Freshwater protection

EU policy and the status of freshwater systems
This paper provides a general overview on the status of freshwater systems within the EU. It describes the different types of water body and their connected ecosystems as well as possible pressures on them. It also presents existing legislation at EU level, in particular the EU Water Framework Directive, and outlines the main requirements regarding freshwater quality and quantity. Finally it outlines the state of affairs concerning the implementation of legislation and attempts to summarise expectations with regard to future developments in the field of water protection.

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EXECUTIVE SUMMARY

Freshwater ecosystems account for only about 5% of the entire area of the European Union, but they are particularly rich in biodiversity and fulfil important ecosystem services. The European Environment Agency (EEA) considers freshwater systems today to be much cleaner than they were 25 years ago. The continuing presence of pollutants does, however, raise ongoing concerns for public health, as well as for the conservation of nature. Moreover, considerable modifications of natural water courses, in particular of rivers, have altered many habitats and threatened aquatic ecosystems.

Surface water bodies and groundwater are threatened by synthetic or naturally occurring substances that can have a negative impact on the aquatic environment and on human health. Increased temperature and over-abstraction of water present further causes for concern. Moreover, heavy modifications to the natural flow and physical changes to water bodies can also cause serious disturbances to water ecosystems.

With the Water Framework Directive (WFD) of 2000, the EU adopted comprehensive legislation for the protection of water within the EU. The WFD aims to address negative influences and provide extensive protection for all water bodies in the EU. The WFD is based on natural geographical and hydrological units, river basins. Under the directive, Member States are required to achieve a good status for all bodies of surface water and groundwater by 2015 or 2027 at the latest. Achieving a good status involves meeting certain standards in terms of ecology, chemistry, morphology, and also quantity of water. In general terms, good status means that the water shows only a slight change from what would be expected under conditions with a low human impact.

The WFD pursues a dual approach of monitoring both emission sources and the quality of the receiving water body. It is complemented by several pieces of legislation dealing with specific pollutants and sources and laying down specific requirements for water bodies. When it comes to implementation, Member States are required to draw up river basin management plans and programmes of measures. Despite considerable improvements in water quality, it was already clear in 2012 that the WFD’s main goal, a good status for all European water bodies, would not be achieved by the end of 2015. Information and data about various aspects of implementation, monitoring of certain substances, and grounds for applying exemptions, for instance, remain incomplete.
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Glossary

Aquifer: layers of rock, sand or gravel that can absorb water and allow it to flow. An aquifer acts as a groundwater reservoir when the underlying rock is impermeable.

Bioaccumulation: the tendency for a pollutant to accumulate in the tissues of plants or animals.

Biodiversity: short for biological diversity. Refers to the number and relative abundance of different species within a particular area, a specific habitat or the world.

Biomagnification: the accumulation of toxic substances along the food chain, i.e. increasing quantities of toxic substances can be found within the bodies of organisms higher up the food chain.

Diffuse pollution: pollution from widespread activities with no discrete source, e.g. pesticides, urban run-off.

Ecosystem services: benefits people obtain from ecosystems, including provisioning services such as food and water; regulating services such as flood and disease control and air purification; cultural services (spiritual and recreational) and benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on earth.

Emission: the release or discharge of a substance into the environment.

Eutrophication: a form of water pollution that involves the enrichment of a freshwater body with nutrients, such as nitrates and phosphates.

Good chemical status: compliance of groundwater or a surface water body with all the water quality standards established for chemical substances.

Good ecological status: status of a surface water body, where there is only a slight deviation from a condition with no or very low human pressure. The definition of ecological status looks at the abundance of aquatic flora and fish fauna, the availability of nutrients, and aspects such as salinity, temperature and pollution by specific pollutants. Morphological features, such as quantity, water flow, water depths, and structures of river beds, are also taken into account.

Good quantitative status: status of a groundwater body where the level of groundwater is such that the available groundwater resource is not exceeded by the long-term annual average rate of abstraction.

Nitrate vulnerable zones: areas of land that drain into already polluted or threatened waters, i.e. waters containing a nitrate concentration of more than 50 mg/l or susceptible to contain such a concentration of nitrates.

Over-abstraction: removal of water from the natural water environment beyond its renewing capacity.

Point sources: a stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g. a pipe, a ship or a factory.

River basin: the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta.

Sensitive areas: water bodies that may become eutrophic if no protective measures are taken, and surface water bodies intended for drinking water that contain more than 50 mg/l of nitrates.

List of main acronyms used

BOD: biological oxygen demand
FRMP: flood risk management plan
PBT: persistent, bioaccumulative and toxic
PoM: programme of measures
POP: persistent organic pollutant
RBMP: river basin management plan
WFD: Water Framework Directive
1. Background

The end of 2015 marked a crucial milestone for European water legislation. First, under the EU’s main legislative work on water protection, the Water Framework Directive (2000/60/EC), by the end of 2015 all European water bodies were supposed to achieve a 'good' status.\(^1\) Second, Member States were to adopt their second river basin management plans (RBMPs), on how to further improve water quality, and adopt their first flood risk management plans (FRMP).

However it had been clear since 2012 that the goal of achieving 'good' status for all European water bodies by 2015 would not be achieved.\(^2\) Despite this fact, the European Environment Agency\(^3\) (EEA) underlines that the quality of water across Europe has improved significantly since the adoption of the first Council directive of 4 May 1976 (76/464/EEC) on pollution caused by dangerous substances discharged into the aquatic environment.

Freshwater is a precondition for any life. Freshwater and its related ecosystems provide a number of key services, including drinking water, food and medicine, natural filtration, protection against floods, erosion control and recreation. Fresh water bodies are also particularly rich in biodiversity: they hold a higher number of species per unit area than the land or sea.\(^4\) However, according to the International Union for Conservation of Nature and Natural Resources (IUCN),\(^5\) freshwater animals – molluscs (55 %) and freshwater fish (43 %) – are the groups with the highest proportion of threatened species. They depend on aquatic environments, such as rivers, lakes and wetlands, a large share of which has an unfavourable conservation status.\(^6\)

Member States' reports under the Habitats Directive (Council Directive 92/43/EEC) confirm this general negative trend for the conservation of freshwater species. According to the EEA's 'message' on freshwater ecosystems, the assessments for several groups of species listed in the Habitats Directive (Council Directive 92/43/EEC) are of particular concern in the Alpine, Atlantic, and Continental biogeographic regions.\(^7\) The main threats identified are human-induced and include eutrophication and pollution, changes to natural water courses resulting in loss of connectivity, over-abstraction and drainage.

\(^1\) With the option to extend the deadline twice for six years, on grounds for instance of technical problems or disproportionately high costs.
\(^3\) The European environment — state and outlook 2015 (SOER), European Environment Agency, 2015.
\(^4\) EU assessment of progress in implementing the EU Biodiversity Strategy to 2020, European Commission, 2015.
\(^5\) Freshwater biodiversity – a hidden resource under threat, IUCN, 2008. These findings were recently endorsed in the Living Planet Report 2016, which showed that worldwide the abundance of populations in freshwater declined by 81 % between 1970 and 2012.
\(^6\) State of Nature in the EU – Results from reporting under the nature directives 2007–2012, European Environment Agency, 2015. In this report the majority of wetland species are given an unfavourable assessment.
\(^7\) 10 messages for 2010 — freshwater ecosystems, European Environment Agency, 2010.
2. Freshwater bodies

Freshwater is characterised as containing little or no salt. Freshwater bodies can be divided roughly into groundwater bodies and surface water bodies.

Groundwater is present everywhere beneath the earth’s surface. It can be found in formations of permeable rock, gravel or sand, saturated with water, known as aquifers. Most groundwater bodies can be found near the surface. As groundwater is constricted by sediment and rock it flows rather slowly. Aquifers are also slowly recharged with water from rainfall or snowmelt, which soaks into the soil by infiltration. The rate of recharge can be influenced by different factors, such as soil type, plant cover, and rainfall intensity. Groundwater recharge may also occur from surface water bodies. If pollutants reach groundwater they can cause serious problems: the hidden nature of groundwater means that contamination may be more difficult to detect, control, and clean up. Moreover, the slow recharge rate means that pollutants can remain in groundwater for a long time or even persist indefinitely. The risk of contamination is particularly high if pollution occurs in a recharge zone, i.e. in an area where water enters an aquifer via infiltration. If contaminated groundwater reaches a discharge zone, i.e. an area where groundwater joins a surface water body, the contamination may also enter the adjacent surface water body. Groundwater reservoirs may be contaminated by harmful chemicals, for instance from storage tanks and pipelines, poorly designed or abandoned landfills, and toxic waste disposal facilities. The most common pollutants in groundwater are untreated sewage and nitrate from agricultural chemicals. About 25% of groundwater across Europe is classified as having poor chemical status, with nitrate being the primary cause. These kinds of pollutant, although biodegradable, are problematic mainly because they are so widespread.

Over-abstraction of groundwater, for instance for drinking water or irrigation purposes, is another cause for concern. It occurs when the discharge of the groundwater in an aquifer exceeds the recharge rate over a certain period of time.

Surface water comprise flowing water (such as rivers) and standing water (such as lakes, ponds and wetlands). They also include artificial water systems such as canals, dams and reservoirs. As they are situated on the earth’s surface and open to the atmosphere, they can provide habitats for water plants such as phytoplankton and algae, which build the basis of the food chain due to their ability to photosynthesise, i.e. to produce organic substances with the aid of sunlight. Organisms feeding on these plants and the products they produce include bacteria and invertebrates living on or in the bottom sediment of a water body, as well as zooplankton, insect larvae and fish. The existence of different kinds of organisms, which provide for the production, consumption and decomposition of biomass, is vital for keeping water healthy. As freshwater bodies are in general nutrient poor, plant growth is naturally restricted, thus limiting the abundance of all other species within the aquatic ecosystem.

Rivers are mainly characterised by their dynamic features, which can cause water to change dramatically on its way from its source upstream to its mouth downstream. Upstream rivers tend to have a strong current and to flow in a small river bed, the water itself being rather cold. Downstream the water tends to be warmer, flowing at a slower pace in broader river bed. The river then tends to deposit stones, gravel and sand. Once

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9 EEA, SOER, and EEA, European waters.
polluted, rivers are to a certain extent able to return to a clean or less polluted condition thanks to their dynamic character, which allows the pollutants to be flushed out and carried down, possibly to the sea. The pollution level in a river therefore depends on the distance from the point where pollutants are released in the water (known as the point of discharge). In particular in the case of organic matter, a river may profit from a flushing effect and be less polluted further down a river. However, if the pollution increases or consists of non-biodegradable substances such as heavy metals, these can be carried over a long distance and accumulate downstream.

With the changing characteristics alongside its watercourse, a river provides a sequence of different habitats that can be classified according to the main fish species found in them. These habitats differ according to their steep or shallow gradient, flow rate, temperature, oxygen level and transparency (e.g. trout habitats are usually characterised by a steep gradient, fast flowing water, a cool temperature and a high oxygen level).

Lakes are much more vulnerable to pollution than rivers. Once a pollutant enters a lake it will stay for a long time, as the flushing effect that characterises rivers is much less evident in lakes. If a lake is not actively cleaned of damaging substances, only the self-purifying ability of the water will mitigate the pollution in the long term.

In a lake, most aquatic life can be found in the shallow area near the shore, where sunlight reaches the bottom sediment, and where the temperature is higher than in more distant areas. This 'littoral zone' is abundant with plant and animal life. Littoral habitats are often particularly impacted by human activity as a result of their position.

Wetlands, such as fens, bogs and swamps are terrestrial environments that merge or link with freshwater ecosystems. Wetlands tend to have a great diversity of plant and animal species. Alongside their ability to store water and to serve as carbon sinks they can absorb surplus nutrients, sediment and other pollutants before they reach other water bodies, thus providing important ecosystem services (see box below).\(^\text{10}\)

The EU has more than 100 000 surface water bodies: 80 % of them rivers, 15 % lakes, and 5 % coastal and estuary waters.\(^\text{11}\) According to the SOER report a large proportion of water bodies have poor ecological status and are affected by pollution pressures, particularly in central and north-western European areas with intensive agricultural practices and a high population density. Inadequately treated sewage and effluents from industry are major sources of river pollution. The EEA's assessment of the status and pressures on freshwater bodies also shows that heavy metals are a dominant pollutant for lakes. 60 % of lakes given a poor status rating are rated as such as a result of heavy metal pollution.\(^\text{12}\) Drainage for land reclamation and hydromorphological pressures, i.e. changes of shape and flow resulting from activities such as navigation, agriculture, flood protection, hydropower and urban development also affect many surface waters and their habitats.

\(^{10}\) Murck, Environmental science.
\(^{11}\) The two latter types are saline and thus not freshwater bodies.
\(^{12}\) EEA, European waters.
Wetland ecosystems

Wetlands are lands that are water-saturated or contain standing water for at least part of the year. They are thus transitional between terrestrial and aquatic ecosystems. Their vegetation is characterised by water tolerance. Typical wetlands are marshes, bogs, swamps and fens. They cover a relatively small area of the EU (about 1.8 %), but they are, according to the latest report on the mapping and assessment of ecosystems (the MAES report), a major source of biodiversity.13 Wetlands perform crucial ecosystem services such as regulating water flows, filtering water, serving as floodplains and storing carbon. 37.5 % of EU wetlands are protected by Natura 2000 sites.14 At international level, wetlands are protected by the Ramsar Convention.15

In spite of their importance and the protection measures in place, wetlands are under severe pressure: according to the MAES report, 85 % of all wetland habitats of European interest and two-thirds of wetland-related species have an unfavourable status. The main causes of wetland loss are conversion to agricultural land, afforestation, urban and infrastructure development, drying out, and climate change.16 Other pressures include pollution and nutrient enrichment, invasive alien species and peat extraction. The drainage of wetlands as a practice to reclaim land has increased significantly in the past 50 years, leading to a substantial decrease in the number of wetland areas and the quality of their ecosystems. By the 1990s, more than 60 % of Europe's wetlands had already been lost, a further 4.8 % was lost between 1990 and 2006, with the loss rate declining slightly at present.

2.1. Chemical substances

The natural characteristics of a water body and its ecosystem can be disturbed by numerous substances. They range from organic material, which becomes a pollutant in high quantities, to very hazardous chemicals, which are toxic even in very small quantities. Pollutants can also be distinguished according to their physical characteristics or the chemical reactions they cause.

Pollution in an aquatic environment can be traced back to two general types of pollution source: 'point sources' and 'diffuse sources' (also known as 'non-point sources'). A point source is an identifiable source from which pollutants are discharged. Discharges from point sources are relatively easy to control and have decreased significantly over the past 30 years on account mainly of improved effluent control. The main point sources are industry and sewage treatment plants. Non-point or diffuse sources are harder to identify and harder to control, as their origin is often not, or not exactly, known. Run-off from agricultural fields or from roads and other surfaces in urban areas accounts for many diffuse sources and represents a major problem worldwide (see box below).17 According to a Commission report18, diffuse pollution significantly affects 90 % of river basin districts, 50 % of surface water bodies and 33 % of groundwater bodies across the EU. Pollutants from agriculture, including nitrogen fertilisers applied to agricultural fields

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14 Natura 2000 is an EU-wide network of protected areas with the aim of ensuring the long-term survival of threatened species and habitats, listed under both the Birds Directive and the Habitats Directive.
15 Ramsar Convention.
16 According to the MAES report, the main reason for wetland loss at global level is the conversion to agricultural land, whereas in Europe the main driver is afforestation.
17 S. Nesaratnam, Water Pollution Control, Wiley, 2014.
and manure from livestock farming, as well as erosion of soil containing nutrients, are responsible for 50 to 80% of all water pollution.\textsuperscript{19} In urban areas with their high amount of impermeable ground cover, surface water is often unable to infiltrate the ground and must flow along the surface until it finds its way to a sewer. During periods of large rainfall, the sewage systems can be unable to cope with the volume of water. The flow may by-pass treatment plants and be discharged as a combined sewer overflow directly to surface water. Sewer overflows are one of the main pollution sources in urban areas. Urban run-off contains a wide range of pollutants, such as metals, pesticides, solvents deriving from various sources including the abrasion of roads, tyres and brakes (see box below).\textsuperscript{20}

\begin{table}[h]
\centering
\begin{tabular}{|l|}
\hline
\textbf{Urban surface water run-off} \\
\hline
In urban areas, rainwater runs off road surfaces, roofs, parking areas and other impervious areas thereby collecting pollutants. The polluted water is often collected in combined sewer systems, together with domestic sewage and industrial wastewater. Under normal conditions, this collected wastewater is transported to a sewage treatment plant. During heavy rainfall or snowmelt the volume of water can however exceed the capacity of the sewer system, and untreated stormwater and wastewater can thus discharge directly into nearby water bodies. This mixture of rainwater and raw sewage can contain a wide range of pollutants, such as:
\begin{itemize}
  \item salt to clear roads of ice and snow;
  \item copper from vehicle brake pads, industrial activities, plumbing and guttering;
  \item lead from industrial activities and residues from historic activities (plumbing, paint, leaded petrol, sprays), vehicle brake pads, roof flashing;
  \item zinc from vehicle tyres, galvanised building materials, paint, industrial activities;
  \item hydrocarbons from vehicle emissions, lubricating oils;
  \item polycyclic aromatic hydrocarbons from domestic fires, industrial emissions, vehicle exhaust (especially from diesel engines), lubricating oils;
  \item plasticisers from building materials, plumbing, litter, sprays;
  \item herbicides, pesticides, fungicides from household and garden activities;
  \item rubber from tyre wear;
  \item detergents from wash-down areas, domestic discharges (e.g. from car washing), industrial discharges;
  \item nutrients from wastewater discharges and overflows, fertilisers, lawn clippings, leaves, compost heaps;
  \item faecal matter and urine mainly from household wastewater;
  \item sediment from construction, road surfaces, emissions from vehicles, domestic fires, industrial sources, vehicle wear;
  \item pharmaceutical residues (synthetic compounds such as stimulants, antibiotics, painkillers and antihistamines) from household wastewater.
\end{itemize}

The impact of combined sewer overflow discharges into water has been particularly noticeable for example in London, where in recent years around 50 to 60 times a year an average of 39 million tonnes of untreated waste water containing raw sewage overflows into the River Thames. The Thames Tideway Tunnel, currently under-construction, is designed to collect the combined raw sewage and rainwater discharges and thus prevent further pollution of the river.\textsuperscript{21}
\end{tabular}
\end{table}

\textsuperscript{20} Nesaratnam, Water Pollution Control.
\textsuperscript{21} Creating a River Thames fit for our future: An updated strategic and economic case for the Thames Tideway Tunnel, Department for Environment, Food and Rural Affairs, 2015.
2.1.1. Organic substances

Organic matter, i.e. material containing carbon and hydrogen, derived from living animals, humans and plants, constitutes a major freshwater pollutant owing to the quantities involved. Natural organic substances in the form of dead plants and animals are normally biodegradable. Bacteria and other organisms, so called decomposers, break dead organic material down into simpler organic or inorganic substances. For this process the decomposing organisms need oxygen. With an increased amount of organic material the oxygen level in an aquatic environment will therefore drop significantly and eventually fall to zero. The major polluting effect of organic matter is thus the reduction in oxygen concentration in water as a result of decomposition. Processes, such as decomposition, that cause the depletion of dissolved oxygen in a water body are said to produce biochemical oxygen demand (BOD). The BOD level shows how much dissolved oxygen is needed for the decomposition of the organic matter present in water and is therefore used as an indicator of organic pollution in water.\(^{22}\) As oxygen is critical for the maintenance of most aquatic life forms, fish and aquatic invertebrates may move away, while smaller organisms such as crabs, snails and sedentary organisms, which are unable to cover longer distances, may die. Moreover in low-oxygen conditions, bacteria that need oxygen for their decomposing activity (known as 'aerobic bacteria') cease their functioning. Bacteria that do not need oxygen for processing organic substances (known as 'anaerobic bacteria') take over the decomposition process, which however remains incomplete and results in the production of methane, hydrogen sulphide and ammonia, giving the water a foul smell.

The most important sources of organic waste load are municipal wastewater, industries such as paper or food processing plants, tanneries and slaughterhouses, silage effluents and manure from agriculture.\(^{23}\) According to the EEA, organic discharges in rivers have been decreasing over the past 20 years while the biological treatment (secondary treatment) of waste water has increased.\(^{24}\)

2.1.2. Nutrients

Plant nutrients, such as nitrogen and phosphorus, are another major source of disturbance in water, and in higher concentrations they can be considered to be pollutants. An excess of these plant nutrients is one of the most common forms of surface water contamination. As freshwater is generally nutrient poor, a relatively small increase in nutrient supply can considerably boost the production of aquatic plants.

Much of the phosphorus in freshwater derives from wastewater treatment plants and phosphorus-containing household detergents. While phosphorus pollution from point sources is gradually becoming less significant, diffuse runoff from agricultural land remains an important problem, in particular in lakes. Moreover, as phosphorus can deposit in sediment, concentrations in lakes can remain high and prevent improvement in water quality despite a reduction in inputs. According to the EEA, phosphorus concentrations have decreased significantly in the last two decades: in European rivers average phosphate concentrations fell by 54% between 1992 and 2010, and the average phosphorus concentrations in lakes decreased by 31%. According to the agency, these

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\(^{22}\) It is based on the amount of oxygen that is consumed in five days in 1 litre of effluent held at 20°C.

\(^{23}\) Nesaratnam, *Water Pollution Control*.

improvements reflect both improvements in wastewater treatment and a reduction in the phosphorus content of household detergents.\textsuperscript{25}

Nitrogen finds its way into water in form of \textit{nitrates}, which leach easily from soil into water. Nitrates are taken in by an aquatic environment, where they can cause nutrient overload, known as \textit{eutrophication}. The excess of available nutrients brings about mass growth of algae (known as an 'algal bloom') which may trigger a cascade of effects. During their lifetime these algae can outcompete other plants thus reducing biological diversity within a water body. Moreover they cover the water surface and prevent sunlight from reaching underwater plants, which are thus kept from photosynthesising. The lack of these underwater plants may in turn deprive other aquatic organisms (such as fish and crabs) of food and shelter. Too many nutrients can thus cause a chain reaction and change species composition throughout the ecosystem. Moreover, when these masses of algae die, their biodegradation or decomposition follows the same procedure as all organic matter, leading to further oxygen reduction, a high BOD rate, and eventually the disappearance or death of all oxygen-demanding organisms. Some algae, such as cyanobacteria or blue-green algae, can themselves be harmful to other organisms by producing toxins. These can kill or damage fish and other organisms, move up the food chain and cause health problems for larger animals and humans. According to the Commission, eutrophication symptoms can be found in about 40\% of Europe's rivers and lakes.\textsuperscript{26}

Nitrogen in the form of nitrate – the form primarily used by plants – can also cause problems in itself if it reaches groundwater, where it is, according to an EEA report,\textsuperscript{27} a major cause of poor groundwater status. In 54\% of the groundwater bodies in Europe that have poor chemical status, excessive nitrate concentration is considered responsible. If groundwater is used for drinking water supplies, these nitrates can present serious risks to human health, in particular for small children. According to figures provided by the EEA, average nitrate concentration in European rivers decreased between 1992 and 2010 by approximately 11\% (from 2.5 mg/l N to 2.2 mg/l N). According to Eurostat figures there has however in general been little change in nitrate concentration in groundwater.\textsuperscript{28} According to the EEA the decreasing trend for nitrate in general is too slow to comply with the legal requirements even in a more distant time perspective. One reason for the slow improvements in groundwater is the groundwater renewal rate, another is the lack of coherence between water and agricultural policy (see below).

\subsection*{2.1.3. Toxic substances}

Some substances, naturally occurring or synthetically produced, are toxic. Toxicity is the ability of a substance to cause severe biological harm or death after exposure to, or contamination with, that substance. One particular group of toxic substances are known as \textit{persistent, bioaccumulative and toxic} (PBTs). They pose a serious risk to aquatic life and human health, even in low quantities. Once released into the environment, PBTs take a long time to break down or do not break down at all. In addition to persistence they show an affinity to the materials that compose animal and plant tissues, i.e. fats, proteins and bone. If an organism is continuously exposed to a PBT

\begin{itemize}
\item\textsuperscript{25} \textit{Nutrients in freshwater}, European Environment Agency website, 2015.
\item\textsuperscript{26} European Commission, \textit{Integrating water policy}.
\item\textsuperscript{27} EEA, \textit{European waters}.
\item\textsuperscript{28} \textit{Agri-environmental indicator} - nitrate pollution of water, Eurostat website, 2012.
\end{itemize}
or ingests it repeatedly, the substance’s concentration can build up over time, in a process known as **bioaccumulation**. When organisms exposed to PBTs are eaten by another organism, the predator consumes all the accumulated substances from all organisms lower in the food chain. As a result, unless the predator can degrade or eliminate the substance, the concentration of PBTs within that (predator) organism will increase accordingly, in a process known as **biomagnification**. Two particularly significant groups of PBTs are persistent organic pollutants (POPs) and heavy metals.

**Persistent organic pollutants (POPs)** are carbon-based organic chemical substances that are toxic to both humans and wildlife. They are not soluble in water, but readily absorbed in fatty tissue, where concentrations of POPs may build up in fish, predatory birds and mammals. As animals are able to travel over longer distances, the accumulated POPs travel with them and can be found in people and animals living in regions thousands of kilometres from any major POP source. The process of biomagnification results in the build-up of very high concentrations in top predators, including humans. It is assumed that POPs can cause for instance damage to the nervous and immune systems, and can have developmental and carcinogenic effects. Some POPs are also considered to be endocrine disrupters, which can have harmful effects on the hormone system, altering development, growth, reproduction, metabolism, immunity and behaviour.

Persistent organic pollutants are governed by the 2001 Stockholm Convention, under which nations agreed to reduce or eliminate the production, use and/or release of certain POPs. The regularly updated list of POPs[^29] comprises pesticides, industrial chemicals and by-products (such as dioxins). In the case of pesticides the principal pathway causing ecological impacts is that of water contaminated by pesticide runoff. In many cases pesticides can have detrimental effects on health throughout the food chain. Moreover the effects of pesticides extend beyond individual organisms and can affect entire ecosystems. While levels of some POPs in the environment, such as dioxins and the pesticide DDT, are decreasing, other substances are still widespread and/or have only recently become the subject of legislation. Examples include polychlorinated biphenyls (PCBs)[^30], perfluorinated compounds (PFCs)[^31] and polybrominated flame retardants. These substances may be released into the environment during their production and use as well as after disposal in landfill, where they may leach out and enter aquatic systems[^32].

Another group of persistent, bioaccumulative, toxic substances are **heavy metals** such as mercury, lead, cadmium, selenium, and arsenic. Solid metals become soluble in water with a low pH value, i.e. in an acidified environment. Once dissolved they can enter the food chain via phytoplankton, which will then reach fish higher up the food chain. Fish can also ingest dissolved metals by diffusion through the membrane of their gills.

[^29]: [Listing of POPs in the Stockholm Convention](#)

[^30]: PCBs are a group of synthetic chlorinated organic compounds that are used mainly in the insolation of electrical equipment, but also in paints, inks, duplicating paper, plasticisers, etc. PCBs are toxic to fish causing spawning failures and killing them at higher doses. In fish-eating animals and humans, PCBs are linked to reproductive failure and immune system oppression. They are also suspected to be human carcinogens.

[^31]: Perfluorinated compounds include perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). They have been used in protective coating for carpets, textiles and leather as well as in different household products and non-stick cookware. See [PFOS and PFOA: General Information](#), Public Health England, 2009 and [Per- und polyfluorierte Chemikalien (PFC)](#), German Umweltbundesamt, 2013.

[^32]: Polybrominated flame retardants are commonly used in electrical and electronic devices, furniture or textiles. See [Brominated flame retardants: guardian angels with a bad streak?](#), German Umweltbundesamt, 2008.
Moreover metals can bind to sediment, where they can be taken up by bottom-dwelling animals. Filter feeders such as oysters and cockles for instance can consume considerable amounts of particulate matter from the water that passes through them. In the case of mercury, accumulation in sediment can be particularly problematic, as some bacteria may turn it into toxic methylmercury, which then can be absorbed by organisms up the food chain. If disturbed, the sediment may release a large quantity of the contaminant into the water. Heavy metals can be released into aquatic systems during several industrial processes, such as metallurgical procedures, paper manufacturing, petroleum refining or mining. Coal-fired power stations, residential coal burning, industrial processes, and also mining for gold and other metals are major sources of mercury pollution.

According to the EEA, in river water bodies classified as having a poor chemical status, heavy metals account for 20% of overall pollution. For lakes, heavy metals are the dominant pollutant, accounting for more than 60% of water bodies having poor status.

3.1.4 An emerging issue: pharmaceutical residues

Awareness of the potential impact of pharmaceuticals in water has only emerged recently. The effects of this kind of residue on an aquatic environment and subsequently on health are not yet fully understood and there is insufficient data on their release and concentration in European waters and sediment. Studies point, however, to a higher occurrence of pharmaceutical residue downstream of urban sewage discharge areas (pharmaceutical residues are often not removed by wastewater treatment plants) as well as intensively used pastures. As pharmaceuticals in general are developed as substances with an intended effect on organisms, they often remain biologically active when they get into the environment and can exert their specific effect on non-target organisms.

Widely used pharmaceuticals such as painkillers, hormonal preparations and antibiotics are suspected of having a negative impact on aquatic organisms and thus on entire ecosystems. Fish can for instance be responsive to hormonal substances, a consequence being alteration of their reproductive organs, such as the feminisation of male fish. According to scientists the consumption of pharmaceuticals is likely to increase in the long term on account of demographic change in European societies.

2.2. Physical pollutants

Suspended solids, small particles in water that neither dissolve nor settle by gravity, such as clay, silt, sand or organic matter, can lead to water turbidity. Although harmless in themselves, an increased content of suspended solids makes water cloudier and limits the sunlight reaching aquatic plants. As plants are at the beginning of the food chain, limited plant growth can impact all living organisms. Moreover predators such as fish

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33 World Health Organization Fact sheet: Mercury and health, 2016; the Commission recently submitted a legislative proposal aimed to align existing EU-legislation with the UN-Minamata Convention on mercury.

34 EEA, European waters.

35 When it comes to pharmaceuticals entering freshwater systems the emphasis is currently on prevention rather than on removal. The introduction of additional carbon filtration in water treatment plants is however being discussed. In 2013 three commonly used pharmaceuticals (two hormonal preparations and a painkiller) were added to the Priority Substances Directive watch list (see below on the Environmental Quality Standards Directive).

may be unable to see and consume their food in turbid water. One of the most important effects is however the damage to fish gills. Prolonged exposure to high levels of suspended solids is likely to do considerable harm to the respiratory system of fish, causing adverse growth and development. Furthermore, some suspended solids can contain or carry damaging substances. The erosion of sediments, for instance from agricultural soil, is one of the main mechanisms by which contaminants are transported into surface water bodies. Substances such as phosphorus, heavy metals, pesticides and other organic compounds, which are able to bind themselves to soil particles, can enter adjacent water bodies in this way.

Another group of particles with a potentially similar impact on ecosystems are **microplastics**. These are fragments smaller than 5 mm, which derive from everyday items, such as body care products, pharmaceuticals, cleaning agents, and also a result of the abrasion and fragmentation of larger synthetic items, such as textiles, car tyres or paints. Microplastics get into water via untreated sewage or sewage overflow and sewage sludge, as well as from agricultural and industrial areas. As there are so far only a few studies on the presence of microplastics in freshwater and their effect on aquatic species, it is not yet known in detail what kind of risk they present in the long term. Studies show however that current water treatment plants do not filter these particles completely from treated water. Given their persistence of an estimated 450 years, it can be assumed that concentrations of microplastics in freshwater will increase over time. Although there is no clear evidence demonstrating their bioaccumulation or biomagnification and a detrimental effect on freshwater species, the possibility exists, that they contain and absorb micropolllutants and pathogens. Due to their small size, microplastics can pose a particular risk for filter feeding organisms (including fish and crustaceans), which capture food of a suitable size without further selection. In all organisms microplastics can be excreted or absorbed from the digestive tract into the body tissue. Scientists assume that ingested particles may cause a false satiety feeling in fish leading to starvation.

Another group of new substances with an uncertain impact on the environment are **nanomaterials**. These are microscopic particles (10 000 times smaller than the diameter of a human hair) with novel properties, which are manufactured for specific purposes. Nanomaterials are used in a broad range of applications, including the public health, energy, transport and environmental protection sectors. In the latter case they can be useful for removing pollutants, and also bacteria, viruses and fungi, from water. In spite of their positive effects on certain environmental aspects, uncertainties and knowledge gaps remain concerning their potential risks.

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37 See e.g. K. Duis et al., *Microplastics in the aquatic and terrestrial environment: sources (with a specific focus on personal care products), fate and effects* in *Environmental Sciences Europe*, 2016, Vol. 28(2) and M. Wagner et al., *Microplastics in freshwater ecosystems: what we know and what we need to know* in *Environmental Sciences Europe*, 2014, Vol. 26(12).


2.3. Thermal pollution

Another type of pollution that occurs mainly in the surface water environment is thermal pollution. It is often associated with the release of heated water from power generation plants. With rising temperature, the amount of dissolved oxygen in water decreases, which is a stress factor for most aquatic life.41 Even a 1° or 2°C increase in temperature can cause higher disease susceptibility and reproduction problems, in particular if the temperature changes suddenly. In addition, increased temperatures can affect processes such as photosynthesis, respiration and decomposition, generally accelerating them. The increased metabolic rates of aquatic organisms thus causes a higher oxygen demand just when oxygen supply is already being reduced. In addition, any animal or plant that dies as a result of an oxygen deficit in water is decomposed by bacteria, which decreases the oxygen level or increases the BOD still more. Another effect of a rise in temperature can be that species indigenous to warmer climates may become established in the heated portion of a river (see box below).42

2.4. Hydromorphological changes and over-abstraction

Another disturbance of water bodies and their connected ecosystems are changes to their flow and physical shape, for instance by dams and weirs, straightening and canalisation (referred to collectively as ‘hydromorphological pressures’), but also by abstraction of water beyond the renewing capacity of nature. Flow modifications relate mainly to surface waters, whereas changes in terms of quantity put pressure on both surface and groundwater.

European surface waters have been altered for centuries to facilitate navigation, to reclaim land for agriculture and urbanisation, to produce energy or to protect from floods. These modifications take the form of straightening and canalisation, as well as the disconnection of flood plains by drainage, dams, weirs and bank reinforcements. Moreover many water courses have had their seasonal or daily flow regimes changed. The EEA SOER report points to the fact that a water body with substantial changes in its structure or water flow will not achieve its full potential as an ecosystem, even if its water quality is good. The EEA also underlines that the straightening, widening and deepening of a natural river bed associated with the canalisation of river courses often implies transporting larger volumes of water per unit of time. This can cause increased rates of erosion and lead to excessive sediment movement (see section on suspended solids) as well as to a further deepening of the river bed. Dykes and dams interrupt the natural flow of a river and can cause fragmentation of habitats with consequences not least for migrant fish species, preventing them from accessing their spawning sites. Artificial barriers like dams and weirs also have an effect on the distribution of natural sediment and other substances within a river, resulting in the retention of sediment upstream of dams and the loss of sediment downstream. Nutrients retained on one side of a dam can thus lead to increased local eutrophication. Moreover, channels and dams that might be effective as flood control in a river section upstream can contribute to more intense flooding further downstream.

Over-extraction of water meanwhile sometimes happens in areas with low rainfall and intensive agricultural activities, such as in Mediterranean and Black Sea countries. It can

41 However the effect depends on the water body’s status: a small increase in the temperature of a clean, fast-flowing river may not affect the ecosystem adversely.

42 Murck, Environmental science, and EEA, 10 messages.
also be caused by urbanisation (in particular if groundwater is used for drinking water) and other economic activities, such as tourism. Excessive water abstraction may cause low river flows, lower groundwater levels, and the drying-up of wetlands, with detrimental impacts on all these freshwater ecosystems. According to the Commission, the abstraction of water is the single most important threat to European freshwater fishes. Climate change, with possible prolonged periods of low rainfall or drought, is projected to further increase water shortages, particularly in the Mediterranean region. Low water levels can also worsen the situation in a polluted aquatic environment, as there is less water to dilute pollutants and concentrations of damaging substances increase. According to the Commission, excessive abstraction significantly affects 10% of surface water bodies and 20% of groundwater bodies.

### Climate change: impact on water and aquatic species

Water temperature is one of the parameters that determine the overall condition of aquatic ecosystems: Most aquatic organisms have a specific range of temperatures that they are able to tolerate. This dependence on temperature determines the species' abundance within a region or within a water body. A long-term increase in temperature induced by climate change can for instance modify a species' distribution in a river system by making it move northwards to colder sections. According to the EEA, aquatic species such as dragonflies and brown trout have already moved to higher latitudes. In cases where no migration is possible, a higher temperature may lead to a species' extinction. This would in turn induce changes in the species composition and in the food chain.

Higher temperatures can be attractive for thermophilic aquatic species originating from warmer regions, which may become invasive and to a certain extent replace the cold-loving species. According to the EEA, 296 species of aquatic invertebrate and 136 fish species found in 2009 in Europe's freshwater environment were alien.

The accelerated metabolic activities caused by higher temperatures mean that climate change may counteract those measures aimed at reducing the vigorous growth of aquatic plants caused by surplus nutrients in water bodies. According to the EEA, amphibians are among the species particularly affected by climate change, on account of their dependence on wetland habitats.

The impact of climate change on future water quality and quantity could become even more tangible in future. Possible scenarios include prolonged drought periods in southern parts of Europe, while in northern parts of Europe there could be more frequent periods of intense rainfall. In the former, periods of drought could lead to higher concentrations of pollutants owing to low water levels and depleted river flows. While in the latter there could be increased urban and agricultural run-off with higher nutrient and pollution levels as a result.

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43 European Red List, European Commission website, 2016.
44 EEA, 10 messages.
45 European Commission, 4th WFD implementation report.
46 EEA, 10 messages.
47 Zandstra, Non-Europe.
3. EU Legislation in the field of water protection


The Water Framework Directive (WFD), adopted in 2000, is the main legislative act on water protection at EU level.\(^{48}\) It aims to protect all water bodies in the EU, comprising surface water (rivers, lakes, transitional waters, coastal waters, artificial and heavily modified waters) and groundwater. Enhancement and prevention of deterioration of the status of water bodies are its fundamental principles.\(^{49}\) The WFD was to be transposed into national law by the end of 2003.

The WFD is based on the concept of natural geographical formations: the river basin districts. A river basin covers an area of land drained by a river and typically includes the source, small tributaries, and the mouth, where a river meets a lake or the sea. It also comprises groundwater beneath a river basin. According to Eurostat\(^{50}\) there are 128 river basin districts designated in the EU, 49 of which are international. The three largest EU river basins are the Danube, the Vistula and the Rhine, which together drain over one quarter of the EU territory.

For surface water the WFD requires the Member States to achieve a good ecological and chemical status by the end of 2015. The WFD provides definitions for high, good and moderate ecological status of surface water bodies. A good ecological status allows only a slight deviation from undisturbed conditions, i.e. without human interference.\(^{51}\) It is determined by the flora and fauna present in water\(^{52}\), as well as hydromorphological and physico-chemical quality elements. Given the wide range of aquatic ecosystems, Member States are responsible for assessing the status of water bodies. National assessment methods are based on the criteria used in the common definition. To ensure that the national assessment methods deliver comparable results, an intercalibration was carried out (see box below). The chemical status of a surface water body is assessed by compliance with environmental standards for chemicals specified in the Environmental Quality Standards Directive (Directive 2008/105/EC amended by Directive 2013/39/EU (see below)). Among these chemical substances are metals, pesticides and various industrial chemicals. In this respect the WFD’s aim is also supported by the Industrial Emissions Directive (Directive 2010/75/EU) and EU legislation on pesticides (Regulation (EC) 1107/2009 and Directive 2009/128/EC). Artificial and heavily modified water bodies\(^{53}\) do not have to meet the same quality criteria required of other surface waters.

\(^{48}\) The EU Water Framework Directive.
\(^{49}\) The European Court of Justice clarified in a preliminary ruling in July 2015 that these principles apply to individual projects and that Member States may not authorise projects that could cause a deterioration in the status of a surface water body unless a derogation is granted.

\(^{50}\) Environmental statistics at regional level, Eurostat website, 2014.

\(^{51}\) Good ecological status is defined in detail in Annex V of the Water Framework Directive.

\(^{52}\) The criteria refer to the abundance and composition of phytoplankton, macrophytes (such as aquatic rooted plants, mosses and ferns), benthic invertebrate fauna (invertebrates living on the bottom sediment of a water body) and fish fauna.

\(^{53}\) An artificial water body is defined as a body of water created by human activity, while a heavily modified body is one that has undergone man-made alterations that have substantially changed its character. A river can be classified as heavily modified when it has been straightened and dredged, and embankments, dams and canals have been built. This is for instance the case for the river Rhine. The classification as heavily modified is meant to allow reconciliation of economic and environmental goals. The proportion of water bodies designated as artificial and heavily modified varies considerably between Member States ranging from 2 % (in Latvia and Ireland) to over 90 % (in the Netherlands).
water bodies. Instead of the 'good ecological status', they need to meet the 'good ecological potential' criterion for their ecosystems. However, artificial and heavily modified bodies still need to achieve the same low level of chemical contamination as other surface water bodies.

Map 1 – EU river basin districts

![EU river basin districts map](image)

**National and International River Basin Districts**

- **International River Basin Districts**
  Compiled from data reported to WISE by EU Member States

- **Approximate extent of International River Basin Districts outside of the EU**
  Compiled from data reported to WISE by AD, CH, LI MC and NO, supplemented with CCM2 SeaOutlets and ICPOR data

- **EU27 extent**

**Intercalibration**

Given the wide range of aquatic ecosystems, Member States choose their own assessment methods based on the common definition of the particular status provided by the WFD. To ensure that national assessment methods to measure good ecological status deliver comparable results and are consistent with the directive, experts from Member States, coordinated by the European Commission's Joint Research Centre, carried out an intercalibration exercise, which took place mainly between 2003 and 2007. The work focused in particular on defining the upper and lower boundaries of good status. Particularly important in this context is the line between 'good' and 'moderate' status, as it defines whether or not a water body will meet the directive's 2015 goal of good status. The intercalibration exercise is still on-going.

The criteria for **groundwater** are different from those for surface water. For groundwater a good quantitative and chemical status is required by 2015. The requirements for groundwater are laid down in the **Groundwater Directive**.

In order to protect their river basins, Member States have to draw up **river basin management plans** (RBMP) covering cycles of six years. They are the main tool for the implementation of the WFD. Member States drew up their first RBMPs in 2009, the second series were to be adopted in 2015. In the case of transboundary rivers, several Member States have to work out joint plans, if possible in collaboration with non-EU Member States. This is for instance the case with the Danube, the Rhine and the Odra. Integrated river basin management plans are meant to explain how the objectives set for the river basin (ecological status, quantitative status, chemical status) are to be reached within the timescale required. They should include the river basin's characteristics, a record of the current status of water bodies within the river basin district, a review of the impact of human activity on the water's status and a **programme of measures** (PoM). The PoM, a key element of river basin management planning, sets out the actions to secure the objectives of the water legislation. The requirements for PoMs distinguish between basic measures and supplementary measures. Basic measures comprise the minimum water body protection requirements, including those laid out in related directives such as the **Urban Wastewater Directive (91/271/EEC)**, the **Nitrate Directive (91/676/EEC)** and the **Drinking Water Directive (80/778/EEC)**. Supplementary measures are necessary in cases where the basic measures are not sufficient to allow the WFD objectives to be reached. Such measures can include construction programmes, rehabilitation projects, legislative, administrative and fiscal instruments, and educational projects.

When it comes to water quality, the WFD pursues a combined approach of 'emission control' (substances released into the environment from a specified source) and 'pollution control' (resilience of the receiving waters). The rationale behind this double approach is that source controls focussed on single polluters could still allow a severe pollution level in cases where there is a concentration of numerous pollution sources or diffuse pollution. Quality standards alone on the other hand could underestimate the effect of a particular single substance on the aquatic ecosystem. In line with this...

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55 The Danube River Basin comprises 19 EU and non-EU Member States, it is considered the most international river basin in the world. River basin management plans for the Danube are developed under the framework of the **International Convention** on the Protection of the Danube River (ICPDR), signed by 14 of these countries.
approach, releases of substances into water are governed by a number of pieces of legislation targeting specific activities, while the requirements of the Environmental Quality Standards Directive aim to prevent the deterioration of waters as a result of the accumulation of pollution from multiple sources.

3.2. Environmental Quality Standards Directive

The Environmental Quality Standards Directive (EQSD) regulates specific aspects and requirements of the WFD by laying down requirements for a good chemical status of surface water. It contains a list\(^{56}\) of pollutants classified as priority substances on account of the significant risk they pose to or via the aquatic environment. The directive also lays down concentration limits for these substances, called environmental quality standards, which must not be exceeded if good chemical status of a water body is to be met.

Persistent, bioaccumulative and toxic substances (PBTs), together with other substances that give rise to a similar level of concern, form the subset of priority hazardous substances. The emission of these substances into the aquatic environment is to be phased out completely under the directive within 20 years of their designation as priority hazardous substances.

**Good chemical status** is achieved if the concentration of substances in a surface water does not exceed the limit values as laid down in the EQSD. Two types of environmental quality standard are set for priority substances: annual average concentrations and maximum allowable concentrations. The former protect against long-term chronic pollution problems, and the latter against short-term exposure. In addition to limiting these substances in water, Member States must also make sure that the concentrations of these substances do not increase in sediment and/or biota, where they are liable to accumulate. They are required to establish an inventory of emissions, discharges and losses of all substances identified in the directive. The quality standards and the list of priority substances are regularly updated in line with the latest scientific findings. In the context of the last revision in 2013, the limit values for seven substances were updated, and 12 new priority substances included, among them PFOS.\(^{57}\) The updated directive also introduces a watchlist.\(^{58}\) This list consists of substances that may pose a significant risk to or via the aquatic environment, but for which not enough monitoring data is available. The list includes three commonly used pharmaceuticals.\(^{59}\)

3.3. Groundwater Directive

The requirements for groundwater are different from those for surface water insofar as a 'good groundwater status' requires a good quantitative and a good chemical status.\(^{60}\)

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56 The initial list of 33 priority substances was complemented by a further 12 substances in 2013 by Directive 2013/39/EU, which also introduced an obligation for the Commission to establish an additional list of substances to be monitored in all Member States, the so-called 'watch list', also including pharmaceutical substances.

57 The new standards for the 2008 priority substances must be taken into account in Member States' second RBMP with the aim of achieving good surface water chemical status in 2021, the standards for newly-identified substances will take effect in 2018, with the aim of achieving good chemical status in 2027.

58 Commission implementing decision 2015/495 establishing a watch list of substances for Union-wide monitoring in the field of water policy.

59 17alphaethinylestradiol, 17beta-estradiol, and the painkiller Diclofenac.

The basic requirements for groundwater are laid down in the WFD and further specified in the **Groundwater Directive (2006/118/EC)**. The standards for groundwater take account of the fact that groundwater is of vital importance both as a source of drinking water and as a water supply for surface water systems affecting all other related aquatic and terrestrial ecosystems. Moreover, once polluted, groundwater may be difficult or impossible to restore to a healthy status.

<table>
<thead>
<tr>
<th>Groundwater</th>
<th>Surface water</th>
<th>Artificial and heavily modified water bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good chemical status and good quantitative status</td>
<td>Good chemical status and good ecological status</td>
<td>Good chemical status and good ecological potential</td>
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The Groundwater Directive lays down EU-wide limit values for nitrates and pesticides. Nitrate levels may not exceed 50 mg/l, while levels of active pesticide ingredients, their metabolites and reaction products may not exceed 0.1 µg/l, if a good status is to be achieved. For other pollutants, Member States are required to establish their own threshold values taking into account the local conditions. The concentration of any other pollutants must conform to the definition of good chemical status as set out in the WFD. This means that in addition to the general prohibition on direct discharges of pollutants, the Groundwater Directive is also aimed at preventing indirect discharges to groundwater via percolation through the ground. Member States must therefore identify any significant and sustained negative pollution trend in bodies of groundwater and take measures to reverse such trends.

In addition to having good chemical status, groundwater also has to fulfil the criteria of a good quantitative status, with the Groundwater Directive specifying that only that portion of the annual recharge that is not needed to support aquatic ecosystems can be abstracted. This is because a certain amount of recharge is needed to support connected ecosystems (surface water bodies or terrestrial systems such as wetlands).

### 3.4. Other legislation

With regard to good chemical status of both ground and surface waters, the **Nitrates Directive (96/676/EEC)** aims to protect waters against pollution caused by nitrates from agricultural sources. It requires Member States to monitor their waters' nitrate concentration levels and to designate so-called 'nitrate vulnerable zones'. These are areas of land that drain into already polluted or threatened waters, i.e. waters containing a nitrates concentration of more than 50 mg/l or susceptible to contain such a nitrates concentration. For these areas, mandatory action programmes have to be established. In addition Member States must draw up a code of good agricultural practice, which farmers can apply on a voluntary basis except in nitrate vulnerable zones where it is binding.

The **Urban Wastewater Treatment Directive (91/271/EEC)** (UWWT Directive) is designed to protect the aquatic environment from the negative effects of urban wastewater effluents, including eutrophication. It also covers wastewater generated by industries such as food-processing and brewing. Under this directive, Member States are

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62. These measures include for instance shorter periods when nitrogen fertilisers are applied on land; a minimum storage capacity for livestock manure; and catch crops to prevent nitrate leaching and run-off during wet seasons.
obliged, among other things, to collect and treat wastewater in all areas with at least 2 000 inhabitants and to conduct at least secondary (biological) treatment of their wastewater. For areas with more than 10 000 inhabitants, a more advanced treatment is required. Stricter requirements are also applied to what are referred to as sensitive areas. Under the UWWT Directive Member States are also required to limit the pollution of receiving waters by storm water overflows under extreme weather situations, such as unusually heavy rain. According to a Commission report, nearly 75% of the EU territory is now designated as a sensitive area. 15 Member States have designated their entire territory as sensitive, whereas 13 Member States have identified only certain water bodies as such.

Under the Floods Directive (2007/60/EC), Member States are required to assess and manage flood risks and to include in their RBMPs (for the period 2016-2021) measures to reduce the risk of floods, which among other things can imply contamination risks in case water treatment plants are affected and/or chemicals involved.

**Directive 2009/128/EC on the sustainable use of pesticides** is aimed at reduce the risks and impacts of pesticide use on people’s health and the environment (it is not therefore aimed specifically at water protection). Under this directive, Member States must adopt national plans to reduce risks from pesticides, among other things to protect water, especially drinking water.

**Directive 2010/75/EU on industrial emissions** is designed to regulate emissions from industrial installations into the environment. Under this directive, listed industrial activities (such as the energy, metal, minerals, and chemicals industries, waste management, paper production, slaughterhouses and intensive animal farming) need a special permit, stating emission limit values. The directive gives priority to preventing pollution at source.

### 4. Implementation of water legislation

As early as 2012 the Commission found in its ‘Blueprint to safeguard Europe’s Water Resources’ that about half of EU surface waters were unlikely to reach a good ecological status by 2015. Recent reports on the implementation of the WFD, such as the 4th implementation report by the Commission and the EPRS Cost of Non-Europe Report attribute the delays in the implementation of the WFD to various circumstances. These include lack of ambition at Member State level, inadequate data availability, as well as insufficient policy coherence, both internally (shortcomings within the legislation itself) and externally (lack of coordination between related policies at EU-level).

Both reports criticise a certain lack of ambition in implementation efforts. According to the EC report, many Member States do not follow a strategic roadmap with the objective of improving water quality, but rely on an approach of ‘moving in the right direction’ by applying already existing and/or feasible measures. Instead of designing measures that have the potential to solve acute and persisting problems within a given timeframe, Member States adopted, according to the Commission, a ‘business as usual’ approach.

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63 Sensitive areas are water bodies which may become eutrophic if no protective measures are taken, and surface water bodies intended for drinking water which contains more than 50 mg/l nitrates.


66 European Commission, 4th WFD implementation report and Zandstra, Non-Europe.
without considering the actual status of a given water body or the clear timetable linked with the WFD. For instance, the Commission report points to the fact that for the implementation of the EQS directive most Member States are not yet quantifying diffuse emissions originating from a variety of sources. Moreover most of the measures identified by Member States in relation to chemical pollution are not targeted at specific substances or sources and have vague outcomes. According to the report, this approach has resulted in too wide an application of exemptions without appropriate justification, thus preventing the achievement of 'good status' of the water bodies. The Cost of Non-Europe Report on water legislation confirms the Commission's view in this respect and comes to the overall conclusion that the implementation of the Water Framework Directive at Member State level has been 'slow and incomplete'. It suggests however that in many cases where Member States are lagging behind, it is the result of implementation discussions at local and regional level.

Another issue hampering the implementation of the WFD is the lack of data in some areas. The EEA states that in 2012 the chemical and biological status of over 40% of water bodies was unknown. With regard to the Environmental Quality Standards Directive the Cost of Non-Europe report acknowledges that its implementation is hard to assess on account of its relatively recent adoption and transposition into national law (in September 2015). The study also points to the lack of monitoring data as a major impediment to the implementation of the directive. Furthermore, the report criticises the lack of information for instance on the cumulative effects of chemicals and on the effects of emerging substances, such as pharmaceutical residues.

The Cost-of-Non-Europe report states furthermore that the WFD shows a certain imbalance regarding its requirements: according to the study, the WFD's combined approach of emission control and quality monitoring for instance shows a clear emphasis on pollution control requirements, whereas measures to prevent pollution, i.e. emission controls, have not been developed to the same degree. According to the study, existing legislation thus lacks effective measures to prevent pollution at source. The Cost of Non-Europe report also notes, critically, that compared with pollution measures, current legislation with regard to hydromorphological changes is less prescriptive. Moreover, the report states that by focusing on preventing further deteriorations the emphasis is on mitigating the negative impacts of new infrastructure projects, rather than existing infrastructure.

As another important cause of implementation gaps, the Cost-of-Non-Europe report notes the lack of coherence between water protection policy and other related policies, in particular agricultural and energy policies. Although agricultural activities, in particular intensive agriculture, and energy production may have adverse impacts on water quality and quantity, this fact is not given sufficient consideration. In this context the European Court of Auditors (ECA) also highlighted in its assessment report the limited integration of water concerns into the common agricultural policy (CAP), in particular via its cross-compliance and rural development approaches. On this note, in its latest report on the implementation of the Nitrates Directive (published in 2013) the Commission pointed to a slight improvement in groundwater nitrate pollution owing to decreasing consumption of chemical fertilisers as well as to an improvement in fresh surface water. However, the

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67 EEA, European waters.
68 See Zandstra, Non-Europe, and Integration of EU water policy objectives with the CAP: a partial success, European Court of Auditors (Special report No 4), 2014.
importance of further implementation of the Nitrates Directive is also underlined as a key measure to counter the perennial issue of diffuse pollution. With regard to energy policy there are several points of tension with water protection. One example is the promotion of renewable sources of electricity generation, with hydropower providing the largest share. While the WFD places emphasis on the quality of hydro-morphological conditions as a prerequisite of healthy habitats and thus good ecological status, hydropower stations are among the main causes of hydro-morphological changes through, for instance, the construction of dams and weirs in rivers.

The EC implementation report and the Cost of Non-Europe report both criticise an insufficient consideration of quantitative aspects. The Commission underlines that the problem of over-abstraction of water bodies is inadequately addressed and exemptions have been widely used. Intensive water use may be the result of irrigation, but also of other economic activities and urbanisation. Although over-abstraction is reported to be particularly evident in Mediterranean and Black Sea countries, several other Member States, such as France, Belgium and the UK have experienced occasional periods of drought. The Commission implementation report indicates that excessive water abstraction significantly affects 10% of surface water bodies and 20% of groundwater bodies. The Cost-of-Non Europe report confirms that progress towards reducing quantitative pressures has so far been limited, pointing in this respect to the fact that legislation itself provides for only a few requirements concerning quantitative aspects. Furthermore it criticises the insufficient use, for instance, of economic instruments, which, according to the report, is apparent from the still widespread use of flat rates for water consumption.

The recent EC report on the implementation of the urban waste water treatment directive points to substantial gaps between older and newer Member States, although it underlines the clear improvements made since the adoption of the UWWT Directive in 1991. It highlights, in particular, positive developments regarding discharges of major pollutants such as organic matter and nutrients. The report shows a high compliance rate in general (with rates of 95 to 100% in many cases), but points also to remaining issues. These comprise, for example, sensitive areas in newer Member States and treatment measures, which are less well advanced than collection measures for wastewater. The UWWT Directive implies substantial financial implications related to major infrastructure investment in sewerage systems and treatment facilities. However, the Commission in

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69 Report on the implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources based on Member State reports for the period. Against this background the Commission referred Germany to the Court of Justice of the EU (October 2016), as the country has not taken sufficient additional measures to effectively address nitrates pollution and revise its legislation to comply with the EU rules on nitrates.

70 15.4% according to EU energy in figures: Statistical pocketbook 2016, European Commission, 2016 (data for 2014).

71 Risk assessments carried out by the Member States in 2005 have shown that hydro-morphological pressures are one of the greatest risks when it comes to achieving WFD objectives. See Common Implementation Strategy For The Water Framework Directive, European Commission, 2013.

72 According to Eurostat, among the river basins for which data are available, the highest volume of groundwater abstracted for public water supply occurred in Italy, in particular in the Po river basin.

73 See Zandstra, Non-Europe. The study acknowledges the attempt to address quantitative water aspects at EU-level given the fact that quantitative water issues require unanimous Council decisions under TEU Article 192(2)(b).

its fourth WFD implementation report highlights that, in some cases, the funding possibilities to support the building of urban wastewater treatment plants are not fully exploited.

**Figure 1 – Infringement cases**

According to Commission statistics, infringement cases arising from non-implementation of water legislation account for a quarter of all infringements in the field of the environment. In 2015, 73 infringement cases were open against Member States on water legislation.75

![Infringement cases graph](image)


According to the Cost of Non-Europe report, full implementation of water-related legislation and thus the achievement of a good status for all water bodies in the EU could bring about savings on water treatment amounting to at least €2.8 billion per year.76

5. European Parliament position

In its 2015 resolution on the European Citizens' Initiative Right2Water (2014/2239(INI)) the European Parliament (EP) expressed concern regarding water quality and asked for increased controls and monitoring of polluting substances.77 In this context it also underlined the importance of internalising the cost of pollution. The EP pointed to the persistence of pollution from diffuse and point sources and argued for water management to be incorporated as a cross-cutting factor in legislation in other fields such as energy, agriculture, fisheries and tourism.

In its 2011 resolution on the implementation of EU water legislation (2011/2297(INI)) Parliament stressed the importance of proper water management for achieving environmental and, in particular, biodiversity targets.78 It also identified water shortages, droughts and adapting to climate change as issues to be addressed. Moreover the EP

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76 Zandstra, *Non-Europe*.
highlighted its holistic approach to water protection calling for better consistency and better integration of water-related objectives into legislation. Moreover it recalled that soil protection is a core element for preserving the quality of water.

6. Outlook

The ambitious goal of achieving a good status by 2015 has not been achieved for all water bodies. For water bodies lagging behind Member States can apply the exemptions provided for by the WFD, which allow them for instance to extend the deadline for reaching good status to 2021, or to 2027 subject to the relevant justifications.\(^{79}\) When it comes to the priority substances introduced in 2013 by the revision of the EQSD, water bodies are supposed to achieve a good status by 2027.\(^{80}\)

Member States were supposed to adopt their second river basin management plans for the 2016-2021 period by the end of 2015. The Commission has launched its assessment procedure for these plans. The results of this assessment should be published by 2018 at the latest and will form the basis for the review of the WFD to be completed by 2019.

The list of priority substances under the EQSD is to be reviewed every six years. The latest review led to the adoption of Directive 2013/39/EU amending the list of priority substances and introducing the watch list. Member States were required to report data for the substances listed by the end of 2016. Based on this data, the Commission will review the watch list substances. In the context of the review of the WFD, one of the Commission's goals is to explore the possibility of developing a new, more holistic approach to chemicals risk assessment and management, taking into account the risk coming from mixtures of chemicals present in the aquatic environment.\(^{81}\)

Another review of the list of priority substances is currently under way. As the WFD review itself is to begin early in 2018, the Commission will not come forward with a legislative proposal in 2018 to modify the list of priority substances. The proposal will instead be linked to any legislative proposals coming out of the WFD review after 2019, in order to ensure consistency between the review of the WFD as a whole and the review of the EQSD.

\(^{79}\) For full details on the justifications required see WFD Article 4.

\(^{80}\) Under certain conditions Member States can extend the time limit for reaching good status up to two further updates of the river basin management plans, i.e. until 2033 and 2039.

\(^{81}\) This principle is in line with the Seventh Environment Action Programme and its protection objectives, ensuring not least 'that (...) the combination effects of chemicals (...) are effectively addressed in all relevant Union legislation'.
7. Main references


Freshwater ecosystems are particularly rich in biodiversity and fulfil important ecosystem services. However, the continuing presence of pollutants still raises concerns for public health, as well as for nature conservation.

Surface water bodies and groundwater alike are threatened by synthetic and also naturally occurring substances that can have a negative impact on the aquatic environment and on human health. Increased temperature and over-abstraction of water are further causes for concern. Meanwhile, heavy modifications to the natural flow and physical changes to water bodies can also cause serious disturbances to water ecosystems.

With the Water Framework Directive (WFD), the EU adopted comprehensive legislation for the protection of water within the EU. Under the directive, Member States are required to achieve good status in all bodies of surface water and groundwater by 2015, or 2027 at the latest. Unfortunately, despite considerable improvements in water quality, this goal was not achieved by the end of 2015 as hoped.