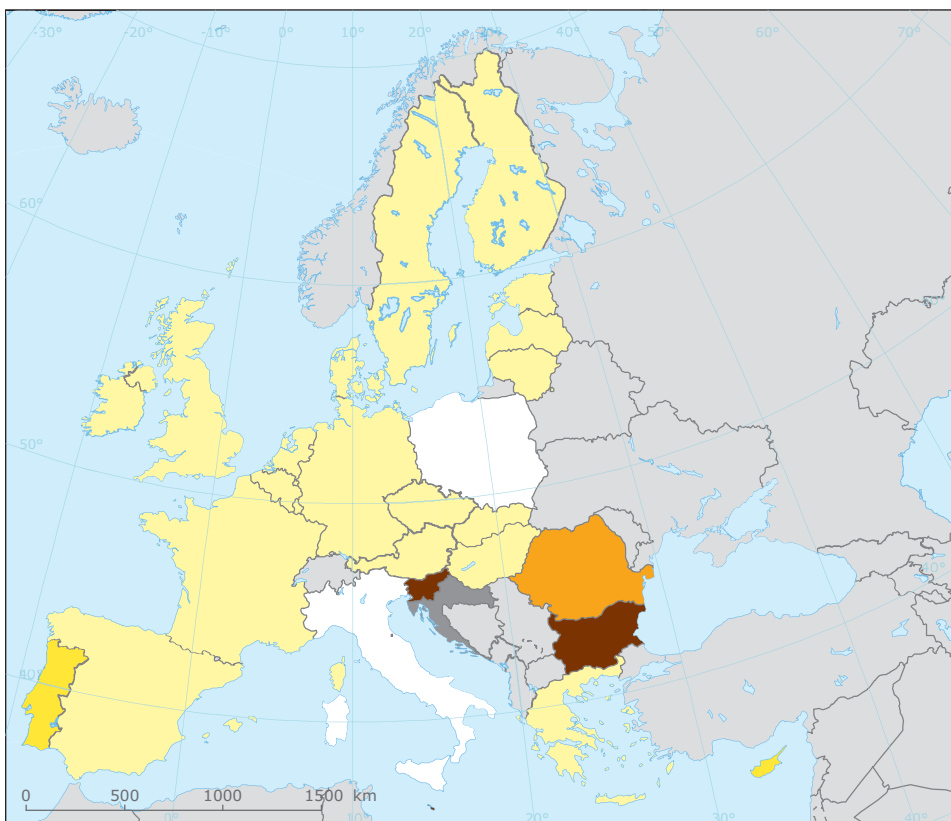
% of compliance

- 80-100
- 60-80
- 40-60
- 20-40
- 0-20

- Not subject to compliance with Article 3 due to ongoing transitional periods
- No complete dataset reported in agreed format
- Non EU-28 countries

Note (*)
In relation to the generated load subject to Article 3

b)



Share of generated load compliant with Article 4 of the Urban Waste Water Treatment Directive in EU-28 Member States (*)

% of compliance

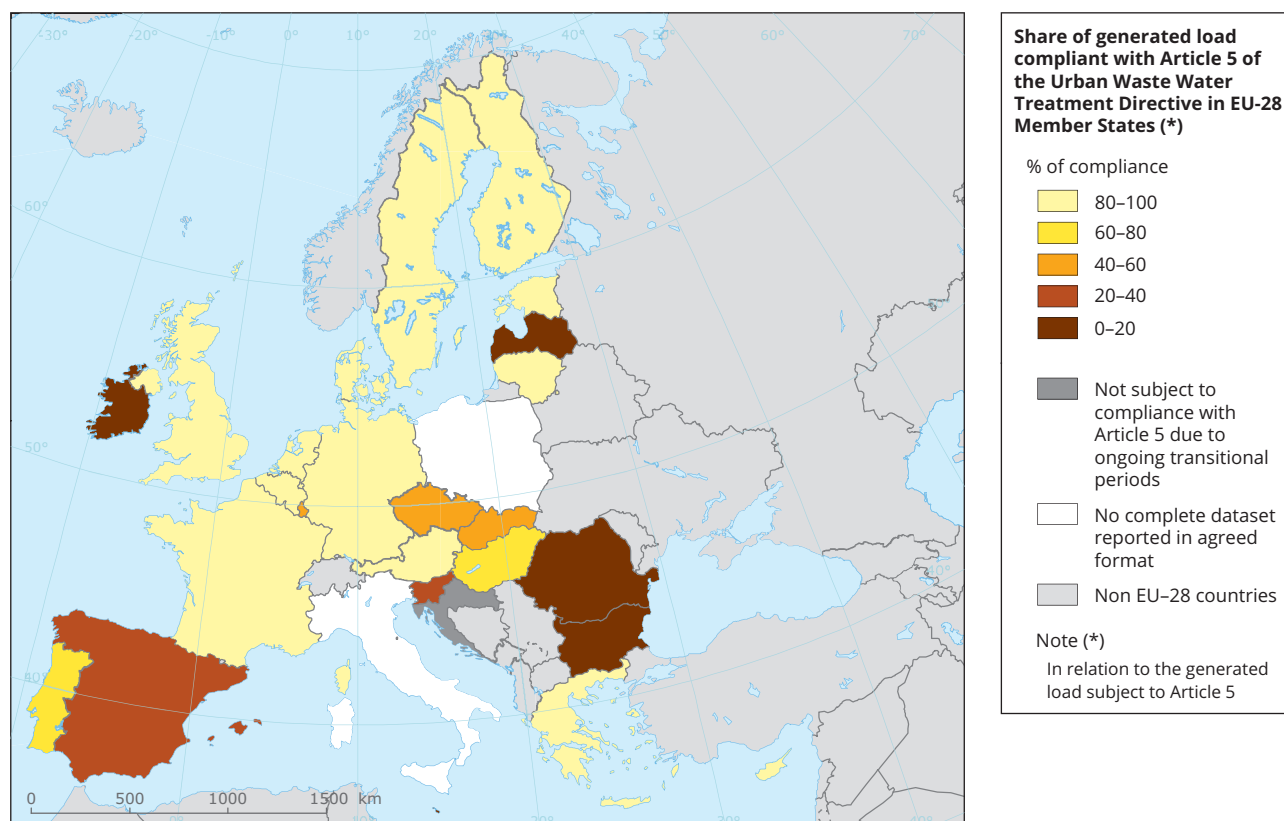
- 80-100
- 60-80
- 40-60
- 20-40
- 0-20

- Not subject to compliance with Article 4 due to ongoing transitional periods
- No complete dataset reported in agreed format
- Non EU-28 countries

Note (*)
In relation to the generated load subject to Article 4

Map A3.1 Share of generated load compliant with Articles 3, 4 and 5 in the EU-28 (cont.)

c)



Source: EC, 2015b.

More stringent treatment of waste waters, also known as tertiary treatment, complements secondary treatment when needed. It mostly aims to eliminate nutrients to combat eutrophication. An additional benefit is increasing the removal rates of hazardous substances. More advanced treatment includes sand filtration, ozonation and ultraviolet (UV) treatment, which are well-known treatment technologies for drinking water. Several treatment plants have installed these measures to reduce bacteriological pollution that might affect human health (e.g. for drinking water zones or bathing waters) and at the same time to further reduce emissions of hazardous substances. Other more stringent treatment technologies are chlorination and membrane technologies. All of the above are widely discussed as ways of reducing the micropollutants (emerging contaminants, including pharmaceuticals, personal care products and industrial chemicals) entering the aquatic environment.

Compliance with Article 5 (more stringent treatment) is between 90 % and 100 % in 10 EU Member States. Five Member States (Belgium, Estonia, Hungary, Portugal and Sweden) show compliance rates of 60 % to 90 %.

On the other hand, 10 Member States are still below 50 % compliance; of these, Latvia and Malta have 0 % compliance with Article 5 and Bulgaria and Ireland show 1 % compliance. However, many countries increased their level of compliance in recent years.

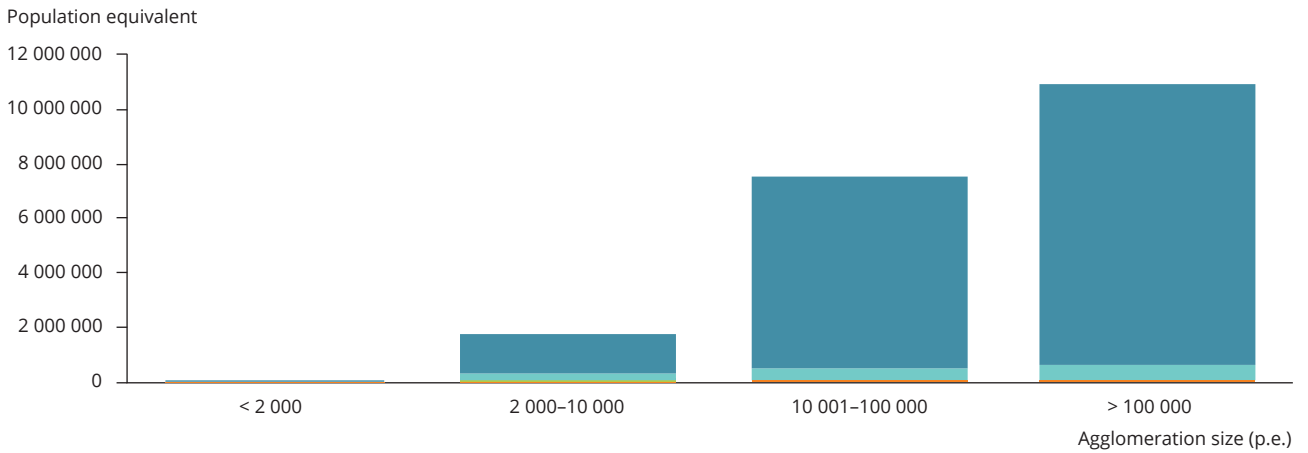
A3.4 Measures to improve treatment

The UWWTD sets minimum requirements for waste water treatment in agglomerations of more than 2 000 p.e. However, other drivers (e.g. the WFD, other water directives, water utilities benchmarking, waste water reuse) encourage 'better treatment' i.e. that which is more efficient, more stringent or addressing hazardous substances.

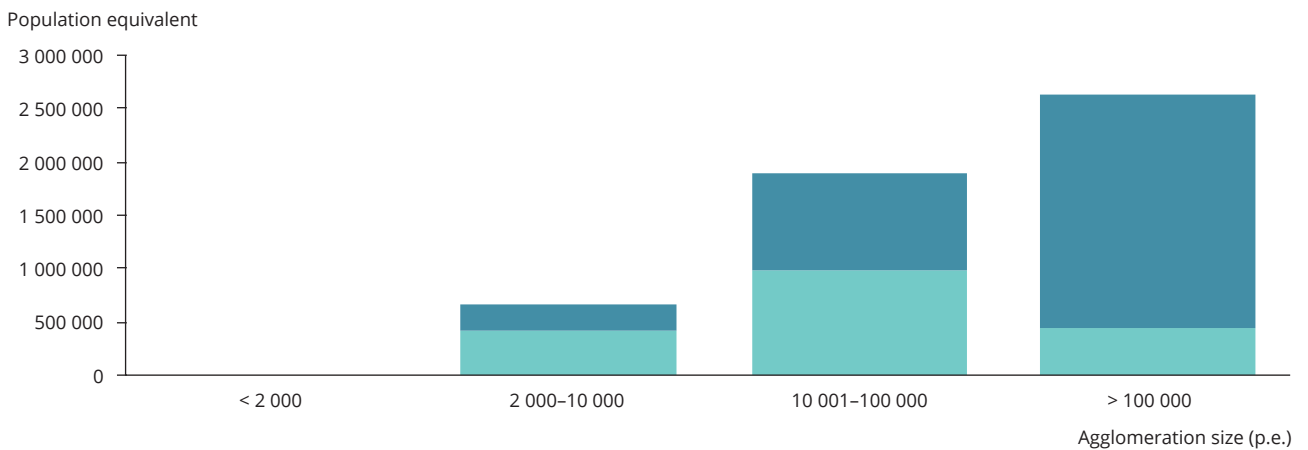
Optimisation of the performance of waste water management systems improves the cost-effectiveness of waste water treatment. Practical solutions include measures based on advanced knowledge of microbiological systems (sequential batch reactors, biological filters, membrane bioreactors) and/or using integrated plant-wide control systems. However there

Figure A3.3 More stringent treatment

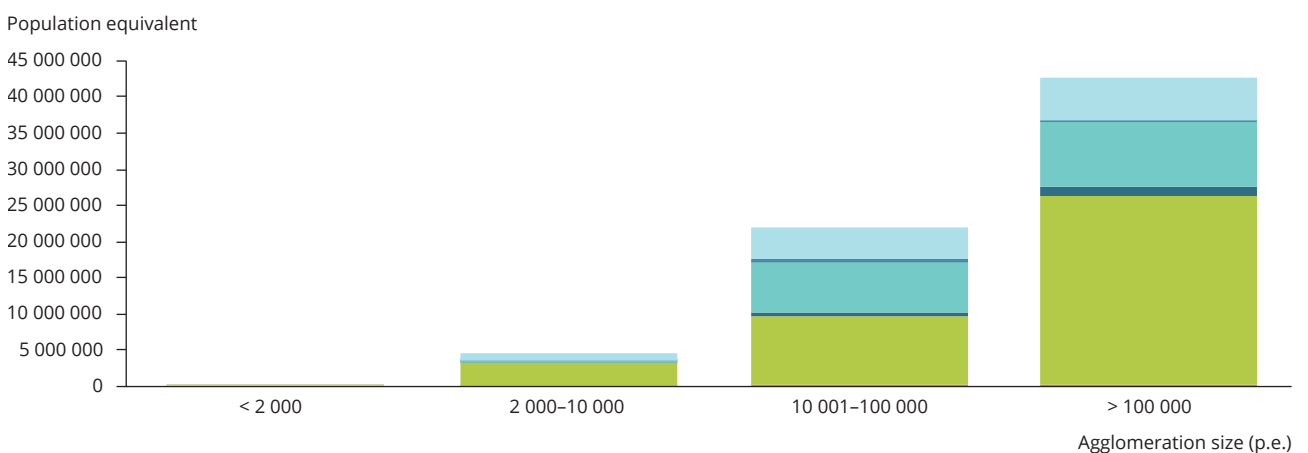
Distribution of agglomeration size in Austria, 2012



Distribution of agglomeration size in Finland, 2011



Distribution of agglomeration size in the United Kingdom, 2012



- Not collected nor addressed via IAS
- Addressed via Individual and Appropriate Systems (IAS)
- Collected and secondary treatment
- Collected and P-Removal
- Collected and other more stringent treatment
- Collected in collecting systems without treatment
- Collected and primary treatment
- Collected and N-Removal
- Collected and NP-Removal

Source: Waterbase — UWWTD: Urban Waste Water Treatment Directive — reported data. <http://www.eea.europa.eu/data-and-maps/data/waterbase-uwtd-urban-waste-water-treatment-directive-4>. EEA, published 27 February 2015.

can also be a need to increase the proportion of waste water receiving treatment. Introducing measures to control the discharge of untreated waste water from storm water overflows; maintaining the hydraulic capacity of existing infrastructure; providing suitable retention facilities or introducing decision support systems.

Several Member States have achieved the maximum level of compliance with Articles 3, 4 and/or 5 in recent years. However, not content with that, they are improving waste water treatment by advancing it further, improving the maintenance and technical equipment of UWWTPs, etc.

Agglomerations of more than 10 000 p.e. in sensitive areas must remove nutrients during waste water treatment. Figure A3.4 shows that nutrient removal is quite common in agglomerations smaller than 10 000 p.e. in Austria, Finland and the United Kingdom.

Other measures that go beyond the requirements of the UWWTD are establishing appropriate waste water collection and treatment in agglomerations smaller than 2 000 p.e.. Actions going beyond the requirements may in particular be taken if the location is in a protected area or if the discharge affects the status of water bodies.

The hygiene standards for bathing water, and the more stringent limits related to waste water reuse, encourage additional treatment methods such as disinfection, chlorination and ozonisation. The Urban Waste Water Treatment Maps (<http://www.eea.europa.eu/data-and-maps/uwwtd/interactive-maps/urban-waste-water-treatment-maps-1>) provide an overview of their use across the EU, in the layer 'types of additional polishing treatment steps'. A total of 25 807 treatment

plants were reported under the UWWTD in 2013. Of them, 778 use UV disinfection, 41 use ozonation and almost 4 000 use chlorination to remove or eliminate pathogens.

Newly identified potential pollutants can be termed 'emerging contaminants'. This group now includes certain pharmaceuticals and personal care products. Studies from numerous European waste water treatment plants have found such emerging contaminants in the treated waste water. Technologies such as flocculation, ozonation, advanced oxidation, membrane filtration (activated carbon adsorption) and photocatalysis could help remove trace amounts of contaminants from waste water effluents (Gadipelly *et al.*, 2014; Castiglioni *et al.*, 2006). Increasingly, countries go beyond the requirements of the UWWTD in their efforts to improve water quality under the WFD.

A3.5 Information dissemination

Every 2 years, the relevant authorities publish situation reports on the disposal of urban waste water and sludge in their areas. The principal aim of these reports is to inform the public regularly of the situation, on a given date, regarding waste water collection and treatment. They also show how the situation has developed over at least the previous 2 years.

At regular intervals, the EC also draws up implementation reports on the situation of waste water treatment and the progress of implementing the UWWTD in the EU. Since 2007, reporting under Article 15 of the UWWTD has followed a new standardised approach. The EC, the EEA and Member States developed it jointly and set it up in line with reporting principles under WISE.

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