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Bathing water management in Europe: Successes and challenges

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Acknowledgements

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Executive summary

Swimming is consistently ranked among the top public outdoor recreational activities in Europe and has numerous positive effects on human health and psychology. Bathing sites are often very attractive tourist destinations. The need to protect and improve bathing water quality in both marine and freshwater environments is thus a key issue for policymakers and environmental managers.

This report summarises how over 40 years of European environmental policy and management have significantly improved bathing water quality across Europe. We outline the key challenges for bathing water management in Europe and describe how these are addressed by governments implementing the BWD through specific management measures, strategies and practices. In addition, we point out that the improvement in bathing water quality can serve as an inspiration for an example of best practice in environmental management. Furthermore, we discuss how bathing water protection and restoration does not necessarily take place only at popular coastal resorts. On the contrary, improving bathing water quality is feasible and desirable for the rivers and lakes within the towns and cities that many of us live in. Throughout the report, we highlight the value and importance of bathing waters in Europe and identify challenges for future bathing water management.

EU response to improve bathing water quality

For decades, European countries have shared a common vision of sustaining good-quality bathing waters. Efforts to achieve this target have been prompted and supported by the Bathing Water Directive (BWD), introduced in 1976 and revised in 2006. The update was based on up-to-date scientific evidence on the most reliable indicator parameters for predicting the microbiological health risk of designated European bathing waters. In addition, the updated BWD included simplified management and surveillance methods.

The bathing season in Europe usually lasts from May to September. During that time, local and national authorities take bathing water samples and analyse them for the types of bacteria that indicate pollution from sewage or livestock (e.g. *Escherichia coli* and intestinal enterococci). Based on the levels of bacteria detected, bathing water quality is then classified as 'excellent', 'good', 'sufficient' or 'poor'.

All EU Member States make great efforts to improve the quality of existing bathing waters, to provide up-to-date information on their state to the public and to make bathing feasible in urbanised and formerly heavily polluted surface waters. Significant investments in urban waste water treatment plants, improvements in sewerage networks and other measures have contributed to a reduction in the number of sites with poor bathing water quality in more than 3 000 large cities in Europe. Safe bathing is now possible in many European capitals — including Amsterdam, Berlin, Budapest, Copenhagen, London, Riga and Vienna — a feat that would have been unimaginable in the 1970s.

Thanks to successful environmental policy and management guided by the BWD, the percentage of European bathing waters achieving at least sufficient quality (the minimum quality standard set by the BWD) increased from just 74 % in 1991 to over 95 % in 2003 and has remained quite stable since then. The percentage of bathing waters with the highest water quality (classified as excellent) increased from 53 % in 1991 to 85 % in 2019. Thanks to common European action, more than 8 out of 10 of Europe's monitored bathing waters now have excellent water quality.

The major bathing water management challenges in Europe

While bathing water quality in Europe is improving and today bathing is possible even in some heavily urbanised areas, there is still a need for integrated and adaptive management to mitigate both existing and emerging pressures.

Faecal bacteria

A common cause of poor bathing water quality is the presence of faecal bacteria, which can pose significant public health risks. Major sources of bacteria include sewage, inefficient waste water treatment plants, animal waste (e.g. birds and dogs at beaches) and water draining from farms and farmland. Significant investments in sewerage systems and treatment plants have helped to reduce faecal bacteria levels in European bathing waters in recent decades.

Storm water overflows

Sewerage systems in cities are not always able to drain all storm water and, after periods of heavy rain, bathing water quality can decrease significantly as a result of overflows. The number of such pollution events has increased in recent years. Sewage overflows across Europe are increasingly being managed using new measures such as the construction of storage tanks and the creation of nature-based retention basins that also serve as urban green areas. Modelling and warning systems can also be put in place to advise bathers against bathing during short-term pollution events.

Nutrient and chemical pollution

Nutrient and chemical pollution due to agricultural run-off and insufficient waste water treatment can have a number of environmental impacts on bathing waters, potentially making them unsafe for public use. Nutrient pollution can cause excessive algal growth and eutrophic blooms of toxic cyanobacteria. Other substances such as heavy metals can enter bathing waters from both natural and anthropogenic sources and be deposited on their coasts and banks. These can originate from either diffuse (non-point) sources, such as run-off from land, or point sources, such as industrial outfall or natural springs containing high concentrations of mercury.

The positive impacts of the wide-ranging and collaborative measures that have been supported by the BWD since 1976 represent a significant positive step for environmental policy and management in Europe. However, the task is not accomplished yet. Although environmental managers continue to deal with the key issues above, emerging challenges such as climate change and plastic pollution are increasing the complexity of bathing water management.

Climate change

Projected climate changes in Europe over the coming decades will bring challenges for bathing water management and the recreation activities and tourism industries that rely on clean bathing waters. The impacts of ongoing climate change on aquatic ecosystems will vary geographically across Europe (EEA 2017b). Many coastal bathing water resorts and infrastructure will be threatened by rising sea levels and more varied and volatile storms. Increased river flows may damage bathing sites, destroy bathing water infrastructure and shift and deposit debris. In some regions, drought and freshwater scarcity may cause bathing sites to disappear or to be affected by issues such as eutrophication. As a result of increases in temperature, the bathing season will be prolonged into spring and autumn in some areas. Climate change will shift the conditions suitable for bathing northwards, meaning that more bathing water sites are expected to be identified and monitored across Europe in the future.

Plastic pollution

A clean coastline is vital for beach tourism. Aesthetically, marine litter is the pollutant most swimmers find unappealing and dirty bathing sites are unattractive to visitors. Litter, particularly plastic litter, is accumulating in our seas and along our coasts and poses threats to both marine biodiversity and bathers (EEA 2015b). Plastic litter damages fisheries and tourism, kills and injures a wide range of marine life, has the capacity to transport potentially harmful chemicals and invasive species and can represent a threat to human health (Thompson, et al., 2009).

Beach and sea floor litter at bathing water sites may cause injuries, and when fractured into micro-pieces in water can be accidentally ingested by swimmers. Accumulation of such 'microlitter' in the human body may cause health effects. The extent of such health effects is still unknown and a precautionary approach is necessary.

Emerging future challenges

It is clear that bathing water legislation has helped to improve the microbiological quality of Europe's bathing waters and, in synergy with the other water-related legislation, has also improved other aspects of water quality. However, the task is not accomplished yet. Achieving the vision of excellent bathing water quality across Europe is closely linked to how we address emerging future challenges such as climate change and plastic pollution.

There are also unexpected risks that may require specific management. This year it is the coronavirus disease 2019 (COVID-19) pandemic. The EEA published the briefing *European bathing water quality in 2019*, in which it provided information on risks in Europe for the 2020 bathing season with regard to COVID-19 and links to key guidance documents. Members of the public are advised to always follow the guidance and instructions at bathing sites and from their local and national authorities to prevent the spread of the disease.

1 Introduction

Outdoor bathing is consistently ranked among the top public recreational activities in Europe. It is also one of the most accessible — at least in places with good access to clean seas, rivers or lakes. Every summer, millions of Europeans visit seas, rivers and lakes for exercise and recreation. Making sure that these bathing waters attain high enough quality standards to make these activities safe is thus a key priority for environmental policy and management.

In Europe, as in many other parts of the world, the quality of coastal waters, rivers and lakes was generally degraded from the 19th century onwards, mainly owing to growing towns and industries discharging untreated waste water. During the 20th century, the increased use of pesticides and fertilisers on agricultural land added chemicals to this pollution 'cocktail', and recent evidence (EEA 2017b) shows that climate change is further degrading water quality in Europe. For example, climate warming can accelerate eutrophication and the frequency of harmful algal blooms caused by excessive nutrient pollution. In other words, European water quality in both freshwater and coastal ecosystems is affected by multiple pressures, some of which can interact to intensify their individual effects. Moreover, many river banks, lake shores and coastlines have been structurally modified for flood protection, navigation, tourism, land transport and construction. Such modifications can also reduce water quality, limit self-purification and increase pollution risks.

Since the 1970s, the EU has introduced numerous ([1]) environmental policies to improve the health and status of Europe's waters. One key policy is the Bathing Water Directive ([2]) (BWD) — originally introduced in 1976 and updated in 2006 — which aims to safeguard public health and recreation through the provision of clean bathing waters. European countries have subsequently made significant improvements in water quality at several bathing sites, identified new sites and prohibited bathing at sites that did not achieve adequate water quality standards.

This report will show how four decades of European water policy and management guided by the BWD has significantly improved bathing conditions across the continent. This represents a significant 'good news' story in an era of environmental decline and reports of disconnection between people and nature, especially in urban areas. This report gives an overview of how specific water management measures, strategies and practices have been implemented in various places in response to local challenges. These serve as examples of 'good practice' management for the future. However, maintaining good bathing water conditions in the future will depend on adaptive management of emerging pressures such as climate change and plastic pollution. The report outlines the nature of these pressures, and their impacts, and highlights the management strategies that might mitigate their effects. The objectives of this report are thus twofold: first, to celebrate the value and importance of bathing waters in the lives of millions of European people; and, second, to outline how we might protect and restore bathing sites for decades to come.

([1]) Directive on surface water quality for drinking water abstraction (EU 1975), followed by the first Groundwater Directive (EU 1980a), and the first Drinking Water Directive (EU 1980b). In the early 1990s, the Nitrates Directive (EU 1991b) and the Urban Waste Water Treatment Directive (EU 1991a) came into force.

([2]) 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 (EU 2006).

Image 1.1 Diving into crystal clear water

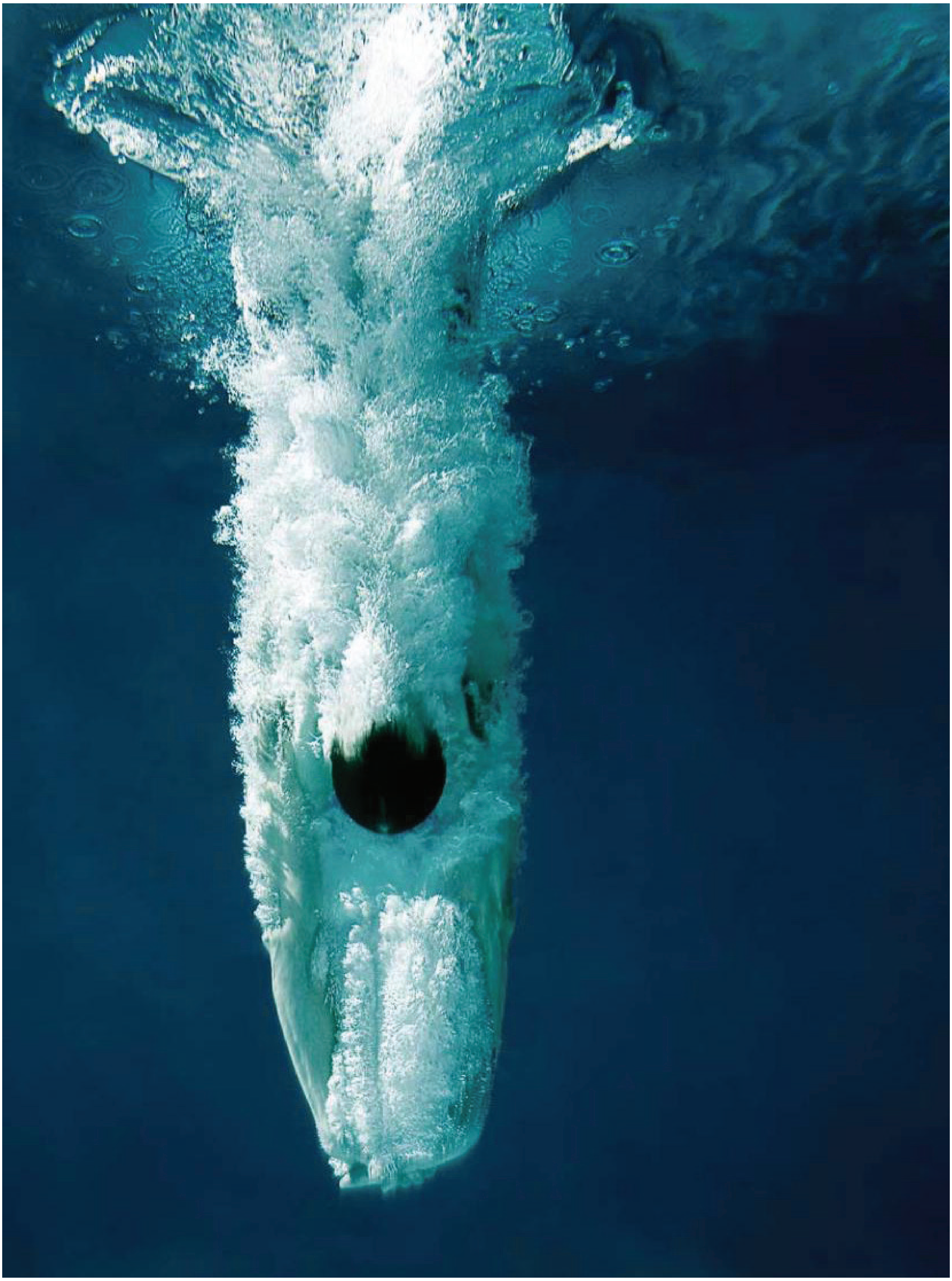


Photo: © Boby

2 Why care for bathing waters?

Few things are as enjoyable as going for a swim on a hot day. Submerging ourselves in crystal clear water is something we do for leisure, sport, relaxation and health. Europe has a great diversity of beautiful beaches and bathing areas. Each year millions of Europeans spend their afternoons, weekends and holidays at the beach chilling and cooling off by the water (EEA 2018).

Bathing has a long and rich history in Europe. Although the myths of the ancient civilisations of the eastern Mediterranean show Europeans' inclination towards water and swimming from the medieval period to the 19th century, the majority of western Europeans did not swim. The population began relearning to swim in schools, spas and barracks during the 17th- and 18th-century Enlightenment period, but mass-participation swimming only took off in the 19th century. In the latter period, the development of the railways gave millions of city residents access to seaside resorts, and a specific act on baths and washhouses enabled English municipalities to build in-ground, heated pools in deprived urban areas. From then, the popularity of bathing grew, and today millions swim for fitness and leisure in pools and take waterside holidays throughout the year (Chaline, 2018).

Bathing can have numerous positive effects on physical and mental health. It can improve cardiovascular functions, blood circulation, lung capacity and oxygen intake (Koopman, 2019). Swimming can also help relieve the mental tensions and anxieties caused by everyday stress (Kjendlie, et al., 2010). Stretching and moving in water has been shown to put low stress on the joints, muscles and bones, but it is very effective in providing an adequate workout through resistance. There is also less chance of injury for people who are at risk of falls, which makes aquatic exercise ideal for the elderly. Chronic fatigue syndrome and some fertility issues can be assisted by bathing in colder temperatures. Alternatively, warm water bathing can increase levels of serotonin — the chemical produced by the brain associated with happiness and well-being (Koopman, 2019). Swimming is consistently ranked among the top public recreational activities in Europe. It is the physical activity recommended in more than 80 % of appropriate medical cases (Petrescu, et al., 2014). It is also one of the most studied sports within the sport sciences research community (Kjendlie, et al., 2010) and is, at least in countries with abundant surface waters and suitable bathing water quality, one of the most accessible recreational outdoor activities.

As bathing water quality has a big impact on public health, it is very important that bathing waters are clean and safe to swim in, and that any potential hazards to the health of bathers are minimised as much as possible.

Image 2.1 Bathing has numerous positive effects on health and general well-being

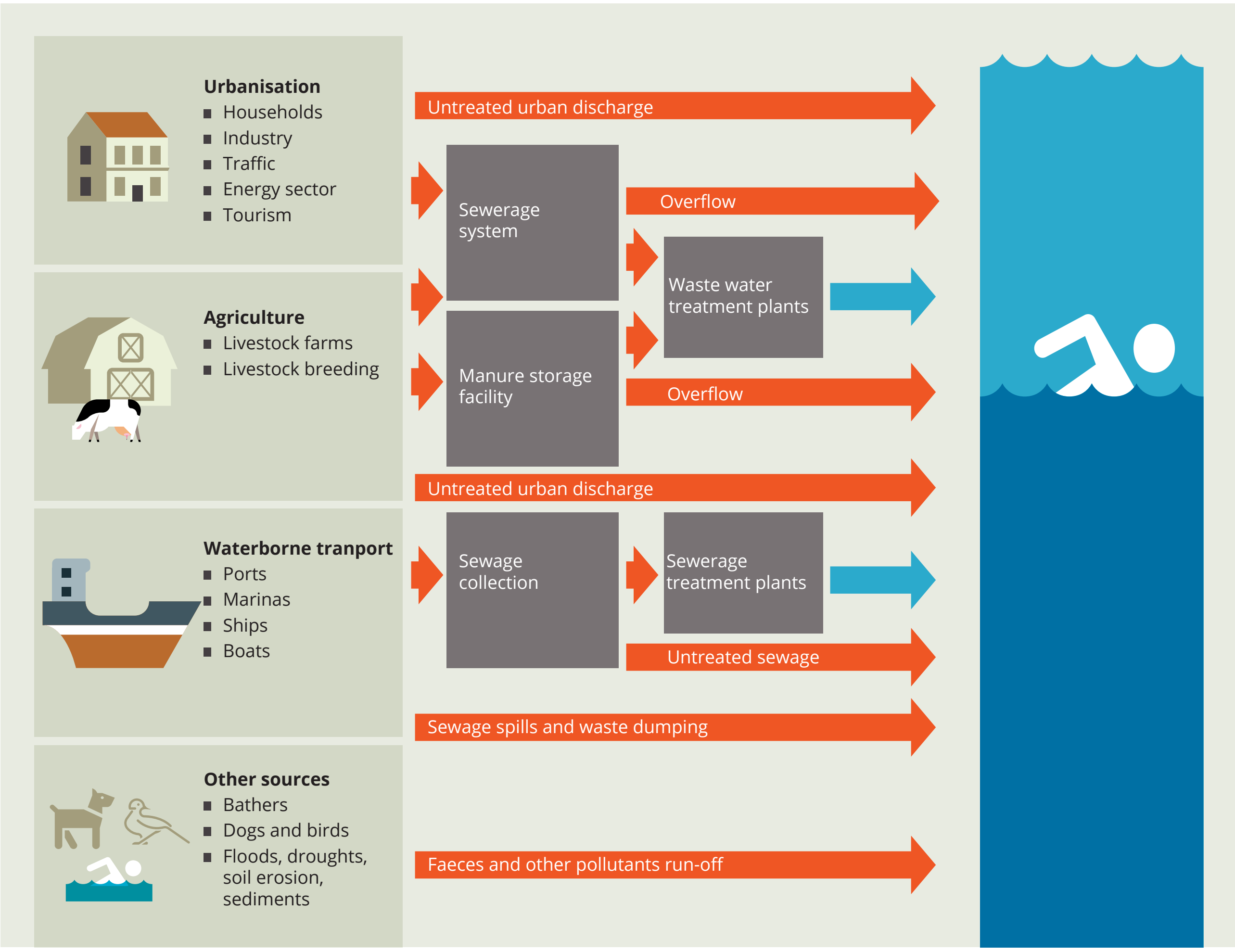
Photo: © Roberto

3 How do we care for bathing waters?

3.1 Control of bathing health risks through legislation

When bathing takes place outdoors, the need to protect and improve water quality is an issue for both human and environmental health. In other words, healthy aquatic ecosystems benefit both human and non-human lives. There are many potential pollution sources affecting bathing water quality that need integrated management (Figure 3.1). Bathing waters are thus sites where European environmental and public health policies overlap and support one another. It is for this reason that the concept of bathing water quality has been addressed in research, policy and legislation. From a global perspective, the term 'bathing water' is predominantly used in Europe and it is here that the need to protect bathing environments was initially identified in the 1970s and was further developed in subsequent decades. The World Health Organization (WHO) activities that aim to foster safe recreational water environments on a global scale are based on this European legacy (WHO 2003), and the EU's Bathing Water Directive (BWD) is based on the same concept.

Figure 3.1 Potential pollution sources affecting bathing waters



Before the BWD was originally adopted in 1976, large quantities of mostly uncontrolled, untreated or partly treated waste water and other waste effluents were discharged into many of Europe's surface waters. As a result, these waters became heavily polluted. Dirty beaches and resulting concerns regarding the health of swimmers and a growing environmental awareness consequently paved the way to the BWD's adoption. EU Member States were obliged to take all necessary measures to ensure that the quality of their bathing water conformed to water quality standards within 10 years. These standards included 19 microbiological (covering several bacteria and viruses) and physico-chemical (e.g. pH, colour, presence of oils, concentration of dissolved oxygen) parameters. Other substances regarded as indications of pollution and potentially dangerous to public health were also included. The BWD is one of the great success stories of EU environmental policy and the overall quality of bathing water across Europe has steadily improved since its adoption.

The initial BWD reflected the state of Europe's population, scientific knowledge and policy experiences of the early 1970s. Patterns of bathing water use have changed since then, as has the state of scientific and technical knowledge. As a result, a revised version of the BWD (EU 2006) came into force in 2006, addressing all surface water sites where a large number of people are expected to bathe during the season. This designation does not include swimming pools, confined waters subject to treatment and artificially created confined waters separated from surface water and groundwater. All EU Member States ([3]) are subject to this legislation and an additional two countries (Albania and Switzerland) are part of the European bathing water monitoring network. The revised BWD uses the latest scientific evidence to implement the most reliable indicator parameters for predicting the microbiological health risk of designated bathing waters and simplifies its management and surveillance methods. The resulting information is presented to the public in a variety of interactive and accessible ways ([4]), allowing people to find clean bathing waters and receive timely notifications of deteriorations in water quality and the consequent health risks.

The BWD's focus on waterborne bacteria — i.e. the risks that can affect human health most directly — supplements the monitoring of nutrients and chemicals required under the Water Framework Directive (WFD), with the aim of improving all aspects of water quality. However, with the BWD now fully implemented throughout the EU, it is essential to assess its results continuously. It is not merely a case of assessing water quality across Europe but also about encouraging various stakeholders — such as national politicians, environmental managers, tourism managers and bathing water managers — to implement the BWD integrally. How do we deal with an (albeit small) number of 'poor' quality bathing waters that are still attractive for swimming? How do we relate bathing water management to broader environmental issues? How do we make bathing safe in urbanised and once heavily polluted environments? And how do we work towards improving the quality of bathing sites with a 'sufficient' status so that they achieve a 'good' or 'excellent' classification status? These are the questions addressed through the concept of integrated bathing water management discussed in this report.

Image 3.1 Taking a bathing water sample

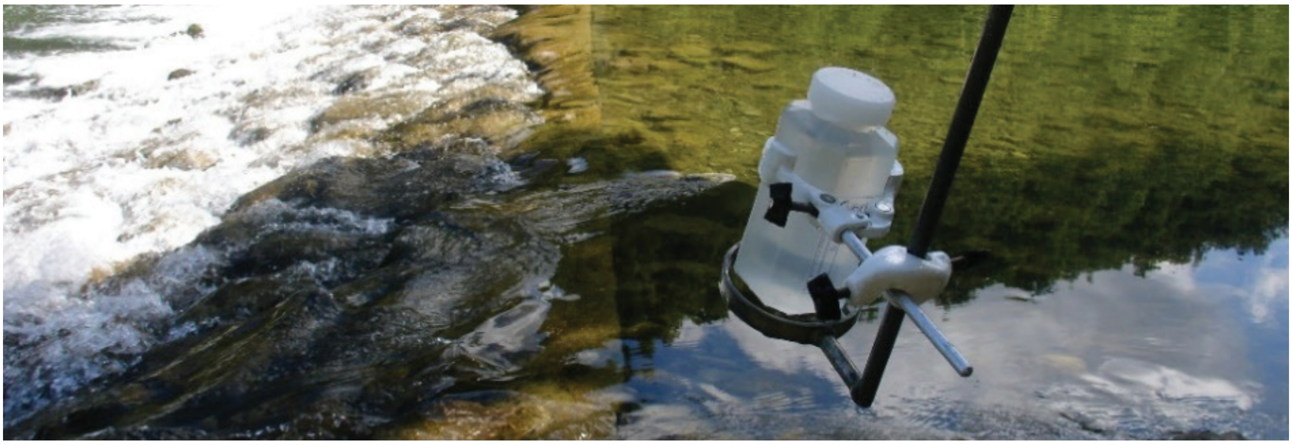


Photo: © Mateja Poje

([3]) The United Kingdom is included among EU Member States because this report is based on BWD data from 2019, when the United Kingdom was still an EU Member State.

([4]) For example, the State of bathing waters interactive dashboard, available on the EEA's website: https://discomap.eea.europa.eu/Bathingwater.

3.2 Integrated bathing water management

Integrated bathing water management involves finding synergies between various interest groups through collaboration to encourage effective bathing water management. Under this approach, bathing water designations should not follow a traditional top-down approach in which a higher authority (e.g. the EU) delegates tasks to participants at lower levels (e.g. a local community). Public consultation and engagement with local communities is vital and plays an important role when dealing with the challenges associated with bathing water management. Every EU Member State tackles its specific issues when managing bathing waters and implementing the BWD. These specifics depend mostly on physical, administrative and socio-economic constraints (EEA 2016b). Nevertheless, all Member States make great efforts to not only improve the quality of existing bathing waters and provide up-to-date information to the public ([5]) but also make bathing feasible in urbanised and formerly heavily polluted surface waters.

Clean water in freshwater ecosystems is beneficial not only for bathing but also for drinking water provision and the wider health of the ecosystem. Efforts to improve bathing water quality, therefore, need to be closely coordinated with the suite of legislation designed to protect and manage European waters. The WFD (EU 2000) ultimately requires European waters to achieve good ecological and chemical status, including bathing waters. In addition, programmes for achieving these statuses need to be supplemented by programmes set out in subsequent European legislation (daughter directives). This includes legislation on urban waste water treatment ([6]), drinking water ([7]), the management of nitrates ([8]) in farming that affect water sources (known collectively as the water industry directives), marine environmental protection ([9]) and, ultimately, the WFD (EU 2000). These directives focus on protecting human health, while at the same time regulating farming and economic practices to reduce and prevent water pollution. Various elements of these policies focus on managing specific parts of the water cycle. Altogether, these directives have established a European monitoring and reporting network to document the quality of the water abstracted and used by humans ([2]) and discharged afterwards ([3]), and the quality of the water available for recreational purposes ([10]) (EEA 2016b). Efficient bathing water quality management therefore dovetails with the implementation of other EU water policies. The Urban Waste Water Treatment Directive (UWWTD) regulates the collection, treatment and discharge of urban waste water, and the Industrial Emissions Directive ([11]) addresses, among other things, emissions to water.

The WFD, however, regulates a holistic approach to maintaining good water status in general. Box 3.1 illustrates an example of how the implementation of the UWWTD and WFD brought positive results by implementing the BWD at the Lacuisine bathing site on the Semois river in Belgium (Box 3.1). The EEA is working on a report on European Significant Water Management Issues (SWMIs), to be published in 2021. The report aims to provide a European overview of the main pressures and drivers by illustrating a selection of SWMIS, including pollution issues, at European level. Moreover, the report discusses the cross-cutting challenges of EU-wide issues, with an emphasis on their role in improving and accelerating the implementation of measures to achieve WFD objectives. Proper implementation of the WFD will evidently improve the quality of bathing waters.

An essential aspect of European bathing water legislation is the involvement of all stakeholders relevant to a given water body, including the public. With this in mind, European legislation has also connected with civil society's activities, for example by integrating the practices of the Blue Flag programme, started in 1985 by a non-governmental organisation and later supported by the EU for 11 years until 1998. The programme seeks to implement various environmental, educational, safety and accessibility criteria in assessing bathing waters globally (EEA 2016b), assigning a 'blue flag' to specific bathing waters at authorities' request if the criteria are met. Although the majority of blue flags have been awarded to coastal bathing sites, the number awarded to inland bathing waters, including in cities, is increasing. In addition, there are other civil society stakeholders actively cooperating with European institutions to improve the quality of bathing waters, one of which is Surfrider Europe.

([5]) While the EU assessment of bathing water quality is published for the previous season, national authorities may provide more up-to-date information, especially in cases of pollutions, risks, etc.
([6]) Urban Waste Water Treatment Directive, 91/271/EEC (EU 1991a).
([7]) Drinking Water Directive, 98/83/EC (EU 1998).
([8]) Nitrates Directive, 91/676/EEC (EU 1991b).
([9]) Marine Strategy Framework Directive, 2008/56/EC (EU 2008).
([10]) Bathing Water Directive, 2006/7/EC (EU 2006).
([11]) Industrial Emissions Directive, 2010/75/EU (EU 2010).

Box 3.1 Successful water policy synergy: the case of Lacuisine (Belgium)

For many years, the Walloon Region in Belgium permanently prohibited bathing at the Lacuisine bathing water site on the Semois river because of its poor bathing water quality. Such prohibition of (or advice against) bathing is prescribed by the Bathing Water Directive to protect human health and to encourage management of the underlying issues that affect environmental quality.

Between 2012 and 2016, numerous measures were undertaken to improve the quality of bathing water at Lacuisine. These included improving urban drainage, constructing a waste water treatment plant and installing a collector in the upstream protection zone, establishing pasture bank fences in the upstream area and controlling storm water overflows in the bathing area. These measures were designed and implemented in line with the framework of the holistic approach provided by the Water Framework Directive. Together, they worked to substantially improve the quality of water at Lacuisine.

After 6 years of water quality management, Lacuisine was re-opened for bathing in 2018.

Box 3.2 Water policy integration: the case of Ardmore beach (Ireland)

Ardmore beach is a sandy beach on the south coast of Ireland near Ardmore village. It is visited by hundreds of bathers, surfers and kayakers during the bathing season. The biodiversity of the beach and its surroundings is relatively high. Between the beach and the harbour, low tide allows access to rock pools, which are home to marine organisms such as shrimps, crabs, fish and anemones. Natural heritage areas situated in the vicinity of the beach include vegetated sea cliffs and coastal dry heather, which are home to many bird species, and the Blackwater estuary, an internationally important wetland site.

During 2014, high tides and strong winds interfered with the normal dispersion and dilution of screened sewage from the nearest waste water treatment plant, causing bathing water to be classified as 'poor'. To improve bathing water quality, water discharged from the treatment plant was given additional treatment during the bathing season. Bacterial levels were significantly reduced. Bathers, surfers and kayakers returned to the beach as soon as the advisory notice was removed.
A new waste water treatment plant for Ardmore village was commissioned in early 2016 and the bathing water quality at Ardmore is now classified as 'excellent'.

Image 3.2 Sandy Ardmore beach

Photo: © Paul Carroll

Successful integration of bathing and urban waste water treatment legislation also had a positive effect on water quality at Ardmore beach in Ireland (Box 3.2).

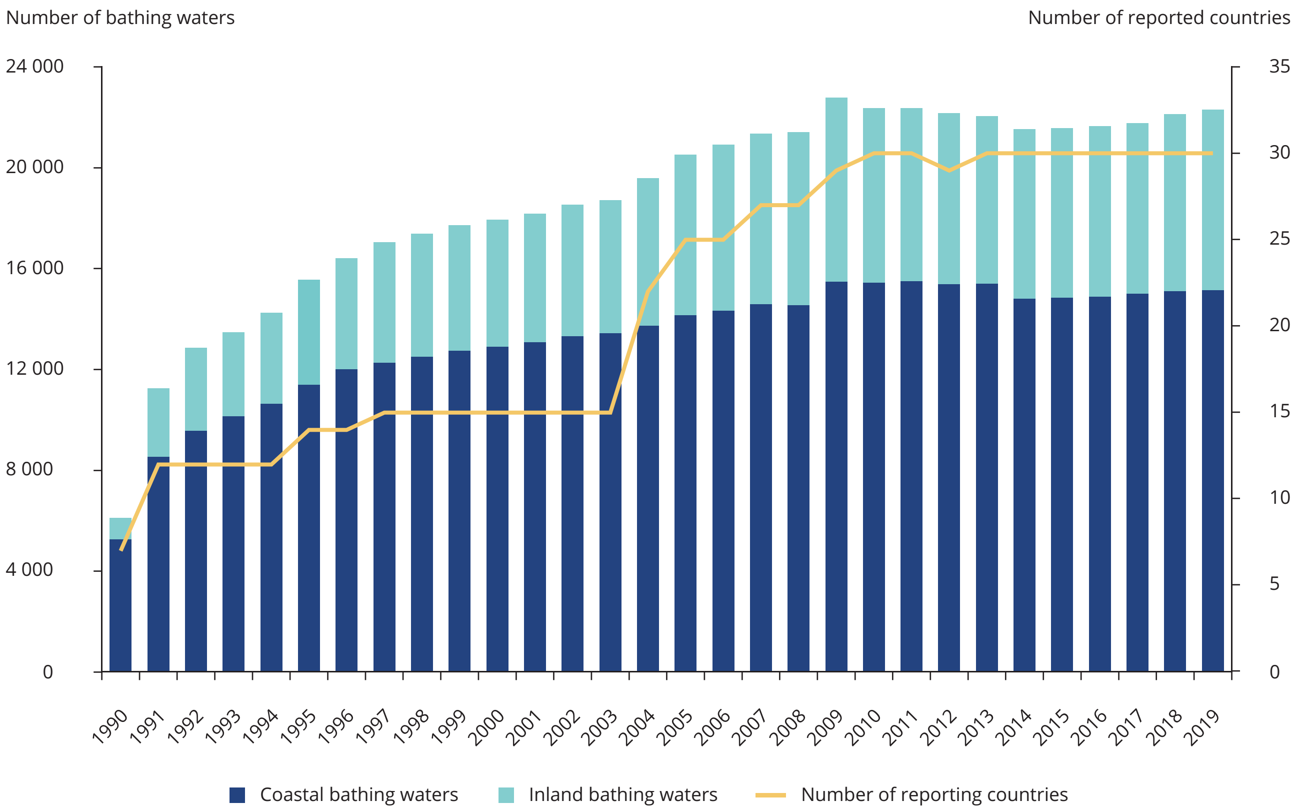
The bathing season in Europe usually lasts from May to September. During that time, local and national authorities take bathing water samples and analyse them for types of bacteria that indicate pollution from sewage or livestock (e.g. *Escherichia coli* and intestinal enterococci). Based on the levels of bacteria detected, bathing water quality is then classified ([12]) as 'excellent', 'good', 'sufficient' or 'poor'. Polluted water can have negative impacts on human health — such as diarrhoea or stomach problems — if swallowed (EEA 2018). According to the BWD, if bathing water quality has been 'poor' for 5 years consecutively, bathing must be permanently prohibited or permanent advice not to bathe must be put in place.

The next section will show how the quality of European bathing waters has improved in recent decades.

3.3 From polluted to excellent-quality bathing waters

Over the course of almost 30 years there has been an increase in the number of European bathing waters that are monitored and managed under the BWD. The increase was especially dramatic between 1990 and 1991: the number of bathing water sites monitored by seven EU Member States in 1990 was 7 539, while, just a year later, there were five more Member States monitoring bathing water sites and the number of bathing waters had increased to 15 075. Since 2004, bathing water quality has been monitored at more than 20 000 locations: in 2019 there were 22 295 official bathing waters in Europe (Figure 3.2).

Figure 3.2 Total number of bathing waters in Europe since 1990



Source: Water Information System for Europe (WISE) bathing water quality database (data from annual reports by European countries).

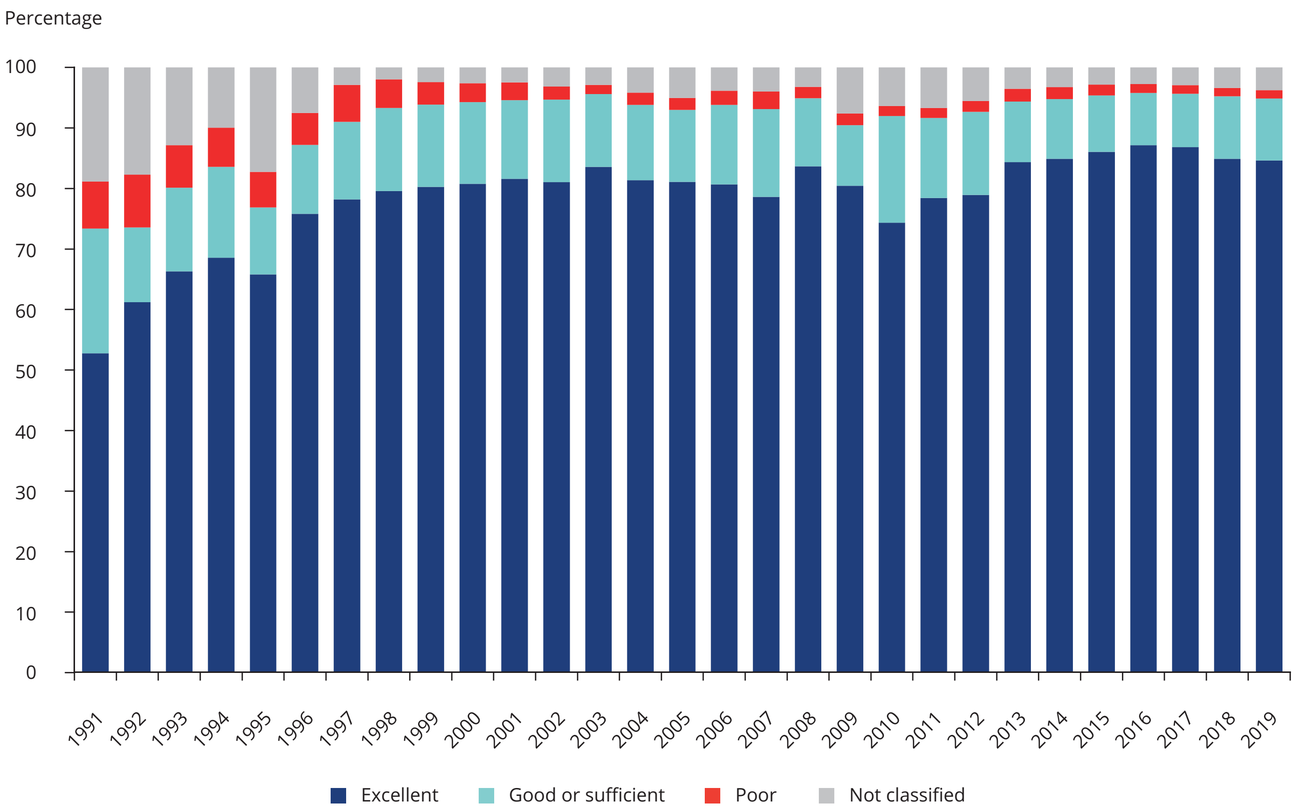
([12]) Every spring, the EEA publishes the results of assessments for the previous bathing season. Up-to date data on bathing water quality, including detailed information for each bathing water site, are usually published regularly by national/regional authorities on their websites.

In recent decades, European countries ([13]) have not only begun to manage a greater number of bathing waters but have also significantly improved their water quality. Great efforts have been made at thousands of bathing sites across Europe to reduce and eliminate pollution and ensure safe bathing. As a result, the percentage of bathing waters achieving at least sufficient quality (the minimum quality standards set by the BWD) increased from just 74 % in 1991 to over 95 % in 2003, and it has remained quite stable since then. The percentage of bathing waters achieving the highest water quality (classified as excellent) increased from 53 % in 1991 to 85 % in 2019. In other words, more than 8 out of 10 of Europe's monitored bathing waters now have excellent water quality (Figure 3.3).

Significant investments in urban waste water treatment plants, improvements in sewerage networks and other measures have contributed to a reduction in poor bathing water quality across Europe in recent decades. In 1991, 9 % of bathing waters were classified as poor, whereas in 2019 this was the case for only 1.4 % of bathing waters. Bathing water quality cannot be improved at all bathing water sites. If the management measures needed to improve quality are disproportionately expensive or too difficult to implement, a bathing water of poor quality is excluded from the monitoring programme; after this, a bathing water is no longer considered an official bathing water.

It is encouraging to see that more and more European bathing water sites have reached the minimum water quality standard (sufficient). It is even more reassuring to note that European countries are making great efforts to ensure that more and more bathing waters are classified at the highest (excellent) quality standard. While most European countries began to improve the quality of bathing waters decades ago, Albania has undergone this process more recently, as explained in Box 3.3.

Figure 3.3 Bathing water quality in Europe since 1991



Source: WISE bathing water quality database (data from annual reports by European countries).

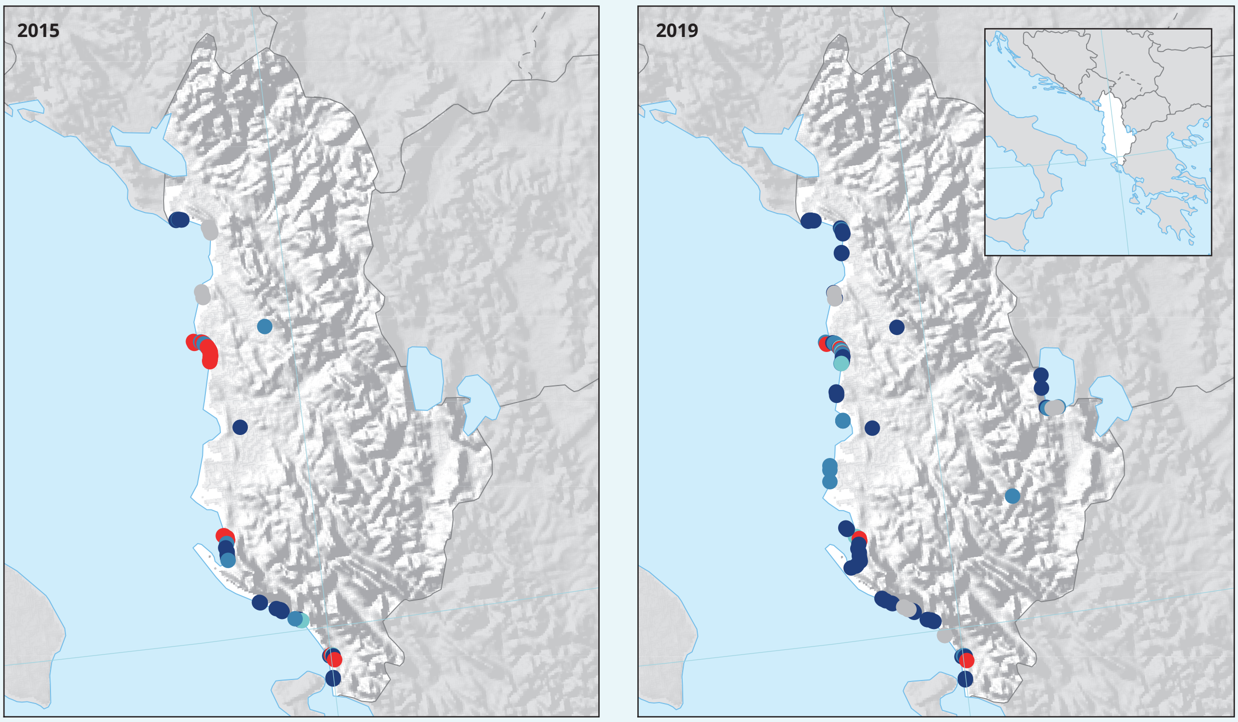
([13]) Apart from EU Member States, data have also been reported by three non-EU countries: Albania (from 2013), Montenegro (2010-2011) and Switzerland (from 2009).

Box 3.3 Albania as a coastal tourist destination

In 2015, almost 40 % of bathing waters (31 bathing sites) in Albania were classified as 'poor' (Map 3.1). The majority of these bathing waters were situated on the coastline of Durres, one of the main tourist destinations and the country's second largest city (EEA 2016a). The national authorities have paid significant attention to the water sector in the Durres area in recent years. The World Bank has also supported investment in Durres' water supply network and in the construction of pipelines to link villages to the city's water supply system and reduce losses in the water distribution network. In addition, the local sewerage network and its capacity to transfer waste water from the tourist beach area to the waste water treatment plant were also enhanced (World Bank 2014). In recent years, five waste water treatment plants providing treatment for almost half a million residents have been constructed in Albania (EEA 2018).

These measures have gradually contributed to better bathing quality and overall water quality in Albania. In 2019, only 7 bathing water sites (or 5.9 %) were classified as poor', which is a significant reduction since 2015, when 31 bathing water sites (almost 40 %) were assessed as poor (Map 3.1). Improving bathing water quality offers great potential for coastal tourism. The tourism industry in Albania contributes more than 8 % of the country's gross domestic product (GDP). Improving bathing water quality by ensuring clean and safe bathing waters is paving the way for Albania to become an established and well-recognised tourist destination.

Map 3.1 Bathing water quality in Albania in 2015 (left) and 2019 (right)



Reference data: ©ESRI

Bathing water quality in Albania in 2015 (left) and 2019 (right)

Water quality

Excellent · Good · Sufficient · Poor · Not classified

0 50 100 km

Outside coverage

Sources: National boundaries: EEA. Bathing water data and coordinates: reporting countries' authorities.

Clean bathing waters are essential not only for safe recreation but also for the environment and the economy. EU water policy has been successful in helping to protect and improve bathing waters in recent decades. What is the next step? One answer is revitalising bathing waters in cities, where the complexity of urban activities and pressures makes ensuring clean and safe bathing a significant challenge.

3.4 Now we can swim in some of our cities again

Since the start of the Industrial Revolution in the 18th century, the geographical distribution of human populations across Europe has changed significantly. In that time, Europe has become one of the most densely populated regions in the world, where almost 75 % of the population lives in urban areas (Koceva, et al., 2016). The gradual increase in the proportion of people living in urban areas has come at a cost to European rivers and lakes over the last century. Many coastal and inland waters were heavily degraded and polluted during this urbanisation process (EEA 2016d). As a result, traditional uses of rivers, such as bathing, disappeared. Large loads of waste water flowing directly to the rivers, lakes and seas made bathing impossible in such places without jeopardising human health.

In recent years, we have made significant progress in improving water quality in European urban seas, rivers and lakes. This is mainly the result of the construction of sewers and new waste water treatment plants, alongside upgrades to existing ones. Cumulative restoration measures, such as reopening previously covered rivers and improving water quality to reach bathing standards, contribute to how both local citizens and visitors experience urban coasts, rivers and lakes.

Restoring urban coasts, lakes and rivers that flow through big cities to the point at which their water quality meets the bathing water standards is becoming more and more realistic and feasible. In recent years there has been a significant increase in the number of safe bathing waters situated in big cities ([14]). In the last decade, the number of urban bathing sites has increased substantially. About 75 % of these bathing waters are coastal and thus situated in cities by the sea, with many on the Mediterranean Sea coasts (Box 3.4) in the cities of Nice (150 bathing waters), Pesaro (almost 90 bathing waters) and Toulon (70 bathing waters). The cities with the highest number of inland urban bathing waters are Amsterdam (38), Stockholm (36), Berlin (33), Lugano (28), Geneva (25), Rotterdam (23) and Vienna (23).

Today, safe bathing is possible even in some European capitals: people can bathe on the banks of the River Danube in Vienna and Budapest, on the River Spree in Berlin, at numerous places in Amsterdam, on the River Daugava in Riga, at Copenhagen harbour and many others.

Although the bathing water quality in Europe is increasing and bathing is possible today even in some heavily urbanised areas, there is still a need for integrated and adaptive management to mitigate both existing and emerging pressures, as outlined in the following chapter.

Image 3.3 Public bathing at the harbour in Copenhagen, Denmark

Photo: © Ursula Bach, Municipality of Copenhagen

([14]) Urban areas reported under UWWTD as 'Big cities' and urban areas (agglomerations) as identified by JRC in riparian zones spatial data.

Box 3.4 Management of large bathing waters in Barcelona (Spain)

Barcelona has a population of 1.6 million inhabitants, with 1.5 million more in the wider metropolitan area. The seafront of the city has been transformed, and it is now a famous tourist site, with over 10 km of beaches, visited by over 3 million tourists each year. Because of its high population density and hilly terrain, Barcelona's bathing waters are exposed to sewerage system overflows. These overflows cause episodes of short-term water contamination that may affect the quality of bathing waters. As is common in Mediterranean climates, heavy rain events are often concentrated in very few days.

Until the early 1990s, Barcelona faced flooding problems and overflows, causing environmental pollution. In 2006, an ambitious plan was proposed with the objective of improving the environment and public well-being: to reduce the combined sewage outflows in order to reduce the number of hours that bathing is not advisable.

Information systems have been developed for both internal coordination and general public information. The public can access bathing information (e.g. bathing water quality predictions, weather forecast, presence of jellyfish) using electronic panels at the beach and on public web pages. A coordination protocol is activated when an overflow is detected, which can be triggered by tele-controlled sensors, camera images or direct observations at the beach. The protocol sets out the measures to be taken. so that those responsible can diagnose the outflow and take corrective action to resolve the problem immediately.

Image 3.4 A popular beach in Barcelona

Photo: © Nikolaï Posner

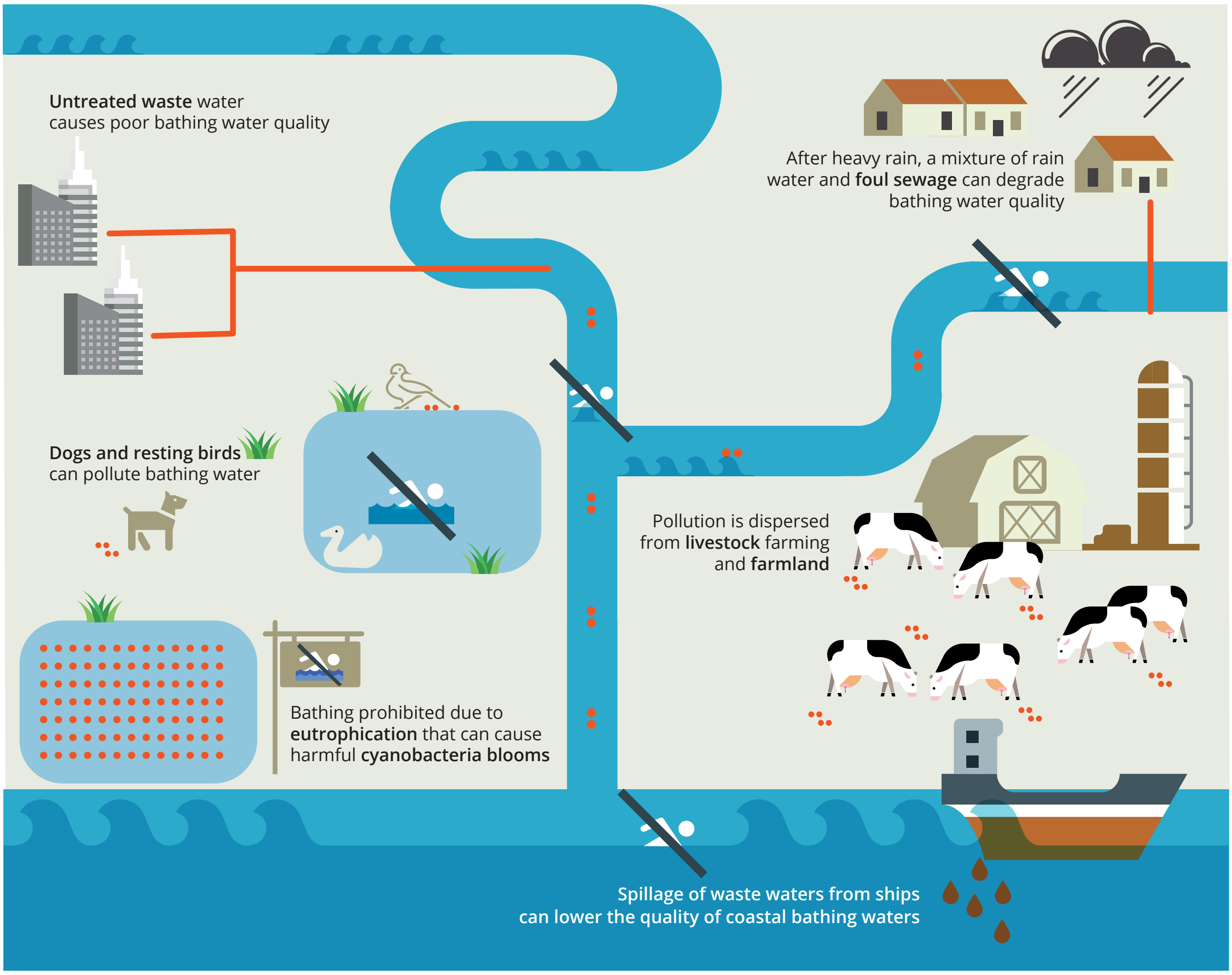
4 Addressing the challenges facing bathing waters

4.1 Faecal bacteria: an invisible health risk

The major sources of faecal bacteria pollution come from untreated waste water, insufficient waste water treatment plants, animals (e.g. birds and dogs at beaches), ships and water draining from farms and farmland (Figure 4.1). The presence of faecal bacteria can lead to poor bathing water quality, which presents a threat to bathers' health. Pollution from sewage is often the result of storm water overflows of sewage, agricultural run-off or from poorly maintained cesspits and septic tanks. Badly connected plumbing — where, for example, water from toilets directly enters surface waters — constitutes another potential source of microbiological pollution (EEA 2018).

In the mid-1970s, large quantities of uncollected, untreated or partly treated waste water were discharged into many European waters. Back then, many of today's 'excellent' bathing waters were heavily polluted and unsafe for recreational use.

Figure 4.1 Threats to bathers' health

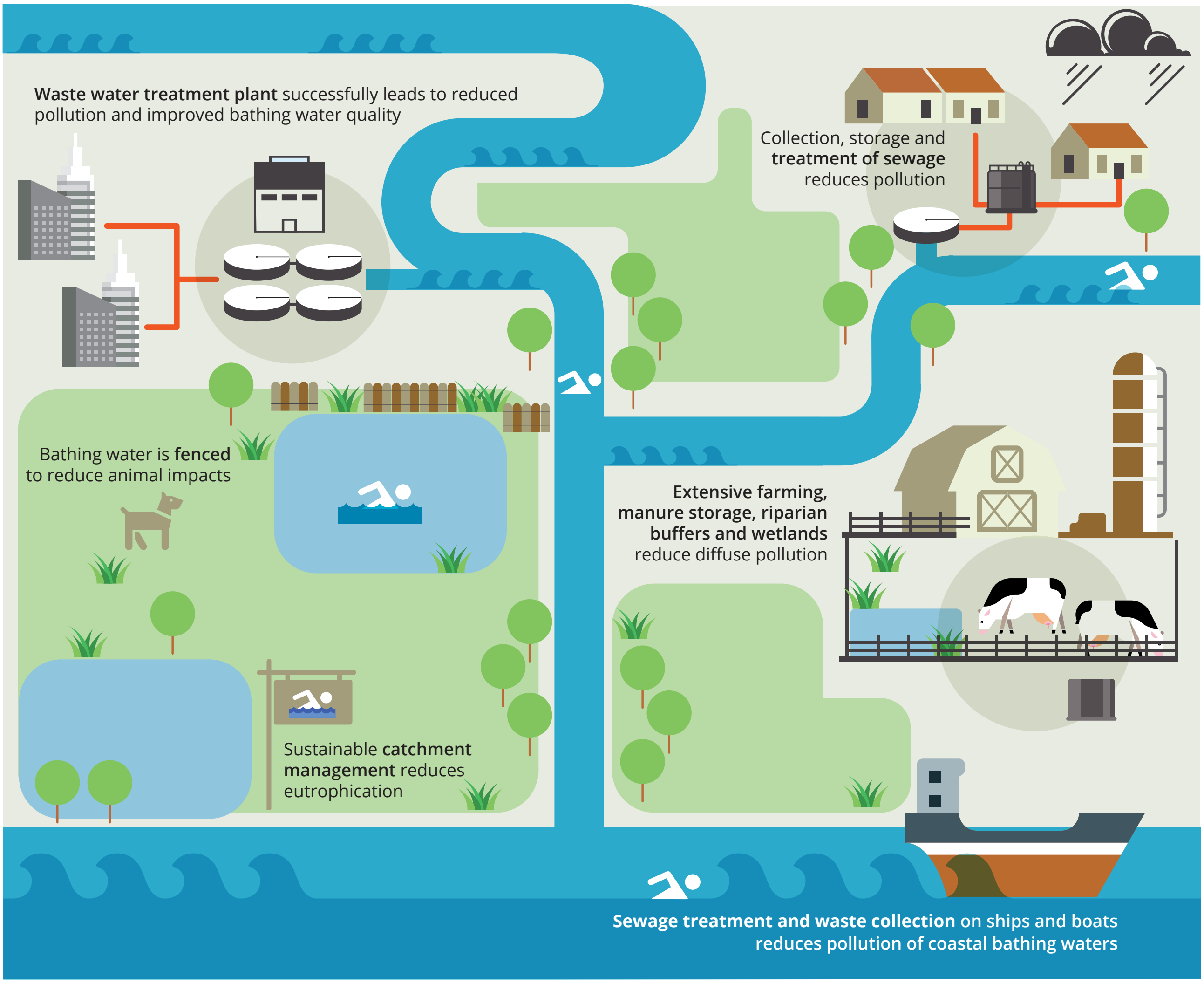


4.1.1 How has it been managed?

Massive investments in sewerage systems and treatment plants — triggered by, among other things, the need to comply with the Urban Waste Water Treatment Directive (UWWTD) — have resulted in much cleaner bathing water in Europe than in previous years in terms of bacterial pollution (EEA 2019a). Today, almost all significant discharges of sewage from households and industry undergo collection and treatment before they are released into seas, rivers and lakes (Figure 4.2). Additional treatment methods, such as disinfection, chlorination and ozonisation, are also being implemented across Europe to ensure high hygiene standards for bathing waters (EEA 2016b).

If microbiological pollution causes poor bathing water quality, the sources and extent of the pollution first have to be assessed (e.g. foul sewerage pipe, pollution from manure) (Box 4.1). If the causes of the poor water quality are not obvious, further investigation to explore the sources may be needed. Implementing the UWWTD has successfully led to reduced pollution and improved water quality at numerous bathing water sites of previously low quality. Although implementing the directive has been expensive, its benefits clearly outweigh its costs (EEA 2019b). The UWWTD is thus the main factor in ensuring that the EU's bathing water sites are safe and, by undertaking the required treatment, its implementation also reduces a number of non-target chemicals (EC 2019). To find and eliminate sources of pollution, inventories of bathing waters affected by water draining from farms and farmland and scattered houses with misconnected drains are established. If bathing waters are affected by a large number of animals (Box 4.2), it may be necessary to restrict their access (e.g. by fencing) or to change the location of the bathing water site. Bathing water sites classified as poor have to be closed throughout the following bathing season, and measures must be put in place to reduce pollution and eliminate hazards to bathers' health.

Figure 4.2 Management measures to reduce pollution and improve bathing water quality



Box 4.1 Uncontrolled sewage at the Arturówek bathing water (Poland)

The Arturówek bathing water is located in the northern part of Łódź at the edge of the Łagiewnicki forest. It consists of three reservoirs, two of which have been adapted for bathing purposes and hiring equipment for water recreation. The Arturówek ponds, situated in an urban environment, are an important place for the inhabitants of Łódź to relax in, as well as a major tourist site during the holiday period.

There were several uncontrolled sewage discharges in the river catchment upstream of these reservoirs. Since the sewage was washed downstream by rain water and snow melt to the Bzura river and reservoirs, the quality of the Arturówek bathing water has been badly degraded.

As all previous attempts to improve the quality of the water in the ponds (e.g. the removal of bottom sediments) only improved the situation temporarily, a systemic approach was taken in the 'Ecohydrological rehabilitation EU LIFE' project. The technical measures implemented (e.g. desludging the bottom of the ponds to remove nutrients and implementing a novel waste water treatment technology involving sequential biofiltration to reduce the load of organic pollution from sewage) improved the water quality and overall attractiveness of the Arturówek site. This demonstrates the application of ecohydrological methods in sustainable water management in urban areas, involving both the public and decision-makers. Finally, it establishes a basis for rehabilitating key water systems in Łódź under the Water Framework Directive.

In 2018, the Arturówek ponds were finally reopened for bathing after 8 years. Although classification of the water quality under the Bathing Water Directive is not yet possible because sufficient samples have not been collected, the results of monitoring water quality already show a gradual improvement.

Image 4.2 Evening at the Arturówek bathing water

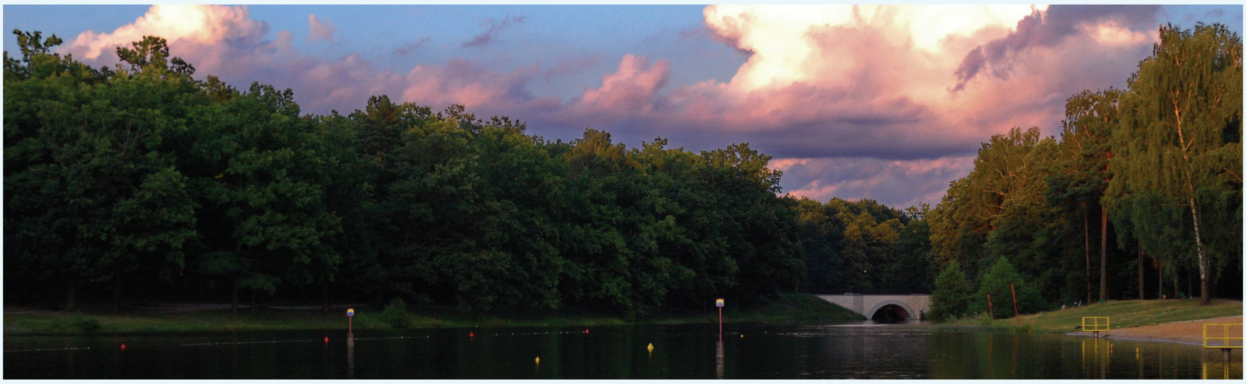


Photo: © Mariusz Kucharcyk

Box 4.2 Birds affecting the quality of bathing water (Czechia)

Brušperk has a reservoir, built in the 1960s to protect against flooding in the vicinity of Ostrava, Czechia. Nowadays, it is used mainly for bathing and fishing. Between 2012 and 2015, the quality of the bathing water was impaired, mainly as a result of the presence of large numbers of water birds, which were fed by visitors to the beach, as well as pollution from a farm located near the reservoir. In the 2012 season, bathing was temporarily prohibited because of microbial pollution caused by water birds' faeces. After the local authorities intervened, the bird feeding areas were moved from the banks of the reservoir to surrounding water bodies, and people were kindly requested to feed the birds at locations not used by bathers. The microbiological quality of the bathing water is now rated 'excellent'.

4.2 Extreme weather and other events: unpredicted impacts on water quality

The causes of short-term pollution episodes are usually weather events, such as excessive precipitation and subsequent surface run-off, and combined sewer overflow, when a mixture of surface water and foul sewage is discharged to the environment in combined sewer flows (EurEau 2016; EEA 2018). Concrete pipes, sewers and particularly paved surfaces make it difficult for storm water to be absorbed (EEA 2015c). It is also evident that concrete sewerage systems in urban areas are not always able to drain all storm water through the systems, and therefore they might be the real cause of urban flooding. For this reason, extreme weather events need to be addressed with integrated urban management, including forecasting pollution in correlation with other factors, managing pollution when it is detected and assessing the overall risk of such events.

Such pollution events are often of short duration — potentially up to 72 hours but often significantly shorter — and have identifiable causes. After heavy rain, a mixture of surface water and sewage is sometimes discharged into bathing waters or their vicinity, affecting water quality by introducing bacteria and viruses that can harm human health. In a small number of cases, short-term pollution events also occur because of technical errors such as malfunctioning sewerage systems or waste water treatment plants or spillage of waste water from ships.

In the last 4 years, more than 3 000 short-term pollution events were reported throughout Europe. The number of events reported is increasing — this may also be an indication of management measures being more frequently applied, resulting in a larger number of events being reported (EEA 2017c). The data collected show that, although short-term pollution events also occur in bathing waters classified as good or excellent, they much more frequently affect bathing waters of poor and sufficient quality ([15]).

In contrast, some inland bathing sites may lack water as a result of drought or even water abstraction for hydropower generation, cooling and irrigation. Because of low flow and weak dilution of pollutants, deterioration in water quality is observed at such sites. High summer temperatures or construction work on bathing sites may worsen the situation.

4.2.1 How has it been managed?

Sewage overflows across Europe are being managed using various measures such as installing equipment for monitoring spills to the environment, constructing storage tunnels and tanks to reduce storm overflows (Box 4.3) and creating nature-based retention basins. At the EU level, the UWWTD only includes a footnote on storm water overflows, stating that ' … during situations such as unusually heavy rainfall, Member States shall decide on measures to limit pollution from storm water overflows. Such measures could be based on dilution rates or capacity in relation to dry weather flow or could specify a certain acceptable number of overflows per year.' The UWWTD does not define what constitutes 'unusually heavy rainfall' or an 'acceptable number of overflows per year'. It also does not require the monitoring of overflows (EC 2019).

Green spaces in urban areas can function as storm water retention basins and mitigate the load on conventional sewage systems. Such solutions are not only less expensive than traditional 'concrete' infrastructure but they also provide a wide array of co-benefits for local economies and social communities (EEA 2015c). Such measures can also prevent flooding and minimise adverse impacts on the environment and bathers' health. The importance of nature-based solutions is also recognised in EU policy such as the Seventh Environment Action Programme (EU and European Parliament, 2013), EU biodiversity strategy (EC 2011) and EU strategy on adaptation to climate change (EC 2013).

([15]) Quality classifications as defined in the Bathing Water Directive.

Box 4.3 Managing storm overflow pollution in Blackpool (United Kingdom)

There are three bathing waters situated on the Fylde coastline around Blackpool, Lancashire, flanked by the urban fringe along the coastline, with agricultural land dominating further inland. Most surface water in the catchment is diverted away from the bathing waters. In the 1990s these bathing waters were of poor quality, mainly because of insufficient sewage infrastructure.

The GBP 500 million coastal clean-up project Sea Change was launched in 1994 by the UK Environment Agency in conjunction with the water service company to improve bathing water quality in north-west England, particularly along the Fylde coast. Under this programme, the company made improvements in the Blackpool area by constructing a tunnel to provide storage for storm discharges and by transferring flows from four coastal pumping stations serving the Blackpool area to a new sewage treatment works at Fleetwood. In addition, large storage tanks were also built to reduce storm overflows. As a result of these measures, the water quality at Blackpool improved gradually, reaching good and even excellent quality.

As part of the improvement programme running from 2015 to 2020, the storm overflow systems at Chorley, Blackburn and Preston sewage treatment works are being improved to sustain more storm discharges. This is expected to improve bathing water quality on the Fylde coast.

Image 4.3 Blackpool beaches

Photo: © Zergo512

Modelling and warning systems are put in place to advise bathers against entering the water after short-term pollution events at bathing waters affected by heavy rain events and storm water overflows (Box 4.4). This is in addition to measures to reduce pollution at source (Box 4.4) and in rainwater storage basins (EEA 2018).

Box 4.4 Early warning system for short-term pollution at Lake Baldeney (Germany)

In the intensely industrialised Ruhr valley in northern Germany, the River Ruhr became increasingly polluted throughout the 20th century. Over time, using the river for recreational purposes became a serious health hazard and bathing was banned because of chemical and microbiological risks between 1971 and 2015 (Strathmann, et al., 2016). The water quality also deteriorated as a result of coal and steel mining.

Following the implementation of all levels of waste water treatment in 2005 in Essen, the site's water quality gradually improved. Decades after it was closed for swimming, people can now safely bathe in Lake Baldeney again. The development of an early warning system for short-term pollution was an important step in managing this site. Short-term pollution events can happen in running water after a heavy rainfall event. To be approved as an official bathing area, it was essential to have an early warning system for swimmers, allowing authorities to swiftly prohibit bathing at the site if needed. The early warning system (Strathmann, et al., 2016) is based on measured precipitation data. It is activated if the rainfall exceeds a certain threshold between the evaluation date and 2 days previously. In such a case, a web application issues an automatic bathing warning and bathing is temporarily prohibited at the site. The early warning system is now operating and it has proved to be a reliable way of protecting swimmers from illness.

Essen has proved to be an environmentally innovative city, especially in the face of a challenging industrial history. Essential success factors in making bathing at Lake Baldeney possible again include strong participation from the local population and an evaluation of the costs and benefits of operating such a bathing area (IWW 2017).

Image 4.4 The beach at Lake Baldeney

Photo: © Seaside Beach Baldeney

4.3 Excessive algal and plant growth: eutrophication as a health risk

The rapid increase in industrial and agricultural production and in household consumption in Europe during the 20th century resulted in greater volumes of nutrient-rich waste water reaching aquatic ecosystems. The nutrient overenrichment (mostly from inputs of nitrogen and phosphorus) of seas, lakes, rivers and streams from land-based sources, marine activities and atmospheric deposition can result in a series of negative ecological effects known as eutrophication (EEA 2019b). The presence of excess nutrients leads to excessive plant and algal growth and decomposition, i.e. eutrophication, which consumes a considerable amount of oxygen (Nemery, 2019). This can affect aquatic ecosystems by lowering the levels of dissolved oxygen — known as hypoxia — to the extent that many aquatic organisms struggle to survive.

Phosphorus is the primary nutrient that causes eutrophication in rivers and lakes, whereas nitrate is the key substance responsible in coastal and marine waters. Increased nutrient concentrations can alter aquatic ecosystems to such an extent that they become unsuitable for drinking and bathing.

The main sources of nitrogen pollution are surpluses of mineral fertilisers and manure, which are washed out of agricultural soil to groundwater, rivers and seas by the rain. Most phosphorous pollution comes from households and industry. If appropriate mitigation measures are not in place, higher concentration of nutrients may be measured at bathing waters situated downstream of pollution sources, potentially leading to problems with public and environmental health. The consequences of such eutrophication can also include blooms of blue-green algae, which reduce water clarity and quality. Decomposing algae can also deplete oxygen levels and induce fish kills (Sanseverino, et al., 2016; CSIRO 2019).

Eutrophication presents an indirect public health risk. In addition to blue-green microalgae, described in the next section, toxic algae such as dinoflagellates also release toxins into the water. The blooms themselves increase water turbidity, kill fish and other marine organisms as a result of lack of oxygen and can also be a nuisance to people (WHO Europe et al., 2003). Bathing tourism, which has benefits for the economy, can be consequently influenced by the change in the coastal or inland water environment triggered by the bloom. These changes include discolouration of the

Image 4.5 Algal blooms can pose a public health risk in bathing waters

Photo: © Dana L. Brown

water, an accumulation of dead fish on the beaches and the smell coming from decomposing algae (Sanseverino, et al., 2016).

4.3.1 How has it been managed?

The implementation of the UWWTD — which includes collection and treatment of waste water in the EU — has reduced releases of nutrients to fresh and coastal bathing waters, diminishing public health risks in some regions of Europe (EEA 2010; EEA, 2012). As a result, bathing waters all over Europe are now much cleaner than they were 30 years ago.

Agriculture continues to be a major source of nutrient pollution, particularly from fertiliser run-off. For example, the Baltic Sea is known to be one of the most eutrophic seas in the world, mainly because of the high loads of nitrogen and phosphorus, originating from agriculture, entering the sea from river systems (EEA and JRC 2013; Helcom 2018). There are also many lakes in Europe with excessive nutrient as is the case of Lake Varesa in Italy (Box 4.5). Mitigation measures include reducing the use of fertilisers, changing land use to reduce nutrient emissions and providing an advisory service to inform farmers about the optimal solutions to be adopted to protect the water body affected (Sanseverino, et al., 2016).

Box 4.5 Eutrophication of Lake Varese (Italy)

Lake Varese is a small lake of glacial origin in Lombardy, in the north of Italy. Since the 1960s, the lake has suffered a deterioration in water quality as the result of intense — and often toxic — algal blooms caused by high phosphorous loads. These have caused fish kills and restricted water use. Lake Varese is the first case in Italy where in-lake methods are being used to counteract the problems caused by excessive nutrient enrichment in a relatively large system. Since the 1990s, the lake has been the subject of a cooperative research programme supported by the European Commission, the Italian Ministry of the Environment, Lombardy region and Varese province. In 1992, a regional water clean-up plan was drawn up, with the objectives of protecting aquatic biota, achieving good ecological status and safeguarding water use, including as a drinking water supply and for bathing (three bathing sites are situated on the lake), fishing and irrigation.

Direct interventions had a key role in accelerating the restoration process in the lake and in controlling the effects of releases of phosphorus from sediments. Major in-lake eutrophication control methods included nutrient inactivation, lake-level drawdown, covering bottom sediments, sediment removal (dredging) and harvesting. As a result, a great amount of total phosphorus, total nitrogen and ammonia was removed from the lake in 2000 and 2001. The lake's transparency is now close to the final objective — 5 m — of the regional water clean-up plan. Algal density has decreased by a factor of four and the frequency of algal blooms has halved.

After decades of neglect because of a lack of beaches, pollution from industrial effluent and eutrophication, Lake Varese has regained its sparkle. In 2018, three bathing waters were operating in the lake: two of them are of excellent quality and one is of poor quality on account of the discharge of insufficiently treated waste water.

Image 4.6 Lake Varese

Photo: © Maxalari

4.4 Cyanobacteria and other hazards

Cyanobacteria — also known as blue-green algae — can be harmful if swallowed and can cause skin rashes. Proliferations of cyanobacteria can occur when environmental conditions are favourable, such as when there are high levels of nutrients in the water, the water column is very stable and temperatures and light are favourable and conditions are calm and windless (Sanseverino, et al., 2017; EEA 2018). Human activities can accelerate this process through, for example, inadequate sewage treatment, agricultural run-off and run-off from roads (WHO 2003).

Cyanobacterial blooms are most pronounced during the summer months, which coincides with the bathing season in Europe and the highest demand for recreational waters. Mass blooms of cyanobacteria can affect the amenity value of recreational waters because they reduce transparency, discolour the water and form scum. Furthermore, decomposing blooms can produce an unpleasant smell (WHO 2003). The information available from European countries indicates issues with cyanobacterial blooms in central European inland bathing waters in Czechia, Germany and Poland, but also in other countries.

Although cyanobacteria are not subject to the quantitative monitoring prescribed by the Bathing Water Directive (B WD), the blooms frequently create the need for issuing temporary advice against, or prohibiting, bathing. Each year, hundreds of bathing water sites are affected by cyanobacterial blooms, which decrease water quality and can affect bathers' health (EEA 2018). Skin contact and swallowing water during bathing are among the most frequent reasons for human poisoning caused by cyanotoxins. The associated symptoms usually range from severe headache to fever, respiratory paralysis, nausea, vomiting, fever and, in rare cases, death (Sanseverino, et al., 2017).

Other hazards, such as chemical pollution and heavy metals, such as mercury, can enter bathing waters or be deposited on their coasts from both natural and anthropogenic sources. These can be either diffuse (non-point) sources, such as run-off from land, or point sources, such as natural springs with high concentrations of mercury or industrial outfall. Understanding the likelihood, extent and frequency of exposure is vital when assessing the risk of such hazards. Many such contaminants tend to settle at the bottom of water bodies where they accumulate

Image 4.7 Cyanobacterial blooms in a bathing water

Photo: © Wouter Rietberg

in sediments. If the sediment remains undisturbed, the risk is relatively low. If the sediment is disturbed or bathers come into direct contact with it, the cause for concern is higher.

Pharmaceutical residues present an additional threat, as treatment plants are not designed to remove the increasing amount of pharmaceuticals contained in waste water (Hofman, 2019). Other challenges include controlling micropollutants, the impact of climate change on waste water treatment, the correct pricing of water services and a lack of public understanding (ÖWAV 2019). Waste water effluent can also contain microplastics (Kay, et al., 2018), as can sewage sludge (the by-product of waste water treatment) (Kay, et al., 2018; UKWIR 2019). The latter can be used as a fertiliser and could thus remain in the aquatic environment through run-off from agricultural land (Kay, et al., 2018).

4.4.1 How it has been managed?

Algal blooms result from a complex interaction between biological, chemical, meteorological and especially hydrographical conditions, of which only few can be controlled. To minimise the health risks due to cyanobacteria blooms, phosphorous concentrations should be kept below a 'carrying capacity' threshold. In particular, nutrient inputs from agricultural run-off can in many cases be reduced by decreasing the application of agricultural fertilisers or protecting the shoreline from erosion by planting trees and other vegetation along the shoreline to create 'buffer strips' for pollutants. Implementing early warning methods to detect cyanobacteria will be necessary to prevent additional human and ecosystem health hazards (Sanseverino, et al., 2017).

After repeated episodes of algal bloom as a result of the toxic alga *Ostreopsis ovata*, for coastal waters and for cyanobacteria in lake waters, management measures for monitoring and managing risks have been established, including appropriate health limit values, to protect bathers' health in Italy.

To minimise the health risks of chemical pollution, it is very important to understand the industrial and other human activities in the catchment area and vicinity of the bathing water, and whether direct or indirect discharges of pollutants are made to the bathing water. Various measures can be applied to reduce the risk of such hazards. In Lake Mälaren in Sweden, 95 % of mercury in the sediment was successfully isolated by covering the polluted lake bed with artificial bottom sediment (Box 4.6).

European overseas bathing waters may be affected by extreme weather or environmental events, such as cyclones or the massive beaching of algae (Box 4.7). As it is difficult to reduce such hazards, these events should be closely monitored so that bathing can be prohibited if necessary to protect public health.

Box 4.6 Releases of mercury and pollution with heavy metals (Sweden)

Lake Mälaren is located west of Stockholm. With an area of 1 140 km^2 and extending for about 120 km across Sweden, it is the country's third largest lake. There are 19 bathing sites on its shores. Until recently, mercury was spreading into Lake Mälaren in the municipality of Nykvarn.

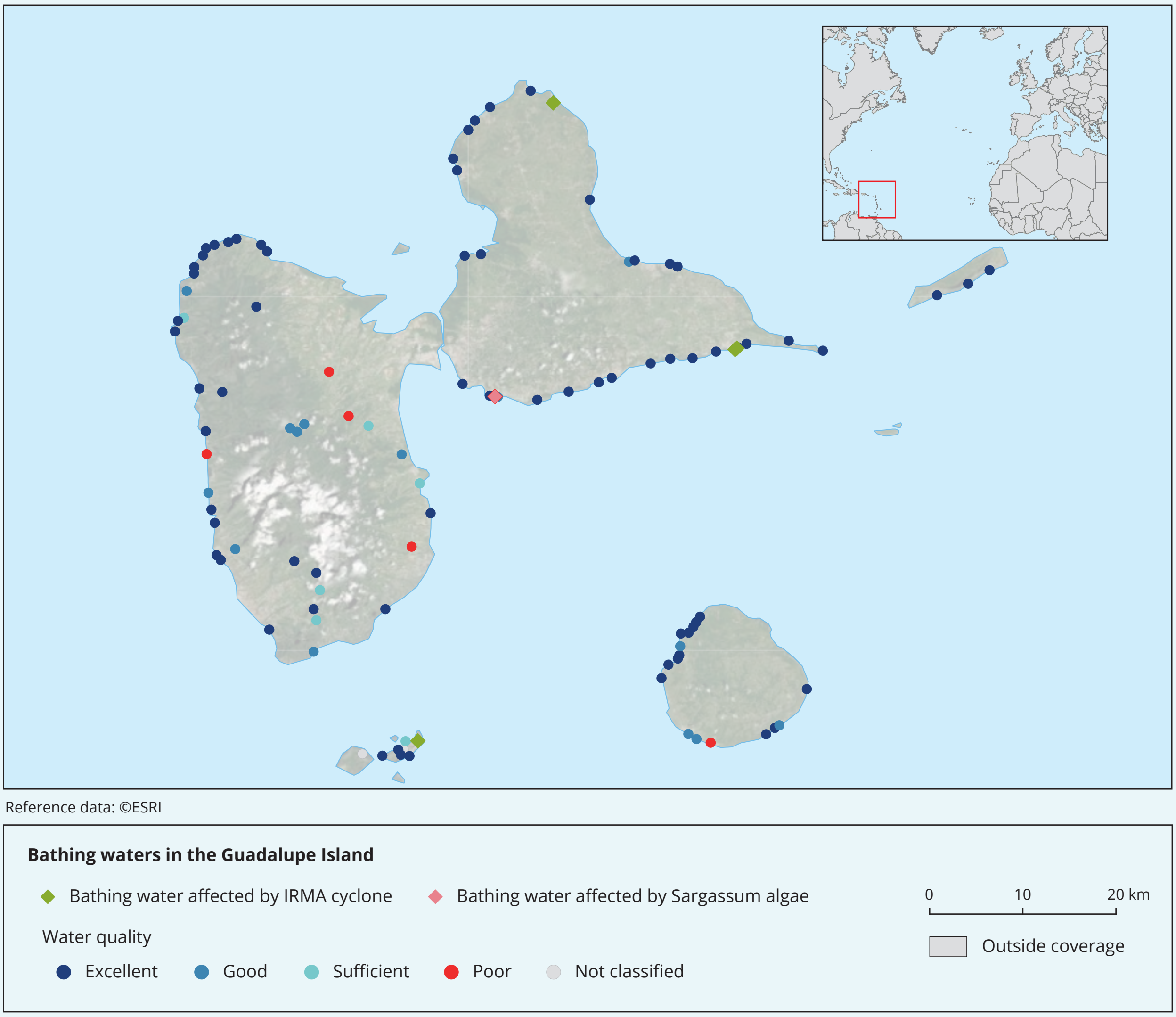
Between 1946 and 1966, a paper mill released fibre residues containing mercury into the Turingeån river and Lake Turingen, which has an outflow to Lake Mälaren. Although the use of mercury was banned in 1966, releases continued, which resulted in high levels of mercury in water and fish tissues. When remediation management started in 1998, there was almost 400 kg of mercury in the river and lake bottoms. In the first stage of the remediation project, the mouth of the Turingeån river and an overgrown bay alongside it were dredged. The dredged materials were placed in the inner part of the bay, covered with a sheet and sealed with a layer of sand. In the second stage, 80 % of the bottom of Lake Turingen was covered with artificial bottom sediment to prevent further leakage of mercury. In addition, 20 % of the area outside the mouth of the river was dredged and capped with a strong, woven geotextile, fine sand and crushed rock. Water barriers were also built to control the exchange of water between the lakes. As a result, about 95 % of the mercury was isolated, and the mercury levels in the lake are steadily declining. This type of remediation could be also applied to cases in which sediments are contaminated with other heavy metals or organic contaminants.

Box 4.7 Bathing waters in overseas territories with specific hazards

There are around 250 bathing waters monitored each year that are situated in European overseas territories. All of these are French bathing waters and are located in the Caribbean islands (Map 4.1), French Guiana, Mayotte and Réunion.

These bathing waters are often affected by major weather or environmental events, such as cyclones accompanied by heavy rain and the massive beaching of *Sargassum* algae. This phenomenon first appeared in 2014 and seems to be lasting. In 2017, two bathing waters were affected by Hurricane Irma and its consequences, while the Caribbean coastline faced the phenomenon of a *Sargassum* algal bloom. The accumulation of these algae can have significant consequences for the environment and the economy and can pose a serious risk to bathers' health. A *Sargassum* algal bloom affected four bathing waters during the 2018 season. National authorities prohibited bathing during the event but did not perform sampling because the sites are difficult to access.

Map 4.1 Bathing waters in Guadeloupe



Reference data: ©ESRI

4.5 Wild bathing in Europe: a challenge for water management

Swimming in natural waters has grown in popularity across Europe in recent years. As a result, the official number of bathing sites identified under the BWD does not cover all the rivers, lakes and seas that adventurous bathers may use. EU legislation, as implemented in national laws, describes the main criteria for a bathing site to be designated as official, such as a large number of bathers visiting the site and/or any infrastructure and facilities provided there. Because not all potential bathing sites meet these conditions, there are many more bathing sites in use than those monitored under the BWD.

Given that unofficial bathing sites are less strictly monitored for potential health risks (if at all) and thus there is no management, their water quality (and thus bathing safety) may remain unknown. For such waters, implementing other directives supporting good ecological status is even more important. Sites where bathing is officially prohibited as a result of poor water quality might still be visited by bathers. At such sites, information boards offering advice against bathing and explanation of the possible health risks are required. Information prohibiting or advising against bathing is also communicated through the press, social media and local websites. Monitoring as set out by the BWD must continue to support ecological restoration measures if implemented.

In Europe, there are many attractive natural waters with high-quality water that are not suitable for bathing because of their ecological vulnerability. Lake ecosystems in alpine and karstic areas, for example, are very sensitive, not only to pollution but also to physical disturbance. Bathing in high mountain lakes can also cause sediment accumulated in the lake to be resuspended (Toro, et al., 2006). Swimming at such sites should be controlled. Information on environmental and potential human health problems could be presented in innovative ways to help raise visitors' awareness and engage them in their own protection. The case study of the small alpine lake Dvojno jezero in Slovenia (Box 4.8) demonstrates such issues around wild bathing in ecologically vulnerable environments.

Box 4.8 Bathing in ecologically sensitive environments (Slovenia)

The so-called 'Double lake' (Dvojno jezero), situated in Triglav National Park in Slovenia, is a highly sensitive ecosystem affected by the anthropogenic introduction of lake char fish, waste water drainage from a nearby mountain hut and summer bathing. As is common in other high mountain lakes in Europe, the Double lake originally did not contain fish (Leskošek, and Brancelj, 2009). The introduction of the fish and waste water have caused the growth of algae (Erhatič, 2010). When people bathe in the lake, they introduce materials into its delicate environment: sun creams, skin excretions, microplastics from bathing costumes and even leftover food. As a result, the water quality in the lake deteriorated (Leskošek, et al., 2009), posing risks to bathers' health. In addition, the physical activity of swimming can damage aquatic plants and stir up sediments.

Triglav National Park and partners have prepared a project called 'VrH Julijcev' (TNP 2020), which aims to restore the ecosystem of Double lake. The measures include extracting fish species, removing organic material and improving the treatment of waste water from the hut (Paladin, 2018). An information and communication campaign has already been started. To raise awareness, visitors to the lake and Triglav National Park are being informed about the fragility of the lake's environment and the adverse consequences of bathing.

Image 4.8 Algae in Double lake (Dvojno jezero)

Photo: © Davorin Tome

5 Bathing in the future

5.1 Climate change impacts

Climate change has substantially affected European landscapes already and will continue to do so for many decades to come. Land and sea temperatures are increasing, precipitation patterns are changing, wet regions in Europe are becoming even wetter, dry regions drier and sea levels are rising. Extreme events such as heat waves, heavy rain and droughts are increasing in frequency and in intensity in many regions across Europe (EEA 2017b). Projected short- and long-term changes to our climate will bring challenges for bathing water management. An increased risk of flooding and strong storms, generating very high waves, as a result of climate change will need to be dealt with to prevent or minimise damage to infrastructure, beaches and settlements (Borja, et al., 2020). Moreover, increased temperatures can also lead to a prolonged growing season (Trnka, et al., 2011) and increased use of pesticides and fertilisers, which can affect both surface water and groundwater quality.

Most of the studies assessing the likely impacts of climate change on beach tourism in Europe use the tourism climate index. This index assesses the climatic elements that are most relevant to the quality of the tourism experience, such as maximum and mean daily temperature, humidity, precipitation, sunshine and wind, to assess human comfort during general outdoor activities (Amelung, and Moreno, 2009; Nicholls, and Amelung, 2015). Over the course of the 21st century, climate change is projected to shift a climate 'favourable' for tourism northwards. As a result, southern Europe's suitability for bathing tourism will be likely to decrease in the summer but increase in spring and autumn. As climatic conditions on the Atlantic and northern European coasts are most likely to improve, competition between bathing destinations in Europe may increase.

It is likely that a projected increase in the number of heat waves and rising air temperatures will encourage more people to seek refreshment in bathing waters during the hot summer months. In many regions, the bathing season could be prolonged into spring and autumn. Increased demand for bathing is likely to force national authorities to expand their bathing water network, identify and monitor new bathing waters and ensure that supporting infrastructure is in place (e.g. car parks, toilets, showers).

This section presents some of the consequences of climate change and their impact on the management of bathing waters in the years to come.

5.1.1 Rise in seawater levels

The global sea level has risen by almost 20 cm in the past 100 years. Sea levels have increased at most locations along the European coastline, and it is expected that, in the future, sea levels are likely to rise faster than they did in the last century (EEA 2017b). Even if greenhouse gas concentrations were stabilised right now, sea levels would continue to rise for many centuries (IPCC 2019). The potential impacts of a rise in sea level also include flooding and coastal erosion, which present a risk to life, property, tourism and recreation. Many coastal bathing water resorts and infrastructure will be threatened by an elevated sea level and occasional flooding. Popular Mediterranean bathing destinations, such as Croatia, Greece, France, Italy and Spain are among the most vulnerable destinations threatened by sea level rise.

5.1.2 River flows and floods

Floods are a natural phenomenon that have shaped floodplains for millennia. Atmospheric warming and associated hydrological changes have significant implications for changing river flows and regional flooding (Andersen, and Shepherd, 2013). As a result, in recent decades river flows in Europe have increased in winter and decreased in summer. However, these changes cannot only be attributed to climate change but involve other factors, such as river engineering (EEA 2017b). Evidence also indicates that there is an increasing trend in the number of floods of large magnitude and severity, although year-to-year variability is still strong (Kundzewicz, et al., 2018). During flooding events, river velocities are higher than during normal flow, water transparency is reduced and pollution levels are often higher (e.g. because of re-suspension

Image 5.1 How will future generations be able to use and enjoy European bathing waters?

Photo: © Katarina Zore

of polluted sediments) (EEA 2017a). In Europe, economic losses from flooding have increased significantly (Barredo, 2009). By the end of the 21st century, the greatest increase in river floods with a recurrence period of 100 years (i.e. probability of flooding is 1 %) is projected for the British Isles, north-west and south-east France, northern Italy and some regions in south-east Spain and the Balkans (Rojas, et al., 2012; EEA 2017a). Minor increases are also projected for central Europe, where more than 200 bathing waters were affected by the so-called central European floods during the 2013 bathing season (Box 5.1).

Increased river flows can damage bathing water infrastructure and deliver a different kind of debris at the bathing sites. Managing bathing waters affected by flooding during the bathing season requires specific measures to be implemented, such as temporary bathing prohibitions and removal of debris and sediment. Only when bathing is considered safe again can the temporary advice against bathing be removed and at that point the bathing site can resume operation. Traditional flood risk reduction measures (e.g. dikes and dams) are costly, have negative impacts on the environment and in some cases may even increase flood risk. In recent years, there has been an increased interest in using so-called nature-based solutions. Such solutions protect, sustainably manage and restore ecosystems to simultaneously provide benefits for human well-being (e.g. protection from flooding) and for biodiversity (IUCN 2016). These can be achieved by re-establishing natural floodplains along parts of a river with the objective of reducing the height of flooding (Hartmann, et al., 2019). One of the key attractions of such nature-based solutions is their multifunctionality. In addition to their economic (e.g. reducing flood risk) and environmental (e.g. conserving biodiversity) benefits, they can also provide valuable recreational and social services if they are also managed as bathing waters. Such infrastructure has the potential to offer win-win solutions by tackling several linked environmental problems and providing a great number of benefits within an economically feasible framework.

Box 5.1 Bathing waters affected by central European floods

The so-called central European floods, which took place in late May and June 2013, particularly affected regions along the Elbe and Danube rivers, including southern and eastern German states, the western part of Czechia and Austria. Between 30 May and 1 June, these regions received up to 250 mm of rainfall, which for some regions is one fifth of the annual average.

Major flooding affected about 200 bathing waters in Austria, Czechia, Germany and Hungary. As a result of the flooding and its consequences, bathing water monitoring and management were interrupted. Information on the temporary suspension of monitoring information for affected bathing waters was provided to the public in these cases. Monitoring could resume and adequate samples for quality assessment were available for some affected bathing waters after the floods had abated (EEA 2014).

Image 5.2 Flooded bathing water infrastructure in Vienna

Photo: © Wolfgang Zoufal

5.1.3 Rise in air and water temperatures

Average air temperatures in Europe are projected to increase by between 1 and 4.5 °C by the end of the 21st century due to climate change, which is more than the projected global increase. The greatest warming is projected for north-eastern Europe and Scandinavia in winter and for southern Europe in summer. The sea surface temperature is also projected to increase, albeit more slowly than the air temperature (EEA 2017b).

As a result of the projected rise in sea surface temperature, increases in harmful algal blooms (see Section 4.4) have been projected for the North Sea, the Baltic Sea (Glibert, et al., 2014) and glacial lakes in central Europe (Chirico, et al., 2020).

Elevated marine water temperatures also accelerate the growth rate of certain pathogens, such as *Vibrio* bacteria (Box 5.2), which can cause wound or ear infections, acute diarrhoeal diseases and outbreaks of food poisoning from infected seafood. Infection usually begins after exposure to seawater or ingestion of raw or undercooked seafood (Baker-Austin, et al., 2016). On rare occasions, ingestion may lead to severe necrotic ulcers, septicaemia and even death if individuals are exposed while bathing in contaminated marine environments (EEA 2017b).

Over the last century, water temperatures in major European rivers (e.g. Danube, Meuse, Rhine) have increased by 1-3 °C and are projected to increase further alongside projected increases in air temperature (Webb, and Nobilis, 1994; EEA 2017b; CLO 2018; FOEN 2020). The mean temperatures of major European rivers are projected to increase by 1.6-2.1 °C during the 21st century (van Vliet, et al., 2013). Bathing will thus become possible in numerous European rivers that are currently unsuitable for bathing because of their low temperatures. The rise in temperature will create more favourable conditions for bathing both temporally (extending to spring and autumn) and spatially (extending northwards), the latter especially after 2050. Some Mediterranean destinations may become too hot in summer, leading to a decrease in tourism in the summer months. Nevertheless, the Mediterranean is likely to remain by far the most popular bathing destination (Perrels, et al., 2015).

As the temperature rises, there is a growing concern that invasive alien species may benefit from climate change and further deterioration in the environment as some locations may become more favourable to previously harmless alien species. (Walther, et al., 2009; EEA 2017b). For example, thick floating mats of invasive *Nymphoides peltata* can prevent bathing, fishing, boating and other activities in ponds and lakes (Kelly, and Maguire, 2009). Droughts and water shortages.

Box 5.2 Heat wave-associated vibriosis, (Sweden and Finland)

An extreme heat wave in northern Scandinavia during summer 2014 led to unprecedentedly high sea surface temperatures, which appear to have been responsible for the emergence of *Vibrio* bacteria at these latitudes. In Sweden, 2014 was the warmest year on record since recordkeeping began in 1860. A total of 89 *Vibrio* infections were reported in Sweden and Finland during the summer and autumn of 2014. Most of the cases in Sweden occurred after bathing in the Baltic Sea. A large number (33 or 37 %) of cases were reported as ear infections; in fewer cases (17 or 19 %), *Vibrio* organisms were isolated directly from blood, suggesting more serious systemic disease progression, and one fatality was recorded.

Reports of infections began in July 2014 and peaked in August, before decreasing significantly in September. The emergence of vibriosis in high-latitude regions requires improved diagnostic techniques and greater clinical awareness of these emerging pathogens in the regions (Baker-Austin, et al., 2016).

Most river monitoring stations in Europe experienced a decreasing trend in summer flows over the second half of the 20th century (Stahl, et al., 2010). The severity and frequency of droughts have increased in parts of Europe and will continue to increase. Studies project significant increases in droughts in most of Europe during the 21st century, except in northern regions. Usually, low river flows, which may result from prolonged meteorological drought, also affect water quality by reducing the rivers' ability to dilute pollution (Mosley, 2015; EEA 2017b). Moreover, decreases in water flow and volume during drought have typically led to increased salinity as a result of reduced dilution and increased concentration (Mosley, 2015). Inland bathing waters in the Mediterranean region (in particular Albania, France, Italy and the Iberian Peninsula) and parts of central (Hungary) and south-eastern Europe are among the most vulnerable to the effects of drought. In these regions, bathing water managers will have to compete with other water uses such as agriculture and industry to ensure an adequate quantity and quality of bathing water during droughts.

The Ružín in Slovakia is a bathing site located close to a hydropower plant (Box 5.3). The quality of water strongly depends on hydropower operations, as does the management of the bathing site.

Box 5.3 Temporary interruption of bathing due to lack of water (Slovakia)

Ružín in Slovakia is a bathing water with excellent water quality that was closed for two consecutive seasons in 2011 and 2012. The closure to bathing was because of nearby construction work. Ružín is a reservoir for a pumped-storage hydropower plant. In 2011 and 2012, construction work at the plant, coupled with a lack of precipitation in the spring, led to a fall in water level of as much as 6.5 m, rendering the location unsafe for bathing. This prompted the authorities to close Ružín as a bathing water. The bathing water has been operating again since 2015 and is of 'excellent' quality (EEA 2015a).

In Czechia, Lhotka, Šeberák and Popovice are other examples of bathing waters rated 'excellent' that were closed in 2014 due to a lack of water in reservoirs. In all of the abovementioned cases the reason for closure was the removal of bottom sediments from the reservoir (EEA 2015a).

Image 5.3 The empty Ružín reservoir

Photo: © Novy čas

5.2 Plastic litter in bathing waters: an emerging issue

Almost 80 % of all litter on European beaches is made of plastic (Addamo, et al., 2017). Plastics have become the standard material of the modern economy, combining unique functional properties with low production costs. Global production of plastic has grown at approximately 9 % per year from around 1.5 million tons in 1950 to 348 million tons per year (PlasticsEurope, 2019). Marine litter is the result of mismanaged plastic waste and a linear economy in which products are often thrown away after one use. Approximately 10 million tonnes of plastic litter ends up in the world's seas and oceans every year.

Plastics — especially cigarette butts and packaging waste such as beverage bottles and single-use bags — are by far the main type of debris found on beaches. The list goes on: damaged fishing nets, ropes, sanitary towels, balloons, tampons, cotton bud sticks, condoms and disposable lighters among many others. Beach and sea floor litter can cause injuries: a study in Australia found that 21.6 % of beach users had received injuries from beach litter at 'clean' beaches (defined using the 'clean coast' index — approximately 1.69 kg of litter per beach), illustrating that even 'clean' beaches pose a threat (Campbell, et al., 2016).

Beach litter at bathing water sites can fracture into micro-pieces in the water where swimmers can accidentally ingest it. Accumulation of such 'microlitter' — particularly microplastics — in the human body may adversely affect health. The extent of such effects is still unknown, and a precautionary approach should be taken (EC et al., 2019).

Marine animals can become entangled in beach, sea floor and floating litter items. Entanglement can be fatal for animals; compromising their ability to capture and digest food, sense hunger, escape from predators and reproduce, as well as reducing their body condition and impairing locomotion (Thompson, et al., 2014). Entanglement is not the only negative issue: animals can also mistake marine litter for food. A comprehensive study revealed marine litter in 100 % of marine turtles, 59 % of whales, 36 % of seals and 40 % of seabird species examined (Kühn, et al., 2015)

In addition to its environmental and health impacts, marine litter also has socio-economic costs, mostly affecting coastal communities. The median litter abundance in the EU is in the order of 150 items per 100 m of beach (Hanke, et al., 2019). To boost the appeal of their bathing sites to tourists, many communities and businesses must clean up the beaches before the start of the summer season (EEA 2016c). In the United Kingdom, municipalities spend approximately EUR 18 million per year on beach clean-ups. The estimated cost of keeping all 34 million kilometres of global coastlines clean is USD 69 billion (EUR 50 billion) per year (UN Environment, 2017), and this figure will continue to increase if we do not stop littering.

There are several pieces of EU policy and legislation associated with the management of marine litter. The Marine Strategy Framework Directive (EU 2008) requires EU Member States to ensure that, by 2020, 'properties and quantities of marine litter do not cause harm to the coastal and marine environment' and requires monitoring and reducing beach litter. The Single-Use Plastics Directive (EU 2019) introduces a

Image 5.4 Plastic pollution on a beach

Photo: © Bo Eide

set of ambitious measures such as a ban on selected single-use products made of plastic (including cutlery, plates, straws, cups), measures to reduce consumption of plastic food containers and beverage cups, and specific marking and labelling of certain products (EU 2019).

We should work together as a European and international community to tackle the growing marine litter problem. The EEA has developed Marine Litter Watch to strengthen Europe's knowledge base and thus provide support to European policymaking. Information from 6 years of collecting beach litter with Marine Litter Watch can be found at: http://www.eea.europa.eu/themes/coast_sea/marine-litterwatch.

5.3 Transboundary cooperation

Water bodies — particularly seas and oceans — are often transboundary in their nature. This means that pressures such as pollution can spread to the whole water body or to neighbouring water bodies. This includes spread from freshwater streams to lakes and vice versa and from freshwaters to marine water bodies. As a result, the transboundary management principle has been embedded in the EU water directives (Box 5.4) and in the international conventions that have been brought in to provide a framework for international standards on pollution, monitoring and assessment, conservation and protection and for cooperation in implementing such standards. For example, the OSPAR Convention (OSPAR 1992) sets out the framework for protecting the North-East Atlantic and the Barcelona Convention (UNEP 1995) for protecting the Mediterranean Sea. Freshwater resources are also subject to transboundary agreements such as the Danube River Protection Convention (1994), the largest body of river basin management expertise in Europe (ICPDR 2019). As the main objectives of the latter include ensuring sustainable water management, the Convention offers the political framework for implementing transboundary projects that affect water quality and therefore bathing.

How can management of bathing waters be embedded in such transboundary cooperation? First, there is the catchment-based approach, introduced by the EU's Water Framework Directive, that treats freshwater, transitional and coastal waters and land bodies within a river catchment as a single system, administered by different parties working together: landowners, government and agencies, public organisations, non-governmental organisations and so on. The approach also introduces the standard that river catchments in Europe should be managed as a single entity, even across national borders. The effects of land-based pollution sources on aquatic environments should be treated at their sources, as there can be a long line of effects throughout the catchment and onward out to sea. The Baltic and Adriatic Seas are examples of semi-enclosed seas with greater vulnerability to pollution from freshwater streams.

In addition to catchment-based approaches, good practices, such as supervising bathing water quality (including monitoring) and taking measures to protect it, are already shared and discussed between EU Member States within an expert framework set out by the Bathing Water Directive. For example, the EU SWIM project, launched during the bathing season of 2019, has brought about cross-border benefits, as schools (in Ireland and the United Kingdom) participating in the weather data collecting programme can link their results, sharing knowledge on interconnected environmental factors that affect bathing water quality and going as far as developing bathing water quality prediction models (EPA Catchment Unit, 2019). Nevertheless, good management practices for critical bathing waters with long-term low bathing water quality should be shared and discussed further. There is still space to improve a number of poor-quality bathing waters throughout EU Member States, mostly in inland areas. In the future, common pollution prediction models and widely available early warning systems can be developed, as they are based on mathematical models and can be relatively easily expanded to different environments, provided that the experts behind them cooperate in a shared effort.

Box 5.4 Cross-border cooperation on the River Kolpa (Slovenia and Croatia)

The River Kolpa runs along the border between Slovenia and Croatia for 100 km of its course. There are nine official bathing waters on the Slovenian side of the Kolpa — six are of excellent water quality and three of good quality. The Slovenian and Croatian water authorities successfully cooperate in managing the river and its catchment area in accordance with the principles of the Water Framework and Floods Directives. The work is coordinated through a bilateral commission. For example, in 2000, a Kolpa water management plan was prepared. Six years ago, a Slovenian-Croatian cross-border project (Frisco1) started to reduce the risk of flooding by implementing non-structural measures. Both countries are also cooperating in managing pollution sources and heavy rain run-off to support good ecological status and prevent any future deterioration in bathing water quality.

Image 5.5 Bathers at the transboundary Kolpa river

Photo: © Mateja Poje

6 Conclusions

Clean bathing waters are vital for both public and environmental health. Bathing sites on seas, lakes and rivers are valuable spaces for people to exercise, relax and engage with nature. Clean bathing waters of excellent quality are therefore important tourist attractions, often bringing jobs and money to local areas and thus offering an ecosystem service also to the economy. Improving the quality of bathing waters, through their sustainable use, conservation and restoration, often benefits the wider aquatic ecosystem by improving biodiversity and other aspects of ecosystem quality.

Seas, lakes and rivers are often the recipients of the excesses of human activities — whether sewage, storm water overflows, plastics or chemicals — making their management complex and multifaceted, particularly given the predictions of climate change in the coming decades. In Europe, the Bathing Water Directive (BWD) has been effective in helping to reverse decades of the degradation of the continent's bathing waters. However, if bathing water management in Europe is to continue to have a successful impact, it needs to address emerging challenges using holistic, innovative and cooperative management approaches.

6.1 Five key issues for bathing water management in Europe

This report has outlined five main groups of issues affecting bathing water quality, each with its specific drivers and pressures but sometimes addressed with the same (or similar) legislative or technical approaches.

1. **Microbiological pollution** is the most obvious risk to human health. Even after decades of pollution management, elevated faecal bacteria levels still affect at least 15 % of European bathing waters that cannot be classified as excellent quality according to the BWD, although they may be of acceptable (i.e. sufficient) quality for bathing. This pollution comes primarily from waste water and sewage outflows, agricultural manure or technical malfunctions in the water infrastructure.

2. **Extreme events** — typically storms or low water levels — are gradually becoming more common causes of bathing water pollution in Europe as the result of climate change. In effect, they are similar to microbiological pollution in that they involve spillages from combined sewage outflows. Such spillages and overflows can contain a wide range of contaminants that reduce bathing water quality. The low water levels increasingly observed in some regions can have the same effect on water quality as high bacterial concentrations.

3. **Eutrophication** of bathing waters — particularly common in lakes — results in an indirect threat to bathers' health, especially through the effects of decomposition, which can create hypoxic conditions and poor water quality. Eutrophication is mainly caused by the run-off of nitrogen fertilisers and manure from agriculture, but it can also originate from household waste water.

4. **Cyanobacterial blooms** are also a result of eutrophication, although they arise from a complex set of synergistic causes, and the effects of climate change are increasing. These have a particular toxic risk for human health. They are most often reported from central European lakes at the height of the summer season. Cyanobacterial blooms often also have significant adverse effects on aquatic life. Case studies show that management approaches should be carefully studied and planned, as some can further harm the ecological conditions of the aquatic environment.

5. **Wild bathing** is increasingly common across Europe, as adventurous swimmers look for new waters to swim in. Such wild bathing has the potential to deepen the engagement between people and the environment, but it also raises new issues for water managers. At some unmonitored sites, the water quality may not be high enough for safe bathing, while, at others, the activities of swimmers might disrupt sensitive ecosystems. Adaptive management approaches with public communication at their core will be necessary to address wild bathing in the future.

Image 6.1 Information for the public at a bathing water site

Photo: © Mateja Poje

6.2 Successful water policy and management guided by the Bathing Water Directive

The multiple pressures acting on seas, rivers and lakes mean that water quality at many European bathing sites could make swimming unsafe. At many sites — especially those in urban areas — bathing would have been unimaginable in the past. Indeed, in 1991, more than a quarter of all identified EU bathing waters could not be declared of sufficient quality for bathing.

EU legislation on bathing water management has developed over the past decades, centred around the BWD. The directive aims to make use of the most recent knowledge and technologies. The main focus is on the integrated management of bathing waters through other interconnected water-related directives and measures that address the causes (e.g. reducing pollution) of different pressures as well as mitigating short- and long-term consequences (e.g. early warning systems).

This management approach has public participation at its core. As a direct result of these policies, water quality has improved significantly in Europe over the past two decades. In the past decade, more than 95 % of European bathing waters have been of at least sufficient quality for bathing, with the majority of them being classified as excellent. As a result, bathing is now possible in the centres of many previously polluted European cities. Through a review of management approaches, this report has shown how the countries that have followed the requirements of the BWD have made vast improvements at a number of bathing sites, opened new sites and prohibited bathing at those that did not achieve an adequate water quality status.

Consequently, the general condition of bathing waters in the EU is getting better from year to year. The case studies listed throughout the report highlight the specific management approaches that resulted in improvements in bathing water quality. However, the small proportion of European bathing waters that are consistently of a quality too low for safe bathing shows that there will be an ongoing need for sound management of bathing water quality.

Continuous efforts to apply existing management approaches alongside innovative solutions that tackle emerging issues are necessary if European bathing water policy and management is to remain a significant success story.

6.3 Innovative approaches to European water management

Over the decades, the array of approaches taken to improve bathing water quality has included various innovative technical, information-sharing and educational solutions, based on the legislative requirements. For example, microbiological pollution issues seem to be best solved by involving a range of stakeholders (most notably the public that has an interest in using bathing waters). The purpose of applying many approaches is to seek both systemic and specific causes of water quality issues and address them with long-term policy measures, so that there will be as little need for coping with the consequences as possible.

It is, however, more challenging to predict the causes of extreme events resulting in acute short-term pollution episodes. Again, integrated and modern approaches should explore the reasons for and address the consequences of extreme events. Green areas in cities can function as storm water retention basins and mitigate the load on conventional sewerage systems. Such solutions are not only less expensive than traditional 'concrete' infrastructure but also provide a wide array of co-benefits for local economies and social communities (EEA 2015a).

As it would be challenging to halt the causes of eutrophication completely, in-lake methods have proved to be effective. These include eutrophication control methods such as nutrient inactivation, lake-level drawdown, covering bottom sediments, sediment removal (dredging) and harvesting.

6.4 Emerging issues for bathing water management in Europe

Chapter 5 surveyed the challenges ahead for bathing water management in Europe. Most notably, there will be climatic changes in the future that will substantially affect bathing and bathing water management. A higher demand for bathing will pressurise national authorities to expand their bathing water networks, identify and monitor new bathing waters and ensure that supporting infrastructure is in place. Rises in sea levels, altered and extreme river flows and floods, and rising air and water temperatures are likely to significantly affect bathing and bathing water management in Europe. However, substantial regional differences are expected in all these processes. Among the issues already present, floods and short-term pollution events are likely to increase, making water managers compete with other water users, such as agriculture and industry, to ensure an adequate quantity and quality of bathing water during such events.

A good example of unexpected risks is the coronavirus disease 2019 (COVID-19) pandemic. The rapid spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV 2) virus around the world was an unexpected development, which also affected the management of bathing sites. The EU must continue to work for a resilient, sustainable and healthy bathing practice to overcome emerging risks. And the EU Member States should continue to implement hygiene measures at bathing sites, such as physical distancing and hand washing or sanitising, for as long as is required to deal with the crisis.

But these changing conditions are not only likely to accentuate current issues but are also expected to introduce new issues, such as accelerating the growth rate of new pathogens that have not been a problem until now. Management under these new conditions will need to be informed, responsive and agile, and based on available data and well-understood technologies, to avoid harm from unforeseen side effects.

An emerging problem in Europe is marine litter, which can be found even in wild bathing destinations. Litter, plastics in particular, is accumulating in our seas and on their coasts. Plastic pollution threatens the health of marine species and humans. In addition to its environmental impacts, marine litter also results in significant economic losses for coastal economies.

There are more than 21 900 bathing waters in the EU, covering diverse environments, landscapes and cultures and subject to a variety of issues and policies. However, the overall quality of bathing waters and their management has been supported by decades of strong EU bathing water policy. The BWD has achieved a high proportion of good- and excellent-quality bathing waters, which comprise 92.5 % of the EU's bathing water inventory. As this 'deep dive' into the issues surrounding bathing water management in Europe has shown, the BWD has created a stable framework for managing and mitigating emerging challenges.

Image 6.2 Punta Molentis, Sardinia

Photo: © Giunta Regionale Sardegna

Abbreviations

BWD	Bathing Water Directive
COVID-19	Coronavirus disease 2019
DWD	Drinking Water Directive
EC	European Commission
EEA	European Environment Agency
ETC/ICM	European Topic Centre on Inland, Coastal and Marine Waters
EU	European Union
IED	Industrial Emissions Directive
NBS	Nature-based solutions
TCI	Tourism climate index
UWWTD	Urban Waste Water Treatment Directive
WFD	Water Framework Directive
WHO	World Health Organization

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