

Water Resource Management in Germany

Part 1: Fundamentals

For our Environment



Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

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Water Resource Management in Germany

**Part 1
– Fundamentals –**

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Contents

1	Introduction	5
1.1	Fundamentals of water resources policy.....	5
1.2.	Sustainable water resources management – Implementation of Chapters 17 and 18 of Agenda 21 in Germany	6
1.3	The human right to drinking water and basic sanitation.....	9
2	Conditions of water resources management	11
2.1	General	11
2.2	Available water resources, water demand, water footprint	14
2.3	Effects of climate change	18
3	Structures and cooperation in water resources management.....	23
3.1	International cooperation.....	23
3.1.1	Cooperation at UN level	23
3.1.2	Cooperation between the European Union and its Member States.....	24
3.1.3	Cooperation with Central and Eastern European countries and with EECCA countries ...	25
3.1.4	German Water Partnership	26
3.2	National cooperation Distribution of tasks between Federal Government and the Länder	26
4.	Statutory mechanisms.....	33
4.1	European legislation.....	33
4.2	Federal legislation	35
4.3	Legislation of the Länder	39
5	Integrated planning and management of water resources	41
5.1	Conceptual framework – Political concepts.....	41
5.1.1	EU Water Framework Directive (WFD)	41
5.1.1.1	The concept behind the WFD.....	41
5.1.1.2	Findings from management planning.....	41
5.1.2	Pollutant Release and Transfer Register (PRTR)...	43
5.1.3	European policy on the protection of the marine environment	44
5.2	Protecting water resources and aquatic ecosystems.....	46
5.2.1	Groundwater	46
5.2.1.1	An important habitat and part of the hydrological cycle	46
5.2.1.2	Groundwater quality	47
5.2.2	Inland waters.....	56
5.2.3	Coastal and marine waters.....	63
5.2.3.1	International marine protection.....	63
5.2.3.2	Regional marine protection	65
5.2.3.3	National marine protection.....	67
5.2.3.4	Maritime spatial planning.....	67
5.2.3.5	Pressures on protected marine assets	67
5.3	International cooperation on the management of waters	72
6	Water uses and water pressures	73
6.1	Water abstraction and water supply	73
6.2.	Drinking water supply	74
6.2.1	Legal framework and organisation of drinking water supply in Germany	74
6.2.2	Water treatment	77
6.2.3	Water distribution.....	78
6.2.4	Drinking water prices.....	79
6.3	Rainwater management	80
6.4.	Wastewater disposal	83
6.4.1	Legal framework	83
6.4.2	Organisation of wastewater disposal in Germany	83
6.4.3.	Impacts of the legal requirements.....	85
6.4.4	Current challenges and problem-solving approaches	85
6.4.4.1	Integrative wastewater management – Option for a new Wastewater Ordinance.....	85
6.4.4.2	Industrial and commercial wastewater	86
6.4.4.3	Public wastewater.....	87
6.4.4.4	Micropollutants	90
6.4.5	Wastewater treatment prices.....	93
6.5	Substances hazardous to water.....	95
6.5.1	Legal framework	95
6.5.2	Installation-related waterbody protection	95
6.5.3	Transport of substances hazardous to water by road, rail and water.....	97
6.5.4	Transport of substances hazardous to water in long-distance pipelines.....	98
6.6	Agriculture.....	99
6.6.1	Legal framework	99
6.6.2	Water pollution from agriculture	101
6.6.3	Sustainable agriculture.....	104
6.6.3.1	Ways of minimising water pollution	104
6.6.3.2	Ways of improving the (environmen- tal) policy framework conditions	105
6.6.4	Use of bio-energy	106
6.7	Other uses and pressures.....	108
6.7.1	Flood risk management	108
6.7.2	Shipping	112
6.7.2.1	Inland shipping	112
6.7.2.2	Maritime shipping.....	113
6.7.3	Hydropower	120
6.7.4	Underground uses	122
6.7.4.1	Geothermia	122
6.7.4.2	CCS – Storage of CO ₂ in the subsoil or ocean floor	123

6.7.4.3	Fracking.....	124	6.7.11	Leisure use of waters.....	135
6.7.5	Energy generation at sea.....	126	6.7.12	Bathing water	136
6.7.6	Extraction of raw materials at sea				
	– deep-sea mining	129	7	Glossary.....	139
6.7.7	Fishing and marine aquaculture.....	130			
6.7.8	Marine litter	132	8	What can each and every one of us do	
6.7.9	Underwater noise.....	133		to help? Tips on water conservation ...	145
6.7.10	Cooling water.....	134			

1 Introduction

1.1 Fundamentals of water resources policy

The precautionary protection of waters as a component of the natural balance and guaranteeing public water supply and public wastewater disposal are two central tasks for the federal, regional and local authorities when drafting their environmental policies.

Thanks to its favourable climatic situation, water quantity problems are uncommon in Germany. In a densely populated, highly industrialised country like Germany, as ever, the principal concern is to improve water quality and waterbody structure.

In the years of reconstruction following the Second World War, water conservation in both East and West Germany was unable to keep pace with the expansion of industrial activity. By the late 1960s and early 1970s, water pollution had reached alarming levels.

In the economically stronger West – the original Federal Republic of Germany – the national and regional authorities prioritised water conservation early on. A raft of measures were introduced, leading to a rapid and permanent improvement in water quality. In particular, industry was required to take far-reaching protective measures to reduce the extent of water pollution.

The construction of over 8,000 biological wastewater treatment plants in the public sector, alongside intensive treatment of wastewater and complementary in-house measures by industrial facilities, led to a considerable reduction in inputs of oxygen-depleting organic wastewater constituents and pollutants into waters, with compelling success for the quality of surface waters.

One major task following German reunification on 3 October 1990 was to ensure the same level of environmental protection throughout the country. The technical standard of water supply and wastewater disposal in the five new Länder (states) was well below that of the old Länder. The goal was therefore to achieve the same high level of environmental conditions throughout Germany.

While the high level of investment in the last 25 years has brought substantial improvements, water protection remains an ongoing task. The general context of the Federal Republic of Germany, i.e. its geographical situation in the centre of Europe, its high population density and high level of industrialisation, together with intensive industrial use, continue to call for special efforts in the field of water con-

servation, also in order to counteract the emerging impacts of climatic change.

Despite the large reductions in inputs of hazardous substances into Germany's waters, a number of persistent, toxic organic substances and heavy metals remain problematic. Some of them have now become ubiquitous in Germany's waters. They are emitted over a large area into soils via the air, and from there via surface runoff and erosion into waterbodies. Rising levels of organic micro-contamination, such as pharmaceutical residues, are also being detected in Germany's waters. In the interests of health protection, and to protect the fauna and flora found in surface waters, hazardous substances must be kept away from all waters as far as possible. This is achieved via a well-developed system of wastewater treatment plants, as well as via avoidance measures at the source, and protective measures directly at the waterbodies themselves (such as riparian buffer zones).

Nutrients represent another problem, something which is particularly evident in the North and Baltic Seas, but also in many lakes and slow-flowing rivers. Over-fertilisation due to inputs of nitrogen and phosphorus, originating primarily from agriculture, has led to excessive algal growth and hence to various cases of oxygen deficiency and fish mortality.

By imposing stringent requirements on municipal and industrial wastewater treatment plants and offering financial incentives under the wastewater charges regulations, agreeing financial support for agricultural measures with the Länder and adopting a continuity programme for Germany's waterways, the Federal Government has paved the way for a substantial reduction in waterbody pressures. However, the polluters concerned must continue to redouble their efforts in the years ahead if they are to meet the EU Water Framework Directive's (WFD)¹ objective of a good status of surface waters and groundwater and the EU Marine Strategy Framework Directive's (MSFD)² objective of a good environmental status of marine waters. In particular, this means reducing the considerable inputs of nutrients from agriculture and improving waterbody morphology.

As an essential component of the hydrological cycle and in the interests of ensuring drinking water supplies, groundwater is an area which requires special protection. In this context, precautions to prevent pollution associated with the handling and use of substances hazardous to water in industry and transport are particularly important. Other potential threats to groundwater include the agricultural use of pesticides

1 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ No. L 327, p. 1 ff.

2 Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy, OJ No. L 164, p. 19 ff.

and nutrients, inputs from contaminated sites, civil and military legacy sites, and defective underground pipelines. More recently, underground activities such as gas fracking, geothermal installations, and the underground storage of CO₂ now pose a threat to groundwater as well.

In the long term, **water resources** must be managed so as to

- ▶ maintain or restore the ecological balance of waterbodies, with a particular regard for waterbody structures (hydromorphology)
- ▶ guarantee reliable water supplies in terms of both quantity and quality
- ▶ ensure that all other water uses serving public welfare continue to be possible.

While tasks are distributed on the basis of subsidiarity³ and decentralisation, water resources management policy is based on the following fundamental principles:

- ▶ Priority of prevention
- ▶ Cooperation between all parties concerned
- ▶ Allocation of costs on the basis of the polluter-pays principle and full recovery of costs

A sustainable water protection policy should not only prevent imminent threats and restore any damage already caused, but should primarily protect and conserve natural resources in a precautionary way.

Water resources management in Germany changed with the entry into force of the new WFD on 22 December 2000 and its implementation in Germany. Key new elements of the WFD include:

- ▶ River basin management in 10 catchment areas, i.e. the integrated management of groundwater and surface waters including lakes, estuaries (river mouths) and coastal waters
- ▶ An emphasis on waterbody ecology
- ▶ More national and international coordination
- ▶ The definition of ecological, chemical and quantitative environmental objectives,
- ▶ The obligation to prepare management plans and programmes of measures to improve the status of waterbodies
- ▶ The involvement of the general public in the planning processes

The MSFD, which entered into force on 4 July 2008, also contains similar and other elements, such as the incorporation of noise and litter requirements pertaining to marine conservation. *Inter alia*, it obligates the Member States to cooperate in the regional Baltic and North Seas.

Transboundary cooperation for the protection of inland waters and the seas is part of the Federal Government's environmental policy work, since responsibility for water and the management thereof does not end at territorial boundaries.

1.2. Sustainable water resources management – Implementation of Chapters 17 and 18 of Agenda 21 in Germany

Agenda 21 was adopted in 1992 at the United Nations Conference on Environment and Development in Rio Janeiro. In 40 chapters, it describes the requirements for environmentally sound and sustainable development in all major policy areas. **Chapters 17** and **18** are particularly relevant for water resources management.

Chapter 17 addresses the protection of the oceans and seas, including coastal regions, and the protection, efficient use and development of their living resources. The following programme areas were defined:

- ▶ integrated management and sustainable development of coastal and marine areas,
- ▶ protection of the marine environment,
- ▶ sustainable utilisation and conservation of living marine resources, and
- ▶ addressing serious uncertainties with regard to climate change and the management of marine environmental resources.

Chapter 18 sets out targets for the conservation of freshwater resources, and is subdivided into seven different programme areas:

- ▶ Integrated planning and management of water resources,
- ▶ Assessing the quantity of available water resources,
- ▶ Protecting water resources, water quality and aquatic ecosystems,
- ▶ Drinking water supply and sanitation,
- ▶ Water and sustainable urban development,
- ▶ Water for sustainable food production and rural development,
- ▶ Impacts of climate change on water resources.

³ The principle of subsidiarity is an important foundation of the European Union: Subordinate bodies (in this case, the Member States), are primarily responsible for governmental duties, whilst the superordinate body (in this case, the EU) takes a back seat.

Agenda 21 formulates a number of sustainable development objectives with worldwide validity. It is therefore only logical that not all the objectives will have the same significance for a highly developed and industrialised country like Germany. While some can already be considered to have been met in Germany – unlike some less developed countries – others continue to pose a major challenge (see **chapter 3.1.1** for details of cooperation at UN level).

Integrated planning and management of water resources

An integrated approach to the management of water resources is pivotal to water conservation policy in Germany today, as well as being a central element of the WFD. The management plans for the 10 river basins relevant to Germany were prepared and published by the required deadline of 22 December 2009, and submitted to the European Commission by 22 March 2010. As well as reviewing waterbody status, the management plans also contain improvement targets and a summary of the planned measures for achieving them. All affected parties and the general public were involved in the decision-making processes. In many areas of water resources management, further improvements and successes are reliant upon greater acceptance. Consequently, the involvement of all affected parties (consumers, agriculture, and industry) must be ensured, and their understanding of water resources requirements enhanced.

The transboundary cooperation in transboundary river basins called for in **Chapter 18** of Agenda 21 is a long-established tradition in Germany, and existing River Basin Commissions were used as platforms to ensure the coordinated implementation of the WFD at international level.

Water resources in Germany are quantified to provide an adequate basis on which to plan water resources management. Water quantity plays a major role in the assessment of groundwater status in particular, and plays a supporting role in the assessment of surface waterbodies.

Protecting water resources, water quality and aquatic ecosystems

Reducing water pollution caused by wastewater discharges has been a central aspect of water protection activities in Germany for the last 35 years. Large sums have been invested in the establishment and operation of wastewater treatment plants, and many industrial sites have managed to reduce their pollution levels substantially by introducing internal production measures (closed cycle systems, substitution of hazardous substances). This has resulted in a remarkable improvement in the quality of surface waters. Nevertheless, many waters are still a long way from achieving a good hygienic, ecological and chemical status in which aquatic communities differ only marginally from their natural state, and which are suitable for unrestricted

use as bathing or fishing waters or for the abstraction of drinking water, for example. This made it necessary to supplement the government regulations focusing on the discharge of wastewater (emission principle) by incorporating quality requirements that consider waterbody status (“combined approach”).

As inputs from point sources have decreased, the relative importance of emissions from diffuse sources (specifically the nutrients nitrate and phosphate, but also pesticides and biocides, oxides of nitrogen, sulphur compounds, heavy metals and polyaromatic hydrocarbons (PAH) from transport and industrial processes) has increased significantly. The environmental quality standards (EQS) for heavy metals (particularly zinc, cadmium, arsenic, copper and mercury) and selected industrial chemicals (e.g. PAH, PCB and HCB) are still frequently exceeded. The concentrations of selected pharmaceuticals also exceed the available proposed EQS (**chapters 5–6** Water Resources Management in Germany, Part 2).

Efforts to reduce pollutant concentrations in wastewater treatment plants still further are now approaching the limits of economic viability in some cases. From both an economic and an ecological perspective, it makes more sense to promote the use of “best available technology”, close substance cycles in industrial processes, and find substitutes for hazardous substances. At the same time, greater efforts must be made to reduce diffuse inputs into waters, primarily via improved agricultural practices and by reducing the deposition of pollutants. However, where all these measures fail to achieve any further reduction in emissions, “end-of-the-pipe” treatment remains an option worth considering.

Groundwater protection must also be addressed in the agricultural sector. As a general principle, agricultural production should be subject to the same standards as apply to pollution from the domestic and industrial sectors.

Drinking water supply and wastewater management

The public drinking water supply in Germany is of a very high standard as regards reliability of supply and the quality of the drinking water. Drinking water is the best monitored of all foods.

Maintaining drinking water quality remains an important task in Germany. The challenges include viruses and parasites that are largely resistant to chlorine (such as giardia, cryptosporidium), and the chemical pollution of untreated water especially with nitrate and pesticides, as well as with “new” environmental chemicals such as perfluorinated components (PFC). The focus here should be on increased resource conservation activities (e.g. greater cooperation between water supply utilities and agriculture) rather than treatment technologies. An old problem – lead pipes – is still on

the agenda following a lowering in the drinking water limit for lead, which had to be met by 2013. These lead pipes need to be replaced with new, safe materials.

The proportion of the population connected to the public drinking water supply system is around 99 %. The proportion of the population connected to the public sewer system is similarly high, and in many cases has reached the limits of financial viability; more work is needed to optimise decentralised systems, also in terms of professional commissioning and maintenance. Improved purification techniques to remove organic substances and remove nutrients more extensively have been introduced in many wastewater treatment plants.

In the field of wastewater disposal, efforts in future will focus on a trans-media approach to technological advancement. The challenge is to minimise resource use and close substance cycles (this applies particularly to nutrients in domestic wastewater). Solutions will vary according to the relevant framework conditions, with due regard for trans-media aspects, but growing importance will also be attached to decentralised techniques.

Water and sustainable urban development

The minimum requirements described in **Chapter 18** of Agenda 21 (40 litres of hygienically safe water per inhabitant, per day; sanitation facilities for 75 % of the urban population; definition of standards for municipal and industrial wastewater discharges; minimum waste disposal standards) are already a reality in Germany. However, many water supply systems, and especially disposal systems, in urban areas were constructed many years ago and require substantial remediation and maintenance work. Infrastructure systems must likewise be adapted in line with changing population figures, climate change and modified consumption behaviour (less water use).

Preventive flood protection for man, the environment and industry

Flooding can cause major damage, as most recently illustrated by the flooding disasters on the Elbe and Danube in June 2013. Man has a considerable influence on the occurrence of flooding (as a result of waterbody development, the sealing and compaction of land and the reduction of natural flood plains), and on the damage caused by such events (e.g. as a result of building activities in flood-prone areas). In order to reduce the frequency and scale of flood damage, there is a need for coordination between various different policy and planning areas. Such measures have been set in motion and are gradually being implemented. In particular, there is a need to restore natural flood plains and modify land use with a view to natural flooding events. In short, this means repairing and raising (where applicable) dykes, as far as necessary, and creating natural flood plains wherever possible.

Flood risk management requires across-the-board coordination within river basins, both between the responsible Länder and on a transboundary level with other countries in the same catchment area.

Impacts of climate change on water resources

One of the aims of Agenda 21 is to understand and quantify the risks that climate change presents for water resources. Such findings are intended to facilitate the implementation of counteractive measures at national level. There is still considerable uncertainty surrounding regional changes in rainfall distribution as a result of climate change. At present there is no reason to expect any fundamental changes in the water resources situation in Germany, but there are foreseeable effects that will impact different regions in different ways. In particular, these include a shift of precipitation from summer to winter, and an increase in heavy rainfall. For this reason, it is vital to take action now and develop measures to adapt water resources management in line with changing conditions. To this end, Germany is working on a national adaptation strategy in which water plays the starring role. Germany also collaborates in the international River Basin Commissions to develop ideas and strategies for adapting to climate change.

Protection of the marine environment

The current use and pollution situation in the North Sea and Baltic Sea far exceeds sustainable levels. In many cases this over-utilisation of our seas and coastlines places an untenable burden on the buffering and self-purifying capacity of the marine ecosystems. Alongside overfishing and discharges of nutrients and pollutants, current research is focusing in particular on the technical uses of our seas and coastlines. Numerous oil and gas pipelines, electrical and telecommunications cables are being laid on or in the seabed, tourism use is on the increase, and there are plans to erect huge offshore wind farms with up to 600 turbines per location. The impacts of many of these uses on the natural balance remain largely unknown, partly due to a lack of knowledge and insufficient research data. We need to develop ecological guidelines on the use of the oceans. The current sectoral approach to planning must be replaced with cross-sectoral management. All this can and must occur within the framework of implementing the MSFD.

We are still a long way from achieving our objective of sustainable, environmentally sound management of our marine bioresources. Fish stocks are in an alarming state, primarily as a result of overfishing putting great pressure on dwindling stocks. In particular, Bottom-trawling and the associated high levels of by-catch, cause physical damage to and destruction of the ocean floor, which result in an ecological damage. The reform of the EU Common Fisheries Policy (CFP) in 2013 highlights the fact that the sustainable use of marine bioresources depends on achieving equilibri-

um between fishing and fish stocks. In the long term, sustainable use can also be ensured by incorporating environmental concerns into European fisheries policy. Apart from reducing fishing intensity and improving controls, technical measures (e.g. more selective nets, designation of protection and conservation zones) can also contribute to sustainable, ecosystem-compatible resource management. The current CFP, whose declared objective is to increase the level of fish stocks, combined with consistent implementation of the MSFD, will make a major contribution towards improving the situation (see [chapter 6.7.7](#)).

1.3 The human right to drinking water and basic sanitation

The “sanitary revolution” – i.e. the supply of safe drinking water and a functioning sewage system – is one of the most important medical achievements of modern times. While this “revolution” has been very effective in our part of the world, on a global scale, waterborne diseases, especially diarrhoeal infections, remain a huge problem. The World Health Organisation (WHO) estimates that they are responsible for around 84 % of global illness in children under the age of 14. As well as the financial implications for the healthcare system, this also incurs high indirect consequential costs to those affected and their families. According to recent estimates by the WHO and UNICEF, there are currently some 780 million people worldwide without access to safe drinking water.

Recognition of the human right to water is often cited as a key pre-requisite for reducing waterborne diseases and their consequences. On 28 July 2010, the United Nations (UN) General Assembly, with a large majority, declared access to safe drinking water and sanitation to be a universal human right. Resolution 64/292 calls upon States and international organisations to provide financial resources through international aid and cooperation, and to foster capacity-building and technology transfer to help countries, particularly developing countries, in their efforts to provide safe, clean, accessible and affordable drinking water and sanitation for all. Germany has long been committed to this philosophy and supports the UN resolution. This is not binding in international law, nor is it individually enforceable, but it will have a major influence on the policies of individual countries and the UN.

Above all, guaranteeing a “human right to water” means ensuring personal, household and food hygiene through adequate water supplies, which in turn affords a good level of protection against waterborne (infectious) diseases. This human right does not include other forms of water use, such as adequate water for food production, maintaining families and livelihoods, environmental protection, recreation and relaxation, cultural and religious practices, nor does it extend to free access to water or distribution entitlements by neighbouring states.

Measures to help implement the human right to water and sanitation are a key focal point of Germany’s development cooperation work.

2 Conditions of water resources management

2.1 General

Population and land use

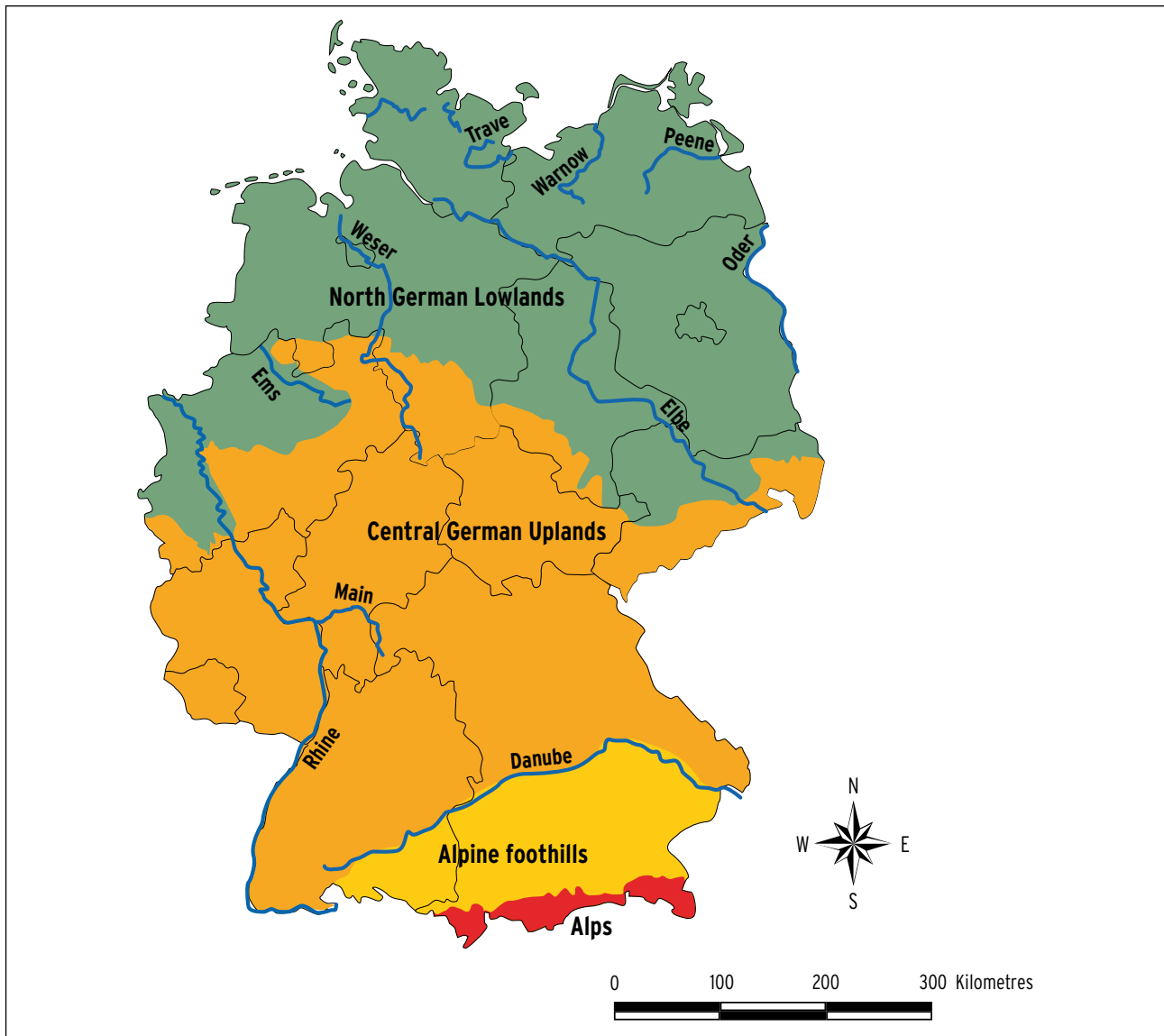
The Federal Republic of Germany is a densely populated country in the centre of Europe. In 2012, there were around 82 million inhabitants living on an area of 357,138 km². With a population density of 229 people per km², Germany is well above the European average of 116 people per km². Population figures vary widely between the *Länder* (States). Berlin has the highest population density, with 3,945 people per km², while Mecklenburg-West Pomerania has a density of just 70 people per km².

Despite the density of population and the high level of industrialisation, much of which is concentrated in particular geographical regions, over four-fifths of the total area of the Federal Republic of Germany is farmland and woodland. Agriculture accounts for 52.3 % and woodland for 30.2 %. 13.4 % of the area is used for settlements and traffic. Water accounts for only a small proportion of land, at 2.4 %.

Climate and precipitation

Germany lies within the moderately humid climate zone, which is characterised by frequent weather changes and precipitation at all times of the year. The average annual precipitation is 789 mm, although there are fluctuations in the volume and frequency of precipitation within Germany and between the seasons. More rain falls on the uplands and alpine regions than in the lowlands. In the North German Lowlands,

Figure 1: Morphological classification of Germany



Source: Umweltbüro Essen, modified by the Federal Environment Agency (UBA)

the annual averages range between 500 and 700 mm, while the Central German Uplands receive 700 mm to 1,500 mm per annum, and in the Alps, annual precipitation can exceed 2,000 mm. Also, rainfall tends to decline from west to east. The summer months are wetter than the winter months, with an average rainfall of 430 mm versus 359 mm.

Landscapes and waterbodies

Geographically speaking, Germany is divided into three parallel landscape types running from north to south: The North German Lowlands, the Central German Uplands, and the Alpine region, which is divided into the South German Alpine foothills and the Bavarian High Alps. These eco-regions also influence the composition of their typical aquatic biota⁴.

During the Ice Age, the level of the North German Lowlands between the North and Baltic Sea coasts and the Central German Uplands were characterised by hilly moraine landscapes with many lakes, as well as lowlands and glacial melt water channels. Many areas of moorland and heath are found in the northwest.

The hills of the Central Uplands separate North Germany from South Germany. The uplands are morphologically subdivided into mountainous regions and valleys, the mountains reaching altitudes of between 700 m and 1,500 m.

The landscape is characterised to a large extent by overground waterbodies. The diverse landscape of the South German Alpine foothills includes a number of large lakes, which merge into the High Alps with

their numerous mountain lakes further south. Germany's largest lake, Lake Constance, with an area of 535.9 km², is located in the Alpine region.

Large interconnected natural lake areas are also found in the North German Lowlands. These include Lake Müritz, the second-largest lake in the Federal Republic of Germany with an area of 109.2 km². There are eleven further lakes with an area of more than 20 km² (Table 1).

Table 1: Natural lakes with a surface area of more than 20 km²

Lake	Area in km ²	Maximum depth in m
Lake Constance	535.9	254
Lake Müritz	109.2	30
Chiemsee	79.9	73
Schweriner See	61.5	52
Starnberger See	56.4	128
Ammersee	46.6	81
Plauer See	38.4	26
Kummerower See	32.5	23
Steinhuder Meer	29.1	3
Großer Plöner See	29.1	58
Schaalsee	19.3	72
Selenter See	21.4	36
Kölpinsee	20.3	30

Source: Federal Statistical Office Germany (2005)

In Germany's ten river basins, rivers and streams with a combined length of more than 400,000 km flow into the coastal regions. The Rhine, Elbe, Weser, Ems, Maas and Eider river basins drain into the North Sea;

⁴ See Water Resources Management in Germany – Part 2 (waterbody types).

Figure 2: Lake Constance – Satellite picture



Obersee with the north-west "finger" of Überlinger See. In the west, the smaller Untersee. In the bottom right, the Alpine Rhine delta. At the left-hand edge of the picture, the Upper Rhine. Obersee and Untersee are connected by a 4 km stretch of the Rhine known as Seerhein.

Source: Wikipedia – http://upload.wikimedia.org/wikipedia/commons/7/79/Bodensee_satellit.jpg

Figure 3: River basin districts in the Federal Republic of Germany



Sections of international river basin districts that lie outside the borders of the Federal Republic of Germany have been labelled for illustrative purposes only; this does not in any way affect the provisions of other countries and international agreements.

Map basis:
LAWA, Federal Agency for Cartography and Geodesy (BKG)

Source: Federal Environment Agency (UBA), 2004

the Oder and the Schlei/Trave and Warno/Peene river basins flow into the Baltic Sea; and the Danube flows back into the Black Sea.

Hydrological intervention for commercial or tourism purposes changes the hydrological, morphological and geochemical features of the waterbodies⁵.

Man-made reservoirs have been part of the landscape in Germany for almost 100 years. They store water for drinking water and energy supply, are used for flood prevention, and often perform a valuable recreational role as well.

The mining of raw materials such as lignite, sand and gravel leaves a legacy of destroyed landscapes and residual pits to begin with. However, since 2000, Germany's water area has increased due to the flooding of these disused pits. The water area currently totals 8,576 km², corresponding to 2.4 % of Germany's territory. Over the next few years, further lakes will be created in the lignite pits.

Germany's transport routes include around 7,300 km of canals, impounded and free-flowing rivers as federal waterways. Natural habitats and contact with water meadows are often lost as a result of development and impoundment. Where water is impounded, algal bloom, sludge accumulation and oxygen deficiency can occur as a result of nutrient pollution (see **Chapter 6.7.2** for further details).

Most overground waterbodies are fed by groundwater inflows. Overall, Germany is rich in groundwater supplies. However, their availability and quality varies widely according to regional geological, hydrological and hydrochemical conditions. The largest coherent region with plentiful groundwater reserves is the North German Lowlands. Large groundwater supplies are also found in the Alpine foothills and in the Upper Rhine Rift.

North and Baltic Seas

The North Sea is a shallow marginal or shelf sea of the North-East Atlantic, covering an area of around 575,000 km². The average depth is 93 m, with a maximum depth of 725 m in the Norwegian Channel. Water exchange with the Atlantic occurs primarily via the open north side, and to a lesser extent via the English Channel as well. Depending on the geographical situation, the average residence time for North Sea water is one or more years. In the coastal region, the water residence time is particularly long due to the existing flow conditions. The North Sea is one of the most biologically productive marine regions in the world, with excessive concentrations of nutrient salts in some areas and a correspondingly high level of plant and animal production.

As an intercontinental marginal sea of the North Sea, the Baltic Sea is almost completely enclosed by land mass and has only a narrow, shallow connection to the North Sea (Sunde, Belte, Kattegat, Skagerrak). It covers an area of approximately 413,000 km², with an average depth of 52 m, and a maximum water depth of 459 m at Tief. As a result of the minimal and irregular discharge of salt water from the North Sea and the high input of river water, the salt content rises from Bottnische Meerbusen (almost freshwater) to Skagerrak (almost seawater), making the Baltic Sea one of the largest cohesive areas of brackish water in the world. The water in the Baltic Sea has a residence time of approximately 25–30 years, with slower rates in the shallow western part, and longer rates in the deep basins of the central Baltic Sea.

2.2 Available water resources, water demand, water footprint

With an available water supply of 188 billion cubic metres, Germany is a country rich in water resources. The available water supply is a variable of the regional water cycle, which is calculated from precipitation and evaporation volumes as well as inflows and outflows. This figure indicates the volume of water that is potentially available for management.

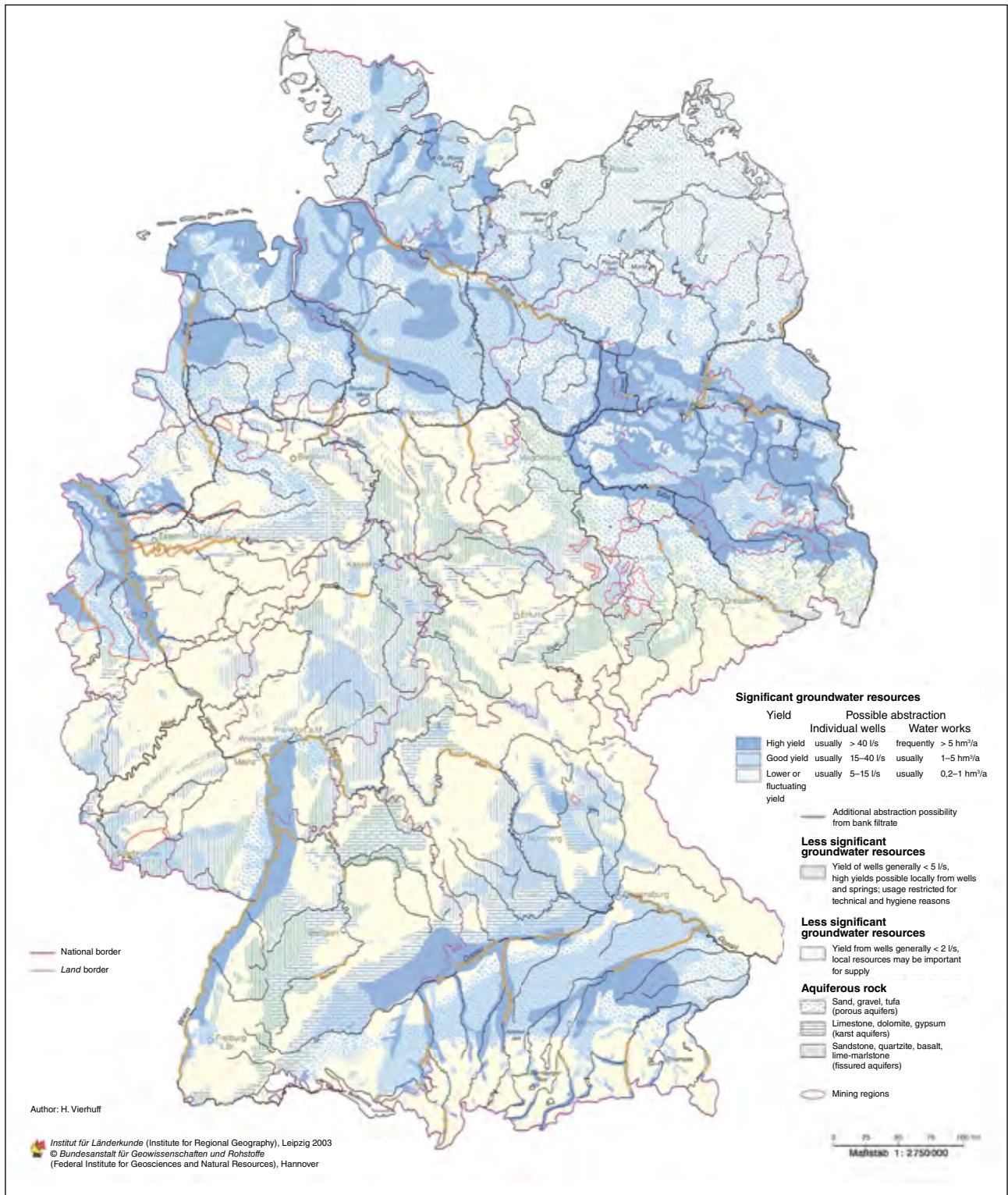
Although the overall water supply is adequate, Germany also has some regions with limited volumes of usable groundwater and surface water supplies, and water shortages can arise as a result of seasonable fluctuations in precipitation and evaporation volumes, as well as variations in water demand. However, the extraction and distribution systems have been modified so that water demand can be adequately met at any time for the various uses within Germany.

In Germany, industry and private households connected to the public water supply use just under 20 % of the available water resources for all sectors (including energy extraction and cooling). In 2010, the total volume of water abstracted was 33.1 billion m³. Over the past 20 years, there has been a tangible reduction in the volume of water abstraction in all areas. Although internationally, usage levels of 20 % of water resources⁶ are classed as "water stress", it is often forgotten that the quantities of water abstracted for power plant cooling are generally returned to surface waters with only minimal evaporation losses, and therefore remain available for use. Excluding cooling water, less than 10 % of the potential water supply is used in Germany. The bulk of water use is attributable to the cooling of thermal power plants which supply energy to the pub-

5 See Water Resources Management in Germany – Part 2.

6 <http://www.worldwatercouncil.org/index.php?id=25>
Other sources define water scarcity as an annual water supply of less than 1,700 m³ (around 4,600 litres) per person, and water stress as less than 1,000 m³ (around 2,700 litres) – cf. <http://www.un.org/waterforlifedecade/scarcity.shtml>

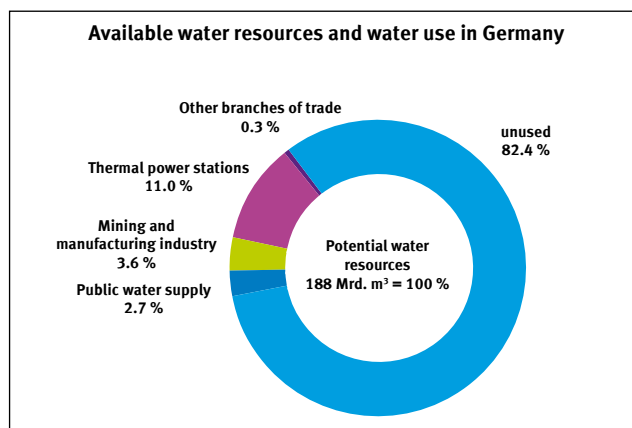
Figure 4: Yield of groundwater resources in Germany



Source: Federal Institute for Geosciences and Natural Resources

lic grid, using around 20.7 billion m³ – equivalent to 11 % of the total water supply. The public water supply which supplies households and small businesses with drinking water only uses less than 3 % of the available water supply, or 5 billion m³. As such, Germany is under no real threat from water stress.

Figure 5: Available water resources and water use in Germany, 2010



Source: Federal Environment Agency (UBA) according to data supplied by the Federal Statistical Office (2013) and the Federal Institute of Hydrology (BfG) (2013)

The available water resources per capita are an initial indicator of whether the available water volume is adequate for the purposes of water supply. Germany has around 2,292 m³ of usable water available per person, per annum for its 82 million or so inhabitants, corresponding to a potential water volume of 6,279 litres per person, per day. However, there are regional and seasonal variations in the distribution of available water resources. For example, Brandenburg, with a renewable water supply of just 3.7 bn m³ per annum [i] (1,484 m³/inh.*a) has significantly less water than Baden-Wuerttemberg, with an available water supply of 49 bn. m³ per annum (4,522 m³/inh.*a).

The differences in the distribution of water resources in Germany are also reflected in other hydrological variables. Precipitation, evaporation and groundwater recharge also vary from region to region. In the period 1961–1990, the average annual precipitation rates in Germany ranged from around 400 mm in the wind-protected area of the Harz mountains to 3,200 mm in the Alps. Values are typically around 500 mm in the east of Germany and 800 mm in the north-west of Germany.

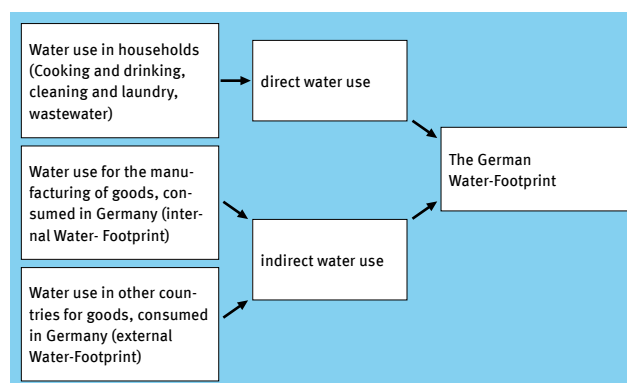
A look at other regions of the world indicates that adequate water supplies for industrial purposes and for the personal sphere are far from self-evident. Usable water resources are extremely unevenly distributed throughout the world, leading to water shortages or deficiencies primarily in arid regions. Some countries of North Africa and the Near East are water-deficient,

with between zero and a maximum of 500 m³ of water available per person, per year. By contrast, countries such as Canada have an annual a supply of more than 100,000 m³ per person. The total water supply on earth is estimated at 1.4 bn km³, but 97.5% of this is salty or brackish water. Only 2.5 % of the world’s water volume is freshwater. In turn, less than 1 % of this amount is directly usable, and the bulk of freshwater supplies are bound by ice and glaciers.

Water footprint

Unlike figures indicating direct water consumption, the term water footprint also includes indirect water use concealed in products, also known as virtual water. The term water footprint refers to the total volume of water used by a country, company or consumer. The characterising feature of this concept is that it combines quantitative data on the volume of water consumed, evaporated and contaminated in a product’s manufacture with information on the region that consumes and produces such products.

Figure 6: Diagrammatic representation of the fundamental principles involved in calculating water footprint



Source: Sonneberg et al. (2009)

In this connection, it is helpful to break down water use into different categories to facilitate subsequent evaluation of the water footprint. “Green water” is the naturally occurring groundwater and rainwater that is absorbed and evaporated by plants. Green water is relevant for agricultural products. “Blue water” is the groundwater or surface water used in the manufacture of a product which is not returned to a body of water. In the case of agricultural production, this is the water absorbed and evaporated by plants that is supplied by irrigation. Numerous calculations are available to determine the demand for green and blue water in the agricultural sector, but the consideration of grey water demand is less common. “Grey water” refers to the volume of water that is contaminated during the manufacturing process.

Grey water is produced by both industrial and agricultural production. In the case of the latter, pollutants

enter the soil and waterbodies due to the use of fertilisers and pesticides. While various process optimisation measures in industrial production and in agriculture have reduced the volume of water used, these do not necessarily translate into a reduced discharge of pollutants into waterbodies. In order to reduce the “grey” water footprint, pollutant discharges into waterbodies must also be reduced, as well as reducing the volume of fresh water used.

Germany’s water footprint

Germany’s total water footprint is approximately 117 billion m³ per annum⁷, of which just 5 km³ per annum is attributable to the public water supply. This volume of water equates to approximately two-and-a-half times the volume of Lake Constance, and corresponds to 3,900 litres per inhabitant (1,426 m³ per annum). By way of comparison, the global average is 1,385 m³ per person, per annum. 68.8 % of the water used in the products and goods we consume originates from outside of Germany – the volume of water needed for imported goods is known as our external water footprint.

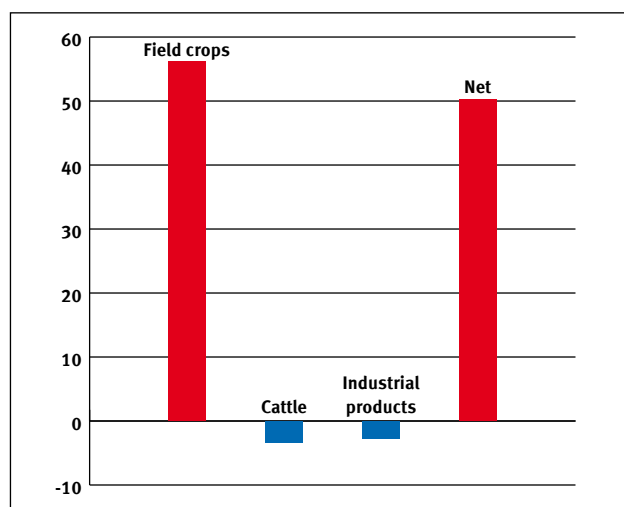
A comparison of indirect water use in the merchandise traded by Germany (both imports and exports) illustrates the dominance of water demand for agricultural produce. Whereas the indirect water use in exports of industrial and animal products is only slightly higher than that of imports, the proportion of indirect water use in imported plant products is far greater (cf. Figure 7).

The concept of the water footprint – An instrument for evaluating water consumption?

The water footprint is an indicator for the use of water resources. In this concept, the green and blue water footprints refer to quantitative aspects, while the grey water footprint is an indicator of water quality. The water footprint does not allow any farther-reaching projections to be made, such as public access to safe drinking water. Furthermore, it is confined to fresh water, and disregards use of the oceans.

⁷ Mekonnen, M.M. and Hoekstra, A.Y. (2011): National water footprint accounts: the green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No. 50, UNESCO-IHE, Delft, the Netherlands.

Figure 7: Germany’s virtual water consumption in relation to the international trade in crop plants, livestock and industrial goods (1996–2005)



Data source: Mekkonen, Hoekstra, 2011

In the interests of global responsibility, it is important to identify areas with water scarcity and evaluate excessive water consumption. The concept of the water footprint is intended to shed light on the concealed trade in water at the expense of countries with limited water resources. However, it is not a matter of reducing the volume of water used in general, but rather of devising options for regions where the overuse of water due to the export of virtual water has adverse ecological and social impacts, and of promoting the sustainable use of renewable water resources.

In the past, communication of the water footprint to the general public has generally been limited to elucidating the dimension of water use associated with everyday products. However, local water availability is decisive for an assessment of direct and indirect water use. A large water footprint in regions abounding in water is less problematic than a smaller water footprint in arid or semi-arid regions. However, awareness of a large (excessive?) water footprint must be followed by action. One option is to selectively modify consumption behaviour. However, consumers must have access to adequate product information in order to refrain from buying products with major human and environ-

Table 2: Definition and examples of the three categories green, blue and grey water

Water type	Definition
green	Volume of rainwater that is stored in the soil and is absorbed by plants and evaporated during the course of the growth process.
blue	Volume of groundwater or water from rivers and lakes used in the manufacture of a product. With agricultural crop production, this refers to the volume of additional irrigation used.
grey	Volume of water that is contaminated during the manufacturing process or that would be needed to dilute contaminated water to such an extent that it complies with valid quality standards.

mental consequences at the point of production due to their high level of water consumption.

2.3 Effects of climate change

It is an undisputed fact that our global climate has begun to change as a result of rising global emissions of greenhouse gases, leading *inter alia* to rising temperatures and altered rainfall patterns. This in turn impacts the water regime, e.g. in the form of increased flooding. To this end, independently of the global efforts to reduce greenhouse gas emissions, adaptation strategies are currently being developed in response to the modified climatic conditions for water resources management.

Global climate change

There are many signs of climate change evident around the world⁸. Since the end of the 19th century, the average annual temperature worldwide has increased by 0.85 °C. Scientists anticipate a further global temperature increase of between 1.5 °C and 4.5 °C compared with pre-industrial levels by the end of the current century, depending on the emissions scenario used.

In continental Europe, the temperature increase is particularly high and exceeds the global average. Here, the average annual temperature has increased by 1.3 °C compared with pre-industrial levels. Projections for Europe predict a further temperature increase of between 2.5 and 4.0 °C by the end of the current century (2071–2100) versus the period 1961 to 1990⁹. This temperature increase is likely to be at its most pronounced in Eastern and Northern Europe in winter, and in the Mediterranean in summer.

Long-term observations of global precipitation indicate a significant increase in northern Europe over the period 1905 to 2005. In the Mediterranean, on the other hand, dry periods have become more pronounced, and there has been a decrease in precipitation. In future, scientists anticipate further changes in precipitation. The trend for rising precipitation levels in northern Europe by between 10 and 20 % by the end of the century versus 1961–1990, and decreasing rainfall in southern Europe by between 5 and 20 %, looks set to continue. Summer precipitation is projected to decrease over southern, central and north-west Europe, by as much as 60 % in the case of southern Europe. According to the models, only north-east Europe is

expected to experience constant or rising summer precipitation. An increase in extreme precipitation is also possible.

Rising global temperatures are causing the glaciers and ice shields to melt, leading to the thermal expansion of sea levels. This has already led to a 19 cm rise in sea levels (between 17 and 21 cm) in the period 1901–2010. Furthermore, there are indications that sea levels have risen more rapidly over the past 20 years, at 3.2 mm per annum, than in the period 1961 to 2003 (1.8 mm/a). Predictions of future sea level development are uncertain and depend on feedback mechanisms that have not yet been fully researched. Depending on the emission scenario used, the models project a further rise in sea levels of between 26 cm and 55 cm (lowest emission scenario) or between 45 cm and 82 cm (highest emissions scenario) by the end of the century. If the Greenland ice shield were to melt, scientists fear that in the longer term, sea levels could rise by up to 7 m.

Rising average water temperatures of the oceans is another direct consequence of the global temperature change. In the top 75 metres, the temperature rose by an average of 0.11 °C between 1971 and 2010. Temperature increases have also been recorded at ocean depths of below 3,000 m. The oceans have absorbed approximately one-third of anthropogenic CO₂ emissions, leading to acidification of the marine environment.

Climate change in Germany

Climate change is happening right now. Studies indicate that average annual temperatures in Germany increased by 1.2 °C between 1881 and 2012. In order to be able to make reliable statements on future climate change in Germany, regionalisation models are used to translate large-scale information from the global climate models onto a regional scale. Temperatures will continue to rise, depending on the development of greenhouse gas emissions in years to come. Based on various emission scenarios, the climate models suggest an increase in average annual temperatures in Germany within the range 2.0 °C to 4.5 °C by the end of this century, compared with the period 1961 to 1990.

The precipitation situation in Germany varies according to region. In the west, an average rainfall of 650 mm to 1,500 mm is common, while in the east – except in the Central German Highlands (*Mittelgebirge*) – the average is just 450 mm to 650 mm. These differences will be exacerbated due to the regional impacts of climate change. For example, the average annual rainfall in Germany has increased by around 9 % since the start of the 20th century. This increase is predominantly confined to the west of Germany. In eastern regions, the approximately 20 % increase in winter rainfall has been largely cancelled out by decreased rainfall during the summer months. Climate

8 On this topic, cf.: IPCC (2013): Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

9 EEA (European Environment Agency) (2012): Climate change, impacts and vulnerability in Europe 2012. An indicator-based report. Copenhagen (EEA Report, No 12/2012).

modelling for Germany suggests that this development will continue. Overall, rainfall is expected to decrease during the summer months, with projections ranging from minus 25 % to plus 5 %. In all probability, we can expect heavy rainfall in summer as a proportion of total precipitation to increase. During the winter months, most regions in Germany can expect an increase of around minus 4 % to plus 25 %, with northern Germany expected to experience the sharpest increase. For the extreme south, by contrast, there will be no significant changes, or even a slight decrease. In future, heavy rainfall will also become more common during winter.

As well as a shift in precipitation from summer to winter, scientists expect more rain but less snow to fall. It is highly probable that in future, dry periods will be more pronounced in terms of both duration and intensity. The number of frosty days will decrease. Particularly in winter, heavy precipitation will become more frequent and more intensive. Generally speaking, we need to prepare for warmer, damper winters and hotter, drier summers in future.

Consequences of climate change in Germany

Germany has a humid climate, which means that over the course of a year, more precipitation falls than is able to evaporate. Generally speaking, Germany has sufficient water reserves. However, in view of the wide variations in precipitation and the geological and natural conditions between regions, the distribution of these water reserves varies considerably, and the consequences of climate change will therefore vary according to region as well.

As well as population density, other pivotal factors in a region's water demand include demographic structure and development, together with land use and changing climatic conditions. In order to calculate the consequences of climate change for waterbodies,

the results of regional climate modelling, particularly precipitation, are fed into water balance models which allow forecasting of future scenarios e.g. with regard to floodwater discharge, the potential extent of flooding, average discharge, low water discharge, and groundwater recharge¹⁰.

Altered volumes of precipitation, also in the form of snow in the mountains, coupled with changes in the distribution of precipitation, affect discharge and water levels in rivers with a characteristic alpine discharge regime, such as the Rhine, Danube and Iller. If less snow is retained in the mountains during winter months due to higher winter temperatures, this will make it harder to compensate for low water discharge in summer. A reduced accumulation of snow in the mountains will reduce the peak of spring melts, which often lead to flooding. The spring melts will occur earlier in the year due to higher temperatures, leading to a shift in peak discharge levels. However, if increased discharge occurs in winter because less precipitation is stored as snow, with winter precipitation falling as rain due to higher temperatures, these two factors may combine to increase the threat of flooding.

Flooding caused by runoff over frozen soils and ice blockages (e.g. River Elbe) is expected to become less frequent due to the higher temperatures in winter.

Flooding associated with lengthy and intensive precipitation and local flooding due to heavy rainfall are likely to increase. Changes in flooding and low water level situations as a result of the modified rainfall conditions will depend on the conditions in each individual river basin area, and must therefore be examined on a case-by-case basis.

¹⁰ On this topic, cf.: BBK (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe), THW (Bundesanstalt Technisches Hilfswerk), DWD (Deutscher Wetterdienst), UBA (Umweltbundesamt) (2012): Auswertung regionaler Klimaprojektionen hinsichtlich der Änderung des Extremverhaltens von Temperatur, Niederschlag und Windgeschwindigkeit. – Bonn, Offenbach, Dessau.

Figure 8: Receding glaciers (Morteratsch/Switzerland) – a comparison between 1911 and 2001



Photographs: Gesellschaft für ökologische Forschung/Sylvia Hamberger

In-depth studies are being carried out in the Länder to investigate the regional impacts of climate change on the water regime. For example, the results of these studies indicate an increased frequency of minor flooding in the winter months in the southern river basins of Baden-Wuerttemberg and parts of Bavaria since the 1970s. Initial studies into future changes in flooding probability suggest that average flood runoff is likely to increase by approximately 40–50 % for the catchment area of the Neckar by 2050. Flood runoff with a probability of occurring once in 100 years will increase by approximately 15 %. Recent results for the Rhine suggest a 10 to 25 % decrease in average runoff in summer by the end of this century, depending on the level, whilst average winter runoff could increase by 5 to 25 % compared with the period 1961–1990. Additionally, projections for the end of the 21st century indicate an increase in low water situations in summer and an increase in winter flooding in particular from around the level of Cologne.

Warming of the lower layers of the atmosphere will lead to an increase in water and soil temperatures. Particularly in low water situations, this will lead to changes in the chemical and biological status of waters, with corresponding impacts on the fauna and flora that inhabit them. One adverse impact could be the reduced solubility of oxygen in waterbodies at higher temperatures, which could prove harmful to fauna. Longer-term increases in the water temperature may also lead to shifts in the species spectrum. Furthermore, evaporation will increase as a result of increased air temperatures. With reduced rainfall, particularly in the summer months, this could impair wetlands or cause them to dry out. Low water levels in rivers reduce the amount of retreat space available for creatures, causing stress to the aquatic biota and possible damage to the aquatic ecosystem as a whole. As well as the direct effects of water temperature on organisms, changes in the ice coverage and the mixing regime are particularly important for lakes, since these processes are responsible for the distribution of oxygen, nutrients and light intensity in stagnant waters.

As well as impacting precipitation, surface runoff, flow, water levels in waterbodies and water quality, climate change will also have consequences for groundwater. In areas with highly permeable subsoils, groundwater recharge will increase as a result of higher winter precipitation, possibly leading to an increased supply of groundwater, despite lower summer rainfall and greater potential evaporation. On the other hand, in certain regions of Germany, groundwater recharge may decline. Studies in small river basins, for example in Saxony and Saxony-Anhalt, expect a decrease in groundwater recharge until 2050.

Adaptation measures

The debate about suitable measures for adapting to climate change is still raging, both nationally and internationally. The prevailing scientific uncertainties concerning the extent and timing of climate change and its specific local impacts make it difficult to assess the effectiveness of such measures. Nevertheless, the majority of scientists agree that steps need to be taken now in order to adapt to climate change. This is particularly important if different regionalisation models produce similar projections on the direction and range of such changes, such as the extent to which precipitation in a given region will increase or decrease. In view of the existing uncertainties, the following fundamental requirements should also be taken into account with regard to adaptation measures:

- ▶ They should be flexible. It must be possible to supplement or readjust a measure.
- ▶ They should be robust. If climate change does not have the anticipated impacts, the measure should take effect nevertheless.
- ▶ They should be effective. The chosen measure must be capable of stemming the adverse impacts of climate change as directly and effectively as possible.
- ▶ In a best case scenario, they should be designed to address several objectives, such as water resources management and nature conservation.

These general considerations on how to deal with uncertainties are part of the German Strategy for Adaptation to Climate Change, adopted by the German Government in December 2008. This strategy outlines the German Government's contribution, creates a framework for national adaptation to climate change, and offers guidance to other players. The overarching objective of this adaptation strategy is to reduce Germany's vulnerability to the consequences of climate change. To this end, the German Strategy for Adaptation to Climate Change lists 14 priority action areas, including water resources management. Civil protection/disaster control, as well as land use planning, regional planning and urban land use planning, are named as cross-sectional areas. The Action Plan for Adaptation was adopted by the Federal Cabinet on 31 August 2011. This supplements Germany's adaptation strategy for climate change with specific activities, primarily by the Federal Government, with a view to ensuring that all action areas covered by the strategy are adapted in line with the consequences of climate change. A progress report on Germany's adaptation strategy is due to be published in 2015, and will report on Germany's achievements since 2008. Part of the progress report will include updating the action plan.

Examples of adaptation measures in water resources management

Drinking water supply

Some areas are already unable to guarantee drinking water supplies entirely from their own resources due to quality problems. They supplement their supplies with water from reservoirs (e.g. Saxony, Thuringia) and long-distance pipelines. However, because the rate of groundwater recharge has tended to exceed the quantity abstracted to date, Germany is unlikely to face any fundamental problems with regard to drinking water supplies, even under altered climatic conditions. Nevertheless, the possibility of regional shortfalls cannot be excluded, particularly during longer periods of drought.

Measures which help to improve the landscape water balance are the most suitable means of supporting groundwater recharge, groundwater being the most important drinking water resource in Germany. Reduced levels of land sealing and the decentralised infiltration of rainwater are two areas particularly worth highlighting.

Flood risk management

Early adaptation measures are needed in order to limit the damage caused by flooding, also with a view to climate change. The measures already adopted and the strategies developed at both national and international level to improve flood risk management, such as the provisions of the updated Federal Water Act and the EU-Flood Risk Management Directive, must be implemented without delay at river basin level. This legisla-

tion already makes allowance for the potential impacts of climate change when assessing the flood risk, based on regular reviews of the planning foundations. In future, special technical flood control measures, such as dykes, should consider the impacts of climate change, e.g. by incorporating a climate factor. Initial examples of the application of climate factors and climate surcharges exist in Bavaria and Baden-Wuerttemberg for river dykes, and in Schleswig-Holstein for storm flood dykes. However, as well as technical adaptation, more widespread social debate is needed in order to ascertain which flood risks may be tolerated. This debate should be based on a map depicting the flood dangers and risks for various flood scenarios. In conjunction with cost/benefit considerations, it may be possible to agree on differentiated levels of protection and explore further options for a flood risk management policy that has been adapted to climate change (cf. **chapter 6.7.1** on flood risk management).

Dealing with low water levels

In future, conflicts of use may occur more frequently in the handling of low water situations as a result of climate change. Watercourses are used for a wide range of purposes, such as shipping, hydropower and the supply of cooling water. In order to limit the adverse impacts on waterbodies and the aquatic biota, e.g. as a result of rising water temperatures, it may become necessary to impose usage restrictions. Overall, an improvement in the morphological structures of waterbodies to strengthen their capacity for self-purification, coupled with an improvement in wastewater treatment, will help to minimise their vulnerability to low water levels (cf. **chapter 6.7.10** on cooling water use).

3 Structures and cooperation in water resources management

3.1 International cooperation

Germany cooperates with other countries in numerous international organisations to protect waterbodies. Many environmental problems, such as the greenhouse effect with its impacts on the global climate (and hence on the water balance), climate adaptation measures and the issues associated with protecting coastal waters, marginal seas and oceans can only be solved through global cooperation. Consequently, Germany is a Contracting Party to numerous international and regional environmental protection conventions, including the UNECE Water Convention and its Protocol on Water and Health, the UN Convention on the Law of the Non-Navigational Uses of International Watercourses, the various Conventions for the protection of the marine environment (London Convention, MARPOL, OSPAR and Helsinki Conventions; cf. **chapter 5.2.3**) and the river basin commissions and coordination committees for the transboundary river catchment areas of the Danube, Elbe, Oder, Rhine, Maas and Ems (IKSD, IKSE, IKSO, IKSR, IMK, cf. **chapter 5.3**).

3.1.1 Cooperation at UN level

Germany is a Contracting Party to several water conventions at UN level and is actively involved in their implementation.

The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention) was adopted on 17 March 1992. The Federal Republic of Germany is one of the 26 signatories to the Convention, which it ratified in 1995¹¹. The Convention has been in force since 6 October 1996. At the present time (as of 20 January 2014), 39 countries have signed up to the Convention.

The UNECE is the United Nations Economic Commission for Europe, one of 5 regional commissions in the United Nations. It has 56 members from the pan-European, North American and Western Asia regions.

The UNECE Water Convention focuses on integrated water resources management in the UNECE region, particularly the protection of transboundary waters, via the avoidance, control and reduction of transboundary pressures. It is also aimed at the appropriate, balanced use of water resources and the conservation and restoration of ecosystems. It contains general provisions on waterbody management, such as the

reduction of pollutant discharges, monitoring and collaborative research. It also regulates specific requirements for countries that share waterbodies or river basin districts, such as an obligation to set up coordination committees, to warn one another in case of incidents, to notify one another of any planned projects that could potentially impact waterbodies, and so on. Several river basin commissions in Europe are based on the principles of this Convention, including the Conventions on the Protection of the Rhine and the Danube.

Since its entry into force, the UNECE Water Convention has evolved into an active mechanism for the transboundary management of waterbodies, which is widely recognised in the UNECE region and beyond. It provides a platform for the exchange of experience and knowledge. Its effective, active work structure has led to the formulation of guidelines on a number of topics, including adaptation to climate change, waterbody monitoring, and ecosystem services. Numerous transboundary projects, workshops, seminars and capacity-building measures take place within the framework of the Convention. Interest in the Convention's work continues to grow among non-UNECE countries as well, particularly against the backdrop of current threats to the quantity and quality of water resources, for example due to the impacts of climate change.

Thanks to its wide-ranging experience in 6 international River Basin Commissions and in implementing the EU Water Framework Directive¹², which was also partly based on the Convention, Germany can contribute to the Convention's work in a variety of ways and utilise synergies.

Prompted by growing interest in the Water Convention and the need to involve third-party countries that share river basin districts with UNECE countries, the Convention is to be opened up to governments outside of the UNECE region. A corresponding amendment to the 2003 Water Convention entered into force in February 2013, and was ratified by Germany¹³. All countries that were Parties to the Convention in 2003 must ratify these amendments in order for them to be implemented in practice. This is expected to occur during the course of 2014.

As a supplement to the UNECE Water Convention, the Protocol on Water and Health aims to improve the protection of public health from water-related diseases. Water-related diseases may be caused, for example, by inadequate drinking water supply or wastewater disposal, poor water resources management or inadequate quality of bathing waters and swimming pool

11 Act on the Convention of 17 March 1992 on the Protection and Use of Transboundary Watercourses and International Lakes (Act on the Convention on the Protection of Transboundary Watercourses) of 2 September 1994, Federal Law Gazette (BGBl.) II, p. 2333.

12 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ No. L 327, p. 1 ff.

13 Act amending the Convention of 17 March 1992 on the protection and use of transboundary watercourses and international lakes of 12 July 2012 (Federal Law Gazette (BGBl.) II, p. 666)

waters, or the unprofessional use of sewage sludge in agriculture.

The Protocol on Water and Health entered into force in 2005. Germany has been a Party to the Protocol¹⁴ since April 2007, and is currently (as at 20 January 2014) one of 26 countries from the UNECE region.

Within two years of becoming a signatory to the Protocol, the Parties are required to define specific targets and objectives, tailored to their national conditions, for preventing, tackling and reducing water-related diseases in future. Article 6, paragraph (3) of the Protocol states that every country must establish and publish the objectives and target dates for the achievement of them.

In Germany, the lead agency responsible for implementing the Protocol is the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), supported by the Federal Ministry for Health (BMG). Because Germany has already achieved high standards of drinking water supply and wastewater disposal and has implemented the relevant EU Directives, national implementation of the Protocol will concentrate primarily on individual, supplementary objectives.

Under its current work programme for the Protocol, covering the period 2014–2016, Germany collaborates closely with the NGO “Women in Europe for a Common Future” (WECF e. V.), and is heading up the work area “Small drinking water supplies and decentralised wastewater disposal”. The aim of this activity is to improve water supply and wastewater disposal in rural regions, for example by preparing a guidance document for political decision-makers and carrying out consulting projects.

Germany is also a Party to the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses¹⁵, adopted on 21 May 1997. This Convention is not yet in force, because two Parties are still needed to meet the required number of 35 (as at 20 January 2014).

The Convention aims to improve collaboration and consideration between littoral states, and particularly to avoid and peacefully resolve intergovernmental conflict over limited freshwater resources. The Con-

vention obligates the Parties to use water fairly and sensibly, and to avoid significant damage for other littoral states. The Convention codifies previously unwritten regulations on neighbourly conduct in the use of transboundary inland waters. It is designed as a framework convention and therefore does not contain detailed regulations, but instead obligates the Parties to observe certain principles.

As soon as this Convention is in force, it will become necessary to consider how its implementation may be expediently interlinked with work under the UNECE Water Convention. Several countries, like Germany, are Parties to both Conventions, which are fully compatible with one another and whose content is mutually complementary.

3.1.2 Cooperation between the European Union and its Member States

To an increasing extent, the European Union (EU) is responsible for deciding individual issues relating to environmental protection and hence also to water resources management (for details of individual mechanisms, see **chapters 4.1** and **5.1**). Cooperation between the Member States of the European Union in the field of water protection is extremely important, because water protection is by definition a transboundary challenge, and differences in environmental standards make it difficult to enforce a single European market.

As a Member State of the EU, Germany is both involved in the drafting of EU legislation (especially Directives and Regulations) and bound by it. Generally speaking, it is the responsibility of the Member States to actually enforce EU legislation in practice, as the institutions of the EU do not possess any enforcement powers of their own. While the Federal Government is responsible for implementing EU law externally in relation to the EU, internally the Länder are responsible for its enforcement, and extensive coordination and presentation work is therefore required.

EU Directives do not become valid law until they have been transposed into national law. In so-called “breach of treaty” cases, which can ultimately lead to the imposition of fines by the European Court of Justice, the EU Commission can compel Member States to implement EU legislation. As EU regulations are often not comprehensive, Member States are at liberty to adopt their own regulations. Furthermore, the Member States generally have the option of exceeding the EU regulations and enforcing more stringent environmental protection requirements.

14 Act on the Protocol of 17 June 1999 on Water and Health to the Convention of 1992 on the Protection and Use of Transboundary Watercourses and International Lakes of 16 August 2006 (Federal Law Gazette (BGBl.) II, p. 763 ff.).

15 Act on the Convention on the Law of the Non-Navigational Uses of International Watercourses of 16 August 2006, Federal Law Gazette (BGBl.) II, p. 742.

3.1.3 Cooperation with Central and Eastern European countries and with EECCA countries¹⁶

Water resources management and water protection are key priorities in the Federal Republic of Germany's international cooperation with the countries of Central and Eastern Europe, the Caucasus and Central Asia. This includes sharing knowledge and experience, exchanging technology recommendations, and preparing environmental investments in a variety of bilateral and multilateral contexts. Apart from international conventions and their protocols (cf. **chapter 3.1**), this cooperation is also based on EU Regulations and Directives, as well as bilateral government and divisional agreements with selected countries in these regions. Germany is also actively involved in the EU water initiative "EUWI – Water for Life", under the regional component for EECCA countries.¹⁷

Germany's international cooperation on water resources management-related issues takes the form of political dialogues, administrative partnerships, and various forms of project cooperation. Alongside various EU instruments (Twinning¹⁸, Taixex), the BMUB also uses its Advisory Assistance Programme¹⁹. The partners and implementing organisations of project cooperation include government authorities, non-governmental organisations, companies and associations of the German water industry, such as the German Water Partnership initiative (see **chapter 3.1.4**), environmental organisations and international organisations such as UNECE, OECD and WHO.

Support with the implementation of EU law in the new EU Member States and in accession candidate countries of Central and Eastern Europe

Croatia was the eleventh Central and Eastern European country to accede to the EU in 2013. Six other countries in the Western Balkans have a prospect of accession. Even though the new Member States will have essentially adopted the *acquis communautaire* relating to water resources management and established the necessary institutions for its implementation at the time of accession, many of them have been granted transitional periods within which to implement EU law. This recognises the fact that further structural adaptations and major investments will be needed in order to meet the EU's environmental objectives in these countries. The restructuring of the water resources management infrastructure remains a particular challenge.

Germany supports countries during the accession phase primarily by helping them to build the requisite administrative infrastructure, transpose the relevant EU law on water resources management into national law, and make vital structural decisions on their water resources management infrastructures. After accession, the focus of cooperation tends to shift towards effective and efficient enforcement.

Through its commitment, Germany aims to ensure effective, efficient EU-wide implementation of environmental standards in the field of water resources management, and to motivate the countries concerned to improve them.

Transfer of European environmental standards into EECCA countries²⁰

Germany supports water protection and the development of the water treatment industry in EECCA countries with a view to establishing the EU's environmental standards in water resources management beyond EU borders. This includes reducing transboundary waterbody pollution, for example in the Baltic Sea and ameliorating competitive distortions associated with the varying stringency of environmental requirements.

To date, cooperation has focused primarily on transferring the environmental policy concepts of the WFD, such as river basin management and water protection areas in the region, and demonstrating exemplary techniques for water supply and disposal.

¹⁶ Eastern Europe, the Caucasus and Central Asia (the successor states to the Soviet Union excluding the three Baltic states).

¹⁷ EUWI is an international initiative by governments, financial institutions, companies in the water sector and NGOs for achieving the millennium goals relating to water.

¹⁸ An overview of administrative partnerships within the context of twinning may be found at: www.bmub.bund.de/P840-1/

¹⁹ Information on the Advisory Assistance Programme and its projects may be found at: www.uba.de/en/advisory-assistance-programme

²⁰ See: <http://www.bmu.de/themen/europa-international/europa-und-umwelt/twinning-instrument/> – liste; <http://www.umweltbundesamt.de/ius/database.php>

3.1.4 German Water Partnership

The water sector is a global future market. There is a huge demand for investment in proper water supply and wastewater disposal in Eastern Europe, in the newly industrialising countries of Asia and Central and South America, and last but not least, in developing countries. Moreover, the global demand for innovative solutions for the efficient use of scarce water resources, for example in industry and agriculture, is escalating. This is not merely a matter of modified and innovative technology. Cooperation in solving water resource management challenges is also a top priority of Germany's development work.

The German water industry can offer wide-ranging expertise and technological solutions. For years, the German water industry and the political debate surrounding the modernisation of the German water industry have largely agreed on the need to improve the German water industry's global image, raise its profile, and combine its wide-ranging skills and services more effectively²¹.

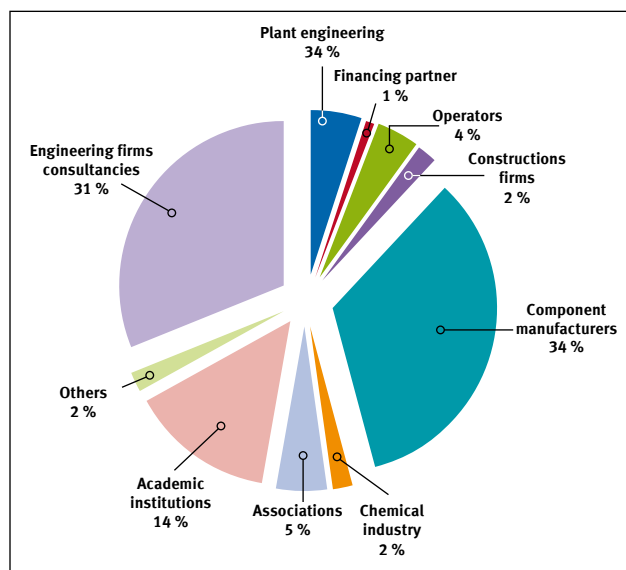
Against this backdrop, in April 2008 a group of dedicated representatives from the German water industry and water research sector, with the support of the Federal Government, set up the German Water Partnership.

German Water Partnership e.V. is a successful, innovative network with around 350 members (as at October 2013), made up of private and public-sector companies in the water sector, specialist organisations, and institutions from academia and research. This innovative platform is supported by its partners, the Federal Ministries for the Environment, Research, Development and Economics and the Foreign Office.

German Water Partnership brings together the activities, information and innovations of the German water sector with a view to strengthening Germany's competitive situation on the international markets and helping to resolve water resources management problems worldwide with an integrated, sustainable approach. Dedicated country forums adapt potential solutions to the specific problems in selected countries and regions.

German Water Partnership is therefore the central point of contact for the German water industry for enquiries from abroad.

Figure 9: Composition of the 332 or so members of German Water Partnership e.V. (as at October 2013)



Source: germanwaterpartnership

3.2 National cooperation

Distribution of tasks between Federal Government and the Länder

According to the German constitution (known as the Basic Law), the Federal Republic of Germany is organised according to federal principles. Government tasks are distributed between the Federal Government and the Länder. The communities (towns, districts and municipalities) are parts of the respective Land, but also have certain discretionary powers (right of self-government) when dealing with local matters, which are protected by the constitution.

A distinction must be made between legislative powers, the competence to enforce regulations, and financial responsibility. Expenditure incurred while exercising their duties is borne separately by the Federal Government and the Länder.

Following the Federalism Reform of 2006, the Federal Government now has concurrent legislative competence with regard to the hydrological regime. This means that the Federal Government is authorised to adopt more detailed regulations on water resources management. The Federal Government made use of its competence and subjected the 2009 Federal Water Act to a thorough overhaul; the updated version entered into force on 1 March 2010.²² By contrast, the Länder may only adopt regulations for as long as and insofar as the Federal Government has not completely exhausted its legislative competence in adopting the Federal Water Act, and has left scope for

21 Modernisierungsstrategie für die deutsche Wasserwirtschaft, UBA Texte 37/2013, : www.umweltbundesamt.de/publikationen/modernisierungsstrategie-fuer-deutsche

22 Federal Water Act (WHG) of 31 July 2009 (Federal Law Gazette (BGBl.) I, p. 2585), most recently amended by Article 6 of the Act of 21 January 2013, Federal Law Gazette (BGBl.) I, p. 95).

Figure 10: The Länder of the Federal Republic of Germany



Source: Federal Agency for Cartography and Geodesy

provisions by the Länder, and does not remove this scope during the course of future updates to the Federal Water Act. Furthermore, the Länder may adopt alternative provisions from the provisions of the Federal Water Act, except for regulations on materials and installations.

Enforcement of the provisions relating to water, including the Federal laws, and hence the exercising of executive powers in water resources management, is the responsibility of the Länder. The Federal waterways are the exception to this rule; their maintenance and development vis-à-vis traffic requirements fall under the exclusive control and administration of the Federal Government. The Federal Government is the owner of the Federal waterways, but is required to safeguard the interests of land improvement and water resources management by mutual consent with the Länder. The Federal Government also performs important functions in the fields of research and data collection.

Progressive water protection is reliant on cooperation between the Federal Government and the Länder. For example, monitoring of groundwater and surface water quality is an important task performed by the administrative authorities for water resources management in the Länder. However, the Federal Government is the competent point of contact for the European Union on this matter, with responsibility for reporting etc. For this reason, the Federal authorities collate and aggregate the data from the Länder and then forward it in a uniform format to Brussels (EU Commission) and Copenhagen (European Environment Agency).

Organisation of water resources management within the Federal Government

In Germany, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) addresses fundamental issues relating to water resources management and related transboundary cooperation.

The BMUB is responsible, *inter alia*, for the Federal Water Act, the Wastewater Charges Act, the Detergents and Cleansing Agents Act, the Federal Soil Act and the Federal Nature Conservation Act. The BMUB also follows European Union regulations on water protection and river basin conventions on transboundary waterbodies, as well as marine conservation conventions.

Environmental policy projects, programmes and opinions, particularly legislative initiatives, must be coordinated between the Federal Ministries concerned. The following Federal Ministries are the principal partners of the BMUB; to a certain extent, they also perform independent tasks in the field of water resources management:

- ▶ The Federal Ministry for Food and Agriculture (BMEL) handles and promotes water resource management projects in the rural sector including flow regulation and flood protection measures, as well as coastal protection of the North and Baltic Seas. It is also responsible for legislation relating to water and soil boards and for fertiliser and plant protection legislation.
- ▶ The Federal Ministry of Health (BMG) is responsible for matters of drinking water supply, with a focus on drinking water quality problems as part of a precautionary health policy, and – together with the BMUB – for matters relating to the quality of bathing waters and for pharmaceutical licensing.
- ▶ The Federal Ministry for Transport and Digital Infrastructure (BMVI) is responsible for the administration of Federal waterways and all matters relating to navigation on maritime and inland waterways and the carriage of dangerous goods. Together with the coastal Länder, it is responsible for combating the pollution of coastal waters with oil and other contaminants. It is also in charge of the waterways and shipping administration.
- ▶ The Federal Ministry of Education and Research (BMBF) coordinates the Federal Government's research promotion efforts and controls basic research, applied research, technological development and innovation, including the areas of water research and water technology.
- ▶ The Federal Ministry of Economics and Energy (BMWE) represents economic interests in all environmental policy measures, and is responsible for key legal framework conditions affecting water resources management, such as cartel and contract allocation law. It also accompanies the restructuring of Germany's energy supply in favour of renewables, and supports measures aimed at saving resources.
- ▶ The Federal Ministry for Economic Cooperation and Development (BMZ) is responsible for basic issues and coordination of all bilateral and multi-lateral German development cooperation.

In executing its tasks in the field of water resources management, the BMUB is assisted by the Federal authorities and research institutions:

Subsidiary authorities to the BMUB are as follows:

- ▶ Federal Environment Agency in Dessau-Roßlau (UBA)
- ▶ Federal Nature Conservation Agency in Bonn (BfN)
- ▶ Federal Office for Radiological Protection in Salzgitter (BfS).

Subsidiary authorities to the BMVI are as follows:

- ▶ Federal Institute of Hydrology in Koblenz (BfG)²³
- ▶ Federal Maritime and Hydrographic Agency in Hamburg (BSH)
- ▶ Federal Institute for Hydraulic Engineering in Karlsruhe (BAW)
- ▶ German Weather Service in Offenbach (DWD).

The subsidiary authority to the BMG is:

- ▶ Federal Institute for Pharmaceuticals and Medical Products in Bonn (BfArM).

The subsidiary authorities to the BMEL are:

- ▶ Johann Heinrich von Thünen-Institut (Federal Research Institute for Rural Areas, Forestry and Fisheries) in Braunschweig (TI)
- ▶ Julius Kühn-Institut (Federal Research Institute for Cultivated Plants) in Quedlinburg (JKI),
- ▶ Federal Institute for Risk Assessment in Berlin (BfR).

The subsidiary authorities to the BMWV are:

- ▶ Federal Institute of Geosciences and Raw Materials in Hanover (BGR),
- ▶ Federal Institute for Materials Research and Testing in Berlin (BAM).

The subsidiary authority to the Federal Ministry of the Interior (BMI) is:

- ▶ Federal Institute for Population Protection and Disaster Protection in Bonn (BBK).

Water resources management by the Länder

The enforcement of water resources management regulations is the sole responsibility of the Länder and the municipalities. In most Länder, water resources management follows the three-tier structure of general administration, although the assignment of tasks varies from state to state:

- ▶ **Supreme authority**
Ministry with a water resources department; predominantly ministry for the environment; duties: water management control and superior administrative procedures
- ▶ **Intermediate tier**
District government, offices of the district government presidents, Länder authorities; duties: regional water resources management planning, important procedures under the water acts
- ▶ **Lower tier**
Lower water authorities (districts and towns not belonging to a district) as well as technical authorities (e.g. water resources authorities, environmental protection authorities); duties: procedures under the water acts as well as technical advice, monitoring of waters and water use, especially wastewater discharges.

²³ Also partly assigned to the BMUB.

Table 3: Water resources management by the Länder

Federal Land	Water resources management administration
Baden-Wuerttemberg	<p>Lower tier: Landratsämter (administrative district offices), municipalities</p> <p>Intermediate tier: Regierungspräsidien (RP) (regional councils)</p> <p>Supreme authority: Ministry for Environment and Transport</p>
Bavaria	<p>Lower tier: 71 Landratsämter (administrative district offices) and 25 independent cities; 17 regional water authorities</p> <p>Intermediate tier: 7 governments; Landesamt für Umweltschutz (State Agency for Environmental Protection, LfU)</p> <p>Supreme authority: Bayerisches Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz (Bavarian State Ministry for the Environment, Health and Consumer Protection)</p>
Berlin	<p>Lower and intermediate tier, supreme authority: Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz (Senate Administration for Health, Environment and Consumer Protection)</p>
Brandenburg	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: Landesumweltamt (State Environment Agency)</p> <p>Supreme authority: Ministerium für Umwelt, Gesundheit und Verbraucherschutz (Ministry for the Environment, Health and Consumer Protection)</p>

Bremen	<p>Lower tier: Senator für Umwelt, Bau, Verkehr und Europa (Senator for the Environment, Construction, Transport and Europe), Magistrat der Stadt Bremerhaven (Municipal Authority of the City of Bremerhaven), Hansestadt Bremische Amt Bremerhaven (Bremian Agency for the City of Bremerhaven)</p> <p>Supreme authority: Senator für Umwelt, Bau, Verkehr und Europa (Senator for the Environment, Construction, Transport and Europe)</p>
Hamburg	<p>Supreme authority: Behörde für Stadtentwicklung und Umwelt (Authority for Urban Development and the Environment)</p>
Hesse	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: RP Kassel, Gießen, Darmstadt</p> <p>Supreme authority: Hessisches Ministerium für Umwelt, ländlichen Raum und Verbraucherschutz (Hessian Ministry for the Environment, Rural Regions and Consumer Protection)</p>
Mecklenburg-Western Pomerania	<p>Lower tier: Staatliche Ämter für Umwelt und Natur (State Agencies for the Environment and Nature), Landkreise (rural districts), independent cities</p> <p>Supreme authority: Environment Ministry, Landesamt für Umwelt, Naturschutz und Geology (State Agency for the Environment, Nature Conservation and Geology)</p>
Lower Saxony	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Supreme authority: Niedersächsisches Ministerium für Umwelt und Klimaschutz (Lower Saxony Ministry for the Environment and Climate Protection)</p>
North-Rhine Westphalia	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: Bezirksregierungen (district governments)</p> <p>Supreme authority: Ministerium für Umwelt- und Naturschutz, Landwirtschaft und Verbraucherschutz (Ministry for Environmental and Nature Conservation, Agriculture and Consumer Protection)</p>
Rhineland-Palatinate	<p>Lower tier: Landkreise (rural districts), independent cities, government environment agencies</p> <p>Intermediate tier: Struktur- und Genehmigungsdirektion (Structural and Approval Directorate)</p> <p>Supreme authority: Ministerium für Umwelt und Forsten (Ministry for the Environment and Forestry)</p>
Saarland	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: Bezirksregierungen (district governments)</p> <p>Supreme authority: Ministerium für Umwelt (Ministry for the Environment)</p>
Saxony	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: RP</p> <p>Supreme authority: Staatsministerium für Umwelt und Landwirtschaft (State Ministry for the Environment and Agriculture)</p>
Saxony-Anhalt	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: Landesverwaltungsamt (State Administrative Office)</p> <p>Supreme authority: Ministerium für Landwirtschaft und Umwelt (Ministry for Agriculture and Environment)</p>
Schleswig-Holstein	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: Landesamt für Natur und Umwelt (State Office for Nature and Environment)</p> <p>Supreme authority: Ministerium für Landwirtschaft, Umwelt und ländliche Räume (Ministry for Agriculture, Environment and Rural Areas)</p>
Thuringia	<p>Lower tier: Landkreise (rural districts), independent cities</p> <p>Intermediate tier: RP</p> <p>Supreme authority: Staatsministerium für Umwelt und Landwirtschaft (State Ministry for Environment and Agriculture)</p>

Source: Wedewardt, M. (2010), SenGUV Berlin

Exceptions exist in some smaller Länder which have a two-tier administration with no intermediate tier (e.g. city states).

In addition to water resources authorities or environmental protection authorities, most Länder possess central state entities with various designations (Land authorities for environmental protection, water resources management, water and waste etc.) which are tasked with handling the extensive scientific aspects of water management. These entities perform various functions in the fields of hydrology, monitoring of waterbodies, water resources management planning, offering technical advice in their capacity as official experts, preparing technical guidelines, education and training; these vary from Land to Land. They are subsidiary to the supreme authorities. In some cases the Land authorities are also charged with enforcement functions (e.g. flood warning services, monitoring of waters and dischargers, wastewater charges).

For the purpose of coordinating common problems and handling legislative instruments under the Water Acts, the Federal Government and the supreme Land authorities working in the field of water resources management have organised themselves in the “Working Group of the Federal States on Water Issues (LAWA)”.

Water resources management by the local authorities

By enforcing the environmental legislation of the Federal Government and Länder, and particularly within the context of their constitutionally guaranteed self-administration, the local authorities perform a number of important environmental protection-related tasks. Their decisions help to shape the local environment for residents.

Under the Water Acts of the individual Länder, central water supply and wastewater disposal are traditional responsibilities of the local authorities. In order to meet the costs incurred in this respect, they levy charges on users (contributions and fees). As the owners of small waterbodies, they are responsible for the maintenance thereof.

In order to ensure the autonomous and effective implementation of water supply and wastewater disposal, the communities may have recourse to a variety of operating forms (cf. also **chapters 6.2.1** and **6.4.2**). To some extent, the possible forms of institutional operation are determined by regional law.

- ▶ Publicly owned enterprise: Operated by the community within the context of general community administration
- ▶ Municipal undertaking: Operated by the community as a special asset with separate book-keeping

- ▶ Company in its own right: Enterprise under private law owned by the community.
- ▶ Operator model: Transfer of plant operation to a private contractor, whereby responsibility for the completion of tasks remains with the community.

Town planning is another important task incumbent upon the local authorities. Within the context of town planning, the local authorities can play a pivotal role in flood prevention, for example.

Associations

In Germany, a particular role is played by cooperation between local authorities in associations, in order to ensure the efficient organisation of water supply, wastewater treatment and waterbody maintenance, both from a technical and financial viewpoint, and also with regard to water protection. This cooperation is usually on a voluntary basis and to a certain extent instigated by the Länder. The associations vary in terms of the task assigned to them, their regional coverage and organisational form:

- ▶ Special-purpose organisations as associations under public law
- ▶ Water and soil associations within the meaning of the Water Organisation Act
- ▶ Water associations for river basins in the industrial region of Rhine/Westphalia on the basis of special legislation

Technical/scientific associations

The following technical/scientific associations, which generally represent scientists, associations and politicians (Federal, Länder and/or local authorities), are dedicated to the purposes of water resources management:

- ▶ Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (German Association for Water Resources Management, Wastewater and Waste, DWA)
- ▶ Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (Federation of Engineers for Water Resources Management, Waste Management and Agricultural Engineering, BWK)
- ▶ Deutsche Gesellschaft für Limnologie (German Limnology Association, DGL)
- ▶ Deutsches Institut für Normung (German Institute for Standardisation, DIN), represented by the Fachnormenausschuss Wasserwesen (Water Sector Standards Committee, NAW)
- ▶ Deutscher Verein des Gas- und Wasserfaches (German Association of Gas and Water Experts, DVGW)

- ▶ Wasserchemische Gesellschaft in der Gesellschaft Deutscher Chemiker e.V. (Hydrochemical Engineering Society in the Association of German Chemists, GDCh)
- ▶ Vereinigung Deutscher Gewässerschutz (Association for German Water Protection, VDG).

These technical organisations have prepared a great number of technical guidelines, most of which are recognised and applied as generally accepted technical standards.

Other important organisations in which large numbers of water utilities and wastewater disposal bodies are represented include:

- ▶ Verband kommunaler Unternehmen e.V. (German Association of Local Utilities, VKU)
- ▶ Bundesverband der Energie- und Wasserwirtschaft e. V. (German Association of Energy and Water Industries, BDEW)

General public

Based on the provisions outlined in water legislation and administrative procedures, the general public must be consulted and invited to submit its opinion in written or verbal form on large projects such as waterbody development projects.

Implementation of the WFD requires the competent authorities to encourage the active involvement of the general public in water resources management planning. The general public must also be given the opportunity to voice its opinion at three separate stages during the formulation of management plans. This requires the involvement, firstly, of the organised general public, i.e. all environmental protection organisations as well as all other interest groups (e.g. from industry, agriculture, shipping and tourism), as well as of each and every individual, i.e. the wider public. The Floods Directive and the MSFD contain similar provisions on the involvement of the general public. For water resources management projects requiring an environmental impact assessment, members of the general public affected by the project are additionally consulted within the context of the procedure.

Support for environmental and nature conservation organisations

The BMUB and UBA support environmental and nature conservation organisations with a view to anchoring environmental policy concerns in society. The projects are intended to raise awareness of and encourage commitment to environmental protection and nature conservation. Support concentrates primarily on projects focusing on topical issues, children's and young people's projects with wide-ranging effects, projects designed to promote eco-awareness and nature-friendly conduct, and measures aimed at environmental advice and education. Associations that advance water protection projects are an important target group in this respect.

Since 2002, a total of 27 projects have been supported in the area of water and waterbody conservation. On the German version of the UBA website, users can search for project information according to selected topic areas, key words or organisations under the "Service and contact" tab → sub-section "Project support and project agencies"²⁴. Here are examples of five water and waterbody conservation projects by environmental and nature conservation organisations supported by the BMUB and UBA:

- ▶ Vereinigung Deutscher Gewässerschutz (Association for German Water Protection, VDG): Mobile exhibition "Water is the future" to sensitize the broader public to the issue of water using comprehensive, visual and action-oriented information.
- ▶ Grüne Liga e.V.: Flyers on effective implementation of the WFD
- ▶ Grüne Liga e.V.: Water protection, Floods Directive
- ▶ Marine Stewardship Council (MSC): Sustainable fish consumption in restaurants and in the fish trade.
- ▶ Naturschutzbund Deutschland e.V. (Nature and Biodiversity Conservation Union, NABU): Tackling marine litter

24 Cf.: <http://www.umweltbundesamt.de/projektfoerderungen/index.htm>

4. Statutory mechanisms

4.1 European legislation

EU Water Framework Directive (WFD)²⁵

The WFD entered into force on 22 December 2000²⁶, marking the beginning of a new dimension in European water protection policy. Since then, waterbodies have been managed across national and regional borders, by means of a coordinated approach within the river basin areas.

The central objective of the WFD is to achieve a “good status” of all waterbodies (watercourses, lakes, coastal waters and groundwater) in the Community. Other key points of the Directive include a combined approach to emission and immission-related measures to reduce pollutants, and the obligation to prepare programmes of measures and management plans, both with the participation of the wider public.

The basic concept underlying a “good status” is that surface waters may be impaired or changed by human use, but only insofar as this does not significantly impair the ecological functions of the waterbody and its typical biota. For surface waters, the WFD prescribes the attainment of a good ecological status and a good chemical status.

For groundwater, the aim is to maintain or achieve a good quantitative status and a good chemical status. The requirements governing the good status of groundwater have since been specified in a separate Groundwater Directive²⁷.

The material provisions of the Water Framework Directive are embedded in a comprehensive concept of river basin planning that is based on the natural classification of river basin areas and which therefore extends beyond the boundaries of the Länder and the Member States. Implementing these planning requirements has necessitated closer cooperation between the various administrative bodies and countries. The programmes of measures and management plans for the individual river basins for the first six-year planning cycle were completed by the end of 2009. Under the ambitious timetable formulated by the Directive, the objective of a good status is to be achieved by the end of 2015. The Parties may deviate from this deadline by obtaining an

extension or by setting less stringent objectives, but only under certain circumstances (cf. also **chapter 5.2.2** on the WFD).

Further EU Directives on water protection

The beginnings of an active European environmental policy date back to 1973. Since then, a number of individual directives on water protection have been adopted. The WFD combines these approaches into a coherent overall concept and repeals a number of these Directives. Other Directives also continue to exist alongside the WFD, and additional Directives have been adopted on the basis of the WFD. The most important of these are:

- ▶ The Protection of Waters Directive on dangerous substances discharged into waters²⁸, which obligates Member States to define quality objectives for certain dangerous substances and to draw up programmes for compliance with such objectives; in a number of follow-on directives, emission regulations were adopted for selected substances in two lists in order to flesh out this Directive. The Directive remained in force until the end of 2013²⁹.
- ▶ The Directive on the quality of fresh waters needing protection or improvement in order to support fish life³⁰ regulates the requirements governing the quality of salmonid and cyprinid waters with regard to temperature, oxygen, nutrients, salts etc. The Directive was in force up until the end of 2013. Germany will incorporate this into the currently ongoing revision of the Surface Waters Ordinance.
- ▶ The Directive on environmental quality standards in the field of water policy³¹ defines environmental quality standards (EQS) with EU-wide validity, intended to limit the occurrence of certain chemical substances which pose a significant risk to the environment. This is a daughter directive of the WFD for ascertaining the chemical status of surface waters.
- ▶ The Groundwater Directive³², designed to prevent and alleviate pollution of the groundwater. It concretises the provisions of the WFD regarding the chemical and quantitative status of groundwater.

25 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, OJ No. L 327, p. 1 ff.

26 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU): “Die Wasserrahmenrichtlinie – Neues Fundament für den Gewässerschutz in Europa”, synopsis, Bonifatius, Paderborn, September 2004 and BMU: “Die Wasserrahmenrichtlinie – Neues Fundament für den Gewässerschutz in Europa”, full-length version, Bonifatius, Paderborn, September 2004.

27 Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (OJ No. L 372, p. 19 ff).

28 Directive 2006/11/EC of the European Parliament and of the Council of 4 March 2006 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community, OJ L 64, p. 52 ff (formerly Directive 76/464/EEC).

29 Rescinded since 22 December 2013.

30 Directive 2006/44/EC of the European Parliament and of the Council of 6 September 2006 on the quality of fresh waters needing protection or improvement in order to support fish life (OJ L 264 p. 20) (formerly Directive 78/659/EEC).

31 Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC and 86/280/EEC and amending Directive 2000/60/EC, OJ L 348, p. 84 ff., amended on 12 August 2013, OJ L 226, p. 1, 6.

32 Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration, OJ L 372, p. 19 ff, L 53, p. 30, L 139, p. 40.

- ▶ The Directive concerning urban wastewater treatment³³, which obligates Member States to collect and treat wastewater from households and small businesses, and aims to reduce organic pollution as well as nitrate and phosphorus discharges from these sources.
- ▶ The Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources³⁴, which serves to reduce nitrate inputs from livestock farming (fertilising).
- ▶ The Bathing Waters Directive³⁵, which lays down provisions for the monitoring, assessment and management of bathing water quality and the provision of information on its quality.
- ▶ The Directive on the quality of water intended for human consumption³⁶, which lays down special quality requirements for water for human consumption. The Drinking Water Directive has at least an indirect effect on water protection, since the main concern of drinking water suppliers (water utilities) is to be able to use untreated water that is as natural as possible; strict limits apply, e.g. on the content of pesticides and nitrate in drinking water.
- ▶ The Marine Strategy Framework Directive (MSFD)³⁷ defines the target of achieving or maintaining a good environmental status of the EU's marine waters by 2020. The Member States are required to develop strategies to protect and conserve the marine environment, prevent any degradation thereof, and where necessary, to restore marine ecosystems. Key stages in this process include defining a good environmental status, formulating environmental objectives, and establishing monitoring programmes and packages of measures.
- ▶ The Flood Risk Management Directive³⁸ is aimed at the assessment and management of flood risks in order to minimise the flood-related consequences for man, the environment, business activities and cultural assets. The Directive provides for close coordination with the WFD in order to ensure consistent, comprehensive management of the river basins.
- ▶ The Industrial Emissions Directive³⁹, which for the first time sets out cross-media requirements for selected industrial sectors. The effects on air and water and in the waste sector are weighed against each other and considered in an integral way when licensing the plant (cf. **chapter 5.1.2**).
- ▶ The Habitats (FFH) Directive⁴⁰ is designed to permanently protect and preserve biological diversity in the territory of the European Union by means of a system of protected areas designated on the basis of uniform criteria.
- ▶ The Birds Directive⁴¹ calls for the establishment of protected areas as a key measure for the preservation, restoration or creation of habitats for wild bird species.
- ▶ The Regulation concerning the placing of plant protection products on the market⁴² and the Directive on the sustainable use of pesticides⁴³.
- ▶ The Biocide Regulation on the marketing and use of biocide products⁴⁴.
- ▶ The EIA Directive⁴⁵ provides the basis for environmental impact assessment (EIA) under European Community law. It prescribes the individual process stages of EIA and the project types for which an EIA must be carried out.

In addition to the water protection directives described above, there are various other measures under EU environmental law that are not specifically aimed at protecting the environmental medium “water”, but are nevertheless significant in this connection. Examples include:

33 Council Directive 91/271/EEC of 21 May 1991, OJ L 135, p. 40 ff., most recently amended by Regulation (EC) No. 1137/2008 of the European Parliament and of the Council of 22 October 2008, OJ L 311, p. 1, 14.

34 Council Directive 91/676/EEC of 12 December 1991, OJ L 375, p. 1 ff., most recently amended by Regulation (EC) No. 1137/2008 of the European Parliament and of the Council of 22 October 2008, OJ L 311, p. 1, 15.

35 Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality, OJ L 64, p. 37 ff, most recently amended by Regulation (EC) No. 596/2009 of the European Parliament and of the Council of 18 June 2009, OJ L 188, p. 14, 31.

36 Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, OJ L 330, p. 32 ff, most recently amended by Annex 2.2 to the Adaptation Regulation (EC) 596/2009 of 18 June 2009, OJ L 188, p. 14 (formerly Directive 76/160/EEC).

37 Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy, OJ L 164, p. 19 ff.

38 Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, OJ L 288, p. 24 ff.

39 Directive (2010/75/EU) of the EP and of the Council of 24 November 2010 on industrial emissions (Integrated pollution prevention and control), OJ L 334, p. 17, recast OJ 2012 L 159, p. 25.

40 Directive (92/43/EC) of the Council of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, OJ L 206, p. 7, most recently amended by Article 1 of the Adaptation Directive 2006/105/EC of 20 November 2006, OJ L 363, p. 368.

41 Directive (79/409/EC) of the Council of 2 April 1979 on the conservation of wild bird species, OJ L 103, p. 1, most recently amended by Article 18 of the Adaptation Directive 2009/147/EC of 30 November 2009, OJ 2010 L 20, p. 7.

42 Regulation (EC) No. 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC, OJ L 309, p. 1 ff.

43 Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides, OJ L 309, p. 71 ff.

44 Regulation (EU) No. 528/2012 of 22 May 2012 concerning the making available on the market and use of biocidal products, OJ L 167, p. 1.

45 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment, OJ 2012 L 26, p. 1.

- ▶ The Directive on the assessment of the effects of certain plans and programmes on the environment (SEA)⁴⁶ supplements the environmental impact assessment, which has existed in Germany since the early 1990s. Whereas EIA only affects the licensing of environmentally relevant projects, the strategic environmental assessment (SEA) applies at planning level, since important environmentally-relevant foundations are often laid within the context of upstream plans and programmes.
- ▶ Regarding facilities that handle substances dangerous to water, an important part is also played by the EU Directive on the control of major-accident hazards involving dangerous substances⁴⁷, the Construction Products Directive⁴⁸ and the standardisation procedure under CEN (Comité Européen de Normalisation).

4.2 Federal legislation

Federal Water Act

The Act on the Regulation of Matters Relating to Water (Federal Water Act – WHG)⁴⁹, which entered into force on 1 March 2010, recodified Germany’s water legislation on the basis of the extended legislative powers granted to Federal Government under the Federalism Reform.

The WHG lays down basic provisions relating to water resources management (management of water quantity and quality). It states that waterbodies, as a component of the ecosystem and as a habitat for fauna and flora, must be protected and managed in such a way as to serve the general public interest and, in harmony with this, must benefit the individual, in a manner which refrains from any avoidable impairments to its ecological function (precautionary principle). A high level of protection for the environment as a whole must be ensured (integrated environmental protection).

As a general principle, waterbodies (inland surface waterbodies, coastal waters and groundwater) are subject to Government control. All uses of water (such as the discharge of substances or the abstraction of water) are subject to official authorisation, apart from a

few significant exceptions. This is intended to prevent impairments to the water regime and enforce a precautionary approach to water protection.

Generally speaking, permits are issued at the discretion of the responsible water authority (management discretion). In certain cases, this discretion is restricted to the protection of waterbodies. For example, a permit to discharge wastewater may only be granted provided certain minimum requirements are adhered to. These minimum requirements, which reflect the best available technology and which are differentiated according to industry and trade sectors, are outlined in greater detail in the Federal Government’s Wastewater Ordinance⁵⁰ (for further details, cf. **chapters 6.4.1 and 6.4.4.1**).

More stringent requirements, including bans on discharges, may be imposed by water authorities in individual cases in the light of immission considerations, in order to achieve the aspired water quality or facilitate specific water uses, for example.

Special provisions apply to installations for handling substances that are potentially hazardous to water. Graduated according to the volume and degree of hazard posed by such substances, these are intended to ensure that the installations are constructed and operated in an eco-friendly manner. In future, the Government plans to adopt a uniform nationwide Ordinance on the handling of substances potentially hazardous to water which will specify the requirements placed on such installations and the classification of such substances.

Important regulations in the WHG also include the provisions governing the construction and operation of wastewater treatment plants, water conservation officers, the development of waters and preventive flood mitigation, as well as the designation of water protection areas in the interests of water supply.

The provisions of the WFD were transposed into national law by the 7th amendment of 2002.

As well as the requirements of the WFD, the WHG also uniformly transposes into national law the content of the Marine Strategy Framework Directive and the Flood Risk Management Directive.

46 Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, OJ L 197, p. 30 ff.

47 Council Directive 96/82/EEC of 9 December 1996 on the control of major-accident hazards involving dangerous substances, OJ L 10, p. 13 ff., most recently amended by Regulation (EC) No. 1137/2008 of the European Parliament and of the Council of 22 October 2008, OJ L 311, p. 1, 17. The Directive will be repealed on 1 July 2015 and replaced by Directive 2012/18/EU, OJ L 197, p. 1.

48 Directive (89/106/EC) of the Council of 22 December 1988 on the approximation of laws, regulations- and administrative provisions of the Member States relating to construction products, OJ L 40, p. 12, most recently amended by Article 65 of the Adaptation Directive (EU) 305/2011 of 9 March 2011, OJ L 88, p. 5.

49 BGBl. (Federal Law Gazette) 2009 part I, no. 51, p. 2585 ff.; last amended on 21 January 2013, Federal Law Gazette (BGBl.) I, page 95).

50 Ordinance concerning requirements for the discharging of wastewater into waters (Wastewater Ordinance – AbwV) in the version promulgated on 17 June 2004 (Federal Law Gazette (BGBl.) I, p. 1108); last amended on 31 July 2009 (Federal Legal Gazette I p. 2585).

The Federal Government additionally regulates the comprehensive protection of surface waters and groundwater through statutory ordinances. The Groundwater Ordinance⁵¹ and the Surface Waters Ordinance⁵² transpose specific EU regulations into national law.

Anyone who pollutes a waterbody without authority is liable to prosecution under the Criminal Code (StGB). Civil compensation obligations are regulated in the WHG itself and in the Environmental Liability Act (UmweltHG)⁵³.

Wastewater Charges Act

The Wastewater Charges Act (AbwAG)⁵⁴ regulates the levying of charges for the direct discharge of wastewater into a waterbody. The charge is the first eco-tax to be levied at Federal level as a steering instrument. It

ensures that the polluter-pays principle is applied in practice, since it requires direct dischargers to bear at least some of the costs associated with their use of the environmental medium water. The charge is determined on the basis of the quantity and harmfulness of specific constituents discharged into the water (Annex to Article 3 of the AbwAG).

The Wastewater Charges Act meets the requirements of the WFD, which states that environmental and resource costs must be internalised in order to recover costs. The charge per unit of noxiousness increased several times from DM 12 initially in 1981 to DM 70 (now € 35.79) in 1997, but has not been adjusted since then. The charge is designed to offer an economic incentive to avoid waste water discharges as far as possible. The AbwAG provides for rate reductions if certain minimum requirements are met. In addition, certain types of investment designed to improve wastewater treatment may be offset against the charge.

The wastewater charge is payable to the Länder. The revenue generated must be used for water pollution control measures.

Wastewater Ordinance

Cf. [chapter 6.4.1](#) for further information.

- 51 Ordinance on the Protection of Groundwater (Groundwater Ordinance) of 9 November 2010, Federal Law Gazette (BGBl.) I, p. 1513.
- 52 Ordinance on the Protection of Surface Waters (Surface Waters Ordinance) of 20 July 2010, Federal Law Gazette (BGBl.) I, p. 1429.
- 53 Environmental Liability Act in the version of 20 December 1990 (Federal Law Gazette (BGBl.) I, p. 2634), most recently amended on 23 November 2007, Federal Law Gazette I page 2631.
- 54 Act Pertaining to Charges Levied for Discharging Wastewater into Waters (AbwAG) in the version promulgated on 18 January 2005 (Federal Law Gazette (BGBl.) I, p. 114), amended on 11 August 2010 (Federal Law Gazette (BGBl.) I page 1163).

Table 4: Annex to Article 3 of the AbwAG – Pollutants and units of noxiousness under the Wastewater Charges Act

No.	Evaluated pollutants and groups of pollutants	The following units of measurement correspond to one unit of noxiousness	Threshold values according to concentration and annual quantity
1	Oxidizable substances in Chemical Oxygen Demand (COD)	50 kilograms of oxygen	20 milligrams per litre and 250 kilograms annual quantity
2	Phosphorous	3 kilograms	0.1 milligrams per litre and 15 kilograms annual quantity
3	Nitrogen as the sum total of individual amounts of nitrate nitrogen, nitrite oxygen and ammonia nitrogen	25 kilograms	5 milligrams per litre and 125 kilograms annual quantity
4	Organohalogen compounds as adsorbable organic fixed halogens (AOX)	2 kilograms of halogen, calculated as organic fixed chlorine	100 micrograms per litre and 10 kilograms annual quantity
5	Metals and their compounds		and
5.1	Mercury	20 grams	1 microgram 100 grams
5.2	Cadmium	100 grams	5 microgram 500 grams
5.3	Chromium	500 grams	50 microgram 2.5 kilograms
5.4	Nickel	500 grams	50 microgram 2.5 kilograms
5.5	Lead	500 grams	50 microgram 2.5 kilograms
5.6	Copper	1 000 grams of metal	100 microgram 5 kilograms per litre annual quantity
6	Fish toxicity	6,000 cubic metres wastewater divided by G_{Ei}	$G_{Ei} = 2$

G_{Ei} is the dilution factor at which wastewater is no longer toxic in the fish egg test. The data in this table is based on the procedures for determining the toxicity of wastewater according to the relevant numbers in the Annex "Analysis and measurement techniques" to the Wastewater Ordinance in the version promulgated on 17 June 2004 (Federal Law Gazette I, page 1108, 2625).

Groundwater Ordinance

The new Groundwater Ordinance⁵⁵ (GrwV) was adopted in October 2010. It transposes the EU Groundwater Directive (2006/118/EC) into national law and replaces the old Groundwater Ordinance of 1997. The Ordinance establishes criteria for the characterization, assessment, classification and monitoring of the groundwater status and for the identification and reversal of significant and sustained upward trends in pollutant concentrations in groundwater bodies. Measures must also be taken to prevent the input of pollutants into groundwater. The aim is to achieve or maintain a good quantitative and chemical status as required by the WFD and the Groundwater Daughter Directive, and to reverse significant pollution trends. The definition of a good quantitative status implements the requirements of the WFD – in other words, a good balance between groundwater abstraction and recharge must be ensured. A good chemical status is based on the prescribed European quality standards for nitrate (50 mg/l) and for pesticides (=plant protection products and biocides) (0.1 µg/l for single substances; 0.5 µg/l in total), as well as nationally established threshold values for arsenic (10 µg/l), mercury (0.2 µg/l), ammonium (0.5 µg/l), chloride (250 µg/l), sulphate (240 µg/l) and tri- and tetrachloroethylene (total: 10 µg/l).

Surface Waters Ordinance

The Surface Waters Ordinance⁵⁶ (OGewV) was adopted on 25 July 2011. As well as Annexes II and V to the WFD, it also transposes Directive 2008/105/EC on environmental quality standards in the field of water policy (EQS Directive), Directive 2009/90/EC⁵⁷ laying down technical specifications for chemical analysis and monitoring of water status, and Decision 2008/915⁵⁸ establishing the values of the Member State monitoring system classifications as a result of the intercalibration exercise into national law. The OGewV has nationwide validity and uniformly regulates fundamental aspects of the protection, monitoring and assessment of surface waters. The Ordinance contains provisions governing the categorisation, typification and demarcation of bodies of surface waters in accordance with the requirements of the WFD, and will therefore replace the existing Länder law. Moreover, the OGewV also transposes European legislation on environmental quality standards (EQS), analysis requirements and intercalibration into national law, and provides uniform nationwide guidelines on chemical and ecological status, *inter alia* via the definition of river basin-specific EQS. At present, the OGewV regulates

a total of 162 contaminants in relation to ecological status. Ordinance on the Protection of Surface Waters (Surface Waters Ordinance) of 20 July 2010, Federal Law Gazette (BGBl.) I, p. 1429.

At European level, the EQS Directive was amended on 12 August 2013 by Directive 2013/39/EU. The 33 priority substances previously regulated by the EQS Directive have been joined by 12 new substances, including pesticides and biocides, and the EQS for seven of the existing substances have been tightened up. Also new is the inclusion of pharmaceuticals, not on the list of priority substances, but at least on a “watch list”, aimed at improving the data basis for assessment. The deadline for implementing national regulations in Member States, and hence for revising the OGewV, is 14 September 2015.

Pipeline Ordinance

The Ordinance on Pipeline Installations (Pipeline Ordinance)⁵⁹ sets out requirements for long-distance pipelines, which are designed to protect man and the environment, and in particular waterbodies, from any harmful effects. Long-distance pipelines are those requiring plan approval or planning permission under the Environmental Impact Assessment Act, for example.

Federal Soil Protection Act and Federal Ordinance on Soil Protection and Contaminated Sites

Significant discharges into groundwater are the result of harmful soil changes and residual contamination. The Federal Soil Protection Act⁶⁰ specifies that polluters and their legal successors, land owners, former owners, parties who have renounced ownership and other liable parties under commercial law may be compelled by the authorities to remediate any groundwater damage caused as a result of harmful soil changes or residual contamination. If the test values in the Soil Protection Ordinance⁶¹ are exceeded, the party liable for remediation is generally required to conduct more extensive analyses. If these suspicions are confirmed, he may be required to make reasonable efforts towards remediation. The requirements pertaining to remediation are derived from water legislation.

55 Ordinance on the Protection of Groundwater (Groundwater Ordinance) of 9 November 2010, Federal Law Gazette (BGBl.) I, p. 1513.

56 Ordinance on the Protection of Surface Waters (Surface Waters Ordinance) of 20 July 2010, Federal Law Gazette (BGBl.) I, p. 1429.

57 Directive laying down, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status, OJ L 201, p. 63.

58 Commission Decision establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise, OJ L 332, p. 20.

59 Ordinance on Pipeline Installations (Pipeline Ordinance) of 27 September 2002 (Federal Law Gazette (BGBl.) I, p. 3777, 3809), most recently amended on 8 November 2011 (Federal Law Gazette I page 2178).

60 Act for protection against harmful soil changes and for remediation of contaminated sites (Federal Soil Protection Act – BBodSchG) of 17 March 1998 (Federal Law Gazette (BGBl.) I, p. 502, most recently amended on 24 February 2012 by Article 5 (30) of the Act Reorganizing the Closed Substance Cycle and Waste Management Act, Federal Law Gazette I page 212).

61 Federal Ordinance on Soil Protection and Contaminated Sites (BBodSchV) of 12 July 1999 (Federal Law Gazette I, no. 36, p. 1554); most recently amended on 24 February 2012. Federal Law Gazette (BGBl.) I, p. 212.

Act on the Environmental Compatibility of Washing and Cleansing Agents (Washing and Cleansing Agents Act)

The Washing and Cleansing Agents Act (WRMG)⁶² regulates the manufacture, labelling and distribution of detergents and cleansing agents, and sets out requirements governing their environmental compatibility. The use of substances harmful to water may be prohibited or restricted. In addition, the principal constituents and correct dosage must be shown on the packaging. The WRMG applies in addition to the Detergents Regulation⁶³.

The Detergents Regulation outlines provisions on the biodegradability of surfactants, among other things. These must be completely biodegradable, i.e. they must have degraded by more than 60 % into CO₂ and water within 28 days.

In 1995, the criteria for a European eco-label for detergents (Euro-flower) formulated under Germany's leadership were adopted on the basis of stringent criteria with regard to complete biodegradability and toxicity to aquatic organisms. The "Euro-flower" has since been extended to include eco-friendly washing-up liquid, dishwasher detergents, all-purposes cleansers and sanitizers.

Infection Protection Act (IfSG)

The Act on the Prevention and Control of Infectious Diseases in Humans (Infection Protection Act – IfSG)⁶⁴ contains provisions governing the quality of water for human consumption, water for swimming and bathing pools, and wastewater. The main requirement governing the quality of drinking water is that no harm to human health is to be feared from its consumption or use, especially as a result of pathogens.

The Act also outlines hygiene requirements governing the disposal of public wastewater. Under these provisions, those responsible for wastewater disposal, usually local authorities or local authority associations, must take action to ensure that wastewater is disposed of in such a way that no risk arises to human health as a result of pathogens.

Drinking Water Ordinance (TrinkwV)

The Drinking Water Ordinance⁶⁵, which also serves to implement the EU Drinking Water Directive (see **chapter 4.1**), was enacted on the Food and Feedstuffs Code in the version promulgated on 22 August 2011, Federal Law Gazette (BGBl.) I, p. 1770, most recently amended by Article 1 of the Ordinance of 3 August 2012, Federal Law Gazette I, p. 1708. basis of the IfSG and the old Food and Utility Articles Act (LMBG)⁶⁶. It also outlines specific requirements governing the properties of drinking water and of water for food factories and drinking water treatment. The provisions of the TrinkwV regulate the properties of drinking water, the obligations incumbent upon the operator of a water supply plant, and hygiene-related monitoring of the operator by the health authorities. The Ordinance also specifies limits for substances harmful to human health (such as heavy metals, nitrate and organic compounds) and pathogens, as well as the scope and frequency of analysis. The limit values for these substances correspond to those in the EU Drinking Water Directive and are set at a level where no harmful effects are expected to result from lifelong intake. For organo-chemical pesticides and insecticides, for example, the maximum concentration is 0.1 µg/l. The sum total of such active ingredients is limited to 0.5 µg/l. The limit for nitrate in drinking water is 50 mg/l.

Ordinance on Fertilization (DüV)

The Ordinance on the Principles of Good Agricultural Practice in Fertilization (Ordinance on Fertilization, DüV)⁶⁷ was adopted on the basis of the old Fertilizers Act, and is intended to ensure more effective protection of waterbodies from (diffuse) contamination, particularly nitrate, from agricultural sources. At the same time, the DüV serves to implement the EU Nitrates Directive⁶⁸. The Fertilizers Act itself was replaced by the Fertilization Act⁶⁹ (DG) in early 2009. Fertilizers may only be used on the basis of good agricultural practice, which means, *inter alia*, that the nature, quantity and timing of fertiliser use must be geared to the needs of the plants and the soil, having regard to the nutrients and organic substances available in the soil and the local and growing conditions. The DüV is currently being revised. The aim is to reduce the amount of nitrate elutriation into groundwater and nutrient surpluses in the soils.

62 Act on the Environmental Compatibility of Washing and Cleansing Agents (WRMG) in the version promulgated on 29 April 2007, Federal Law Gazette I, p. 600, most recently amended by Article 2 of the Act implementing Regulation (EC) No. 1272/2008 and amending the Chemicals Act and other Acts in line with the Treaty of Lisbon of 2 November 2011, Federal Law Gazette (BGBl.) I, p. 2162.

63 Regulation (EC) No. 648/2004 of the European Parliament and of the Council of 31 March 2004 on detergents, OJ L 104, p. 1, most recently amended by Article 1 of the Adaptation Regulation (EU) 259/2012 of 14 March 2012, OJ L 94, p. 16.

64 Act on the Prevention and Control of Infectious Diseases in Humans (IfSG) dated 20 June 2000, Federal Law Gazette (BGBl.) I, p. 1045, most recently amended by Article 3 of the Act of 21 March 2013, Federal Law Gazette (BGBl.) I, p. 566.

65 Food and Feedstuffs Code in the version promulgated on 22 August 2011, Federal Law Gazette (BGBl.) I, p. 1770, most recently amended by Article 1 of the Ordinance of 3 August 2012, Federal Law Gazette I, p. 1708.

66 Ordinance on the Quality of Water for Human Consumption (Drinking Water Ordinance, TrinkwV) of 21 May 2000, Federal Law Gazette (BGBl.) I, p. 959, most recently amended by Article 1 of the Second Adaptation Ordinance of 5 December 2012, Federal Law Gazette (BGBl.) I page 2562.

67 Ordinance on the Principles of Good Agricultural Practice in Fertilization of 26 January 1996, Federal Law Gazette (BGBl.) I p. 118, most recently amended by Article 5 (36) of the Act Reorganizing the Closed Substance Cycle and Waste Management Act of 24 February 2012, Federal Law Gazette I page 212.

68 Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, OJ L 375, p. 1, most recently amended on 11 December 2008, OJ L 311, p. 1.

69 Fertilizers Act of 9 January 2009 (Federal Law Gazette (BGBl.) I, p. 54), most recently amended by Article 1 of the Act to Reform the Fertilizers Act (DüngeG), the Seed Marketing Act (SaatgutverkehrsG) and the Food and Feedstuffs Code (FuttermittelG) of 15 March 2012, Federal Law Gazette I page 481.

4.3 Legislation of the Länder

Despite the Federalism Reform of 2006 and the Federal Government's new extended WHG, the water legislation of the Länder (Land water acts, Land wastewater acts and various legal ordinances) remains significant, because it transposes and supplements Federal Government legislation. The Länder have made varying degrees of use of the deviation rights granted to them under Article 72, para. 3 of the Basic Law (GG)⁷⁰ and in some cases have replaced the regulations under Federal law with their own provisions.

The local authorities, within the context of their powers to adopt by-laws, may also adopt binding regulations, particularly provisions regulating connection to public water supply and wastewater disposal plants, discharges into their wastewater plants (indirect discharges) and the levying of cost-covering fees.

Under Länder law, a charge is currently made for the abstraction of water in 13 Länder (excluding Bavaria, Hesse and Thuringia). The charge is payable by the party that extracts the water (groundwater, and in some cases surface water as well); in the case of public water supplies this is the supply utility, which passes the costs on to the consumer. The purpose of the water abstraction charge is to reduce water extraction and thereby conserve the waterbodies used for this purpose. The water abstraction charges collected are often used for water protection measures. In some Länder, the legislation explicitly states that the water abstraction charges must be earmarked for such purposes. The WHG does not contain any provisions on the water abstraction charge.

⁷⁰ Basic Law for the Federal Republic of Germany of 23 May 1949, Federal Law Gazette (BGBl.) p. 1, most recently amended by Article 1 of the Adaptation Act of 11 July 2012, Federal Law Gazette I page 1478.

5 Integrated planning and management of water resources

5.1 Conceptual framework – Political concepts

The legal structuring of integrated water resources management occurs at various different levels. The EU plays a leading role in this respect, by aiming to achieve integrated political concepts relating to water with a series of directives (such as the WFD, IPPC Directive and MSFD) backed up by reporting obligations (such as the PRTR Regulation).

5.1.1 EU Water Framework Directive (WFD)

5.1.1.1 The concept behind the WFD

In the mid-1990s, the Member States of the EU realized that there was no point in simply amending and updating the existing EU water directives, most of which dated back to the 1970s. These directives were based on individual uses – for example, they formulated requirements governing the protection of shellfish waters, fishing waters, drinking water abstraction and bathing waters, and were not coordinated with one another. They only ever covered selected sub-aspects of water protection, and monitoring and reporting requirements were not harmonized with one another. The WFD replaces some of the existing EU Directives completely, and creates a framework for others, encompassing new management and planning elements which are designed to increase the effectiveness and acceptance of both new and old regulations.

The integrative approach of the WFD is expressed in the following aspects:

- ▶ The WFD applies to all waterbody categories within the European Union, i.e. rivers, lakes, estuaries, coastal waters and groundwater.
- ▶ The WFD also includes conservation of the marine environment, *inter alia* by aiming to gradually phase out the discharge of priority hazardous substances into marine waters.
- ▶ Waterbodies are to be managed on the basis of river basins, i.e. from the source to the mouth with all tributaries, whereby the WFD puts special emphasis on the transboundary dimension.
- ▶ The waterbody ecology, particularly its biology, is just as relevant for the quality of surface waters as its chemical properties. Hydromorphological aspects are likewise taken into account.

- ▶ Groundwater quality is assessed according to qualitative and quantitative criteria.
- ▶ Economic aspects must be taken into account. For example, Member States must aim for cost-recovering prices including environmental and resource costs, for all water services (water supply and wastewater disposal) and must develop effective, cost-efficient measures to achieve the WFD objectives. In cases where the Member States are hoping to invoke the deadline extensions or exemption clauses provided for in the WFD, e.g. for lower objectives, economic considerations likewise play a major role. Proof that achieving the objectives within the envisaged timescale by 2015 would entail disproportionately high costs would be one possible justification. To this end, it would be necessary to present affordability criteria or cost/benefit analyses.
- ▶ Member States are required to prepare programmes of measures and management plans which contain or build on all the aforementioned elements and must be updated at regular intervals (every six years). This occurred for the first time on 22 December 2009 (cf. **chapter 5.1.1.2**).
- ▶ The general public is consulted on the plans.

For the purposes of German water legislation, a crucial new feature concerns the detailed management provisions of the WFD, whereby all uses which affect groundwater and surface waters are to be aligned with the management objectives. This restricts the managerial discretion of the water authorities, and also entails comprehensive monitoring duties. The WFD's requirement for the joint transboundary preparation of management plans with other riparian countries in the river basin poses a particular challenge.

5.1.1.2 Findings from management planning

Following a time-consuming planning process involving the general public, the management plans and programmes of measures for the 10 river basins relevant for Germany were duly completed by the competent authorities on 22 December 2009, and published on the Internet. The status and pollution of German waters may be summarised as follows:

As far as pollutants are concerned, waterbodies today indicate a good chemical quality for most substances. Degradable substances from wastewater treatment plant discharges only rarely pose a problem. With regard to pollutants, problems are concentrated on diffuse sources, substances with poor degradability, even in wastewater treatment plants, and pollution originating from earlier emissions.

However, nutrient pollution from agriculture remains a key problem in water resources management. One-quarter of groundwater bodies fall short of a good chemical status due to excessively high nitrate loads. The aim of achieving a balance between groundwater abstraction and groundwater recharge is achieved almost everywhere. By contrast, 37 % of groundwater bodies indicate problems with substances. Nitrate is almost always the culprit (see above), and in some cases pesticides are also a problem.

The management plans indicate that the ecological targets for surface waters set by the WFD are ambitious. It states that the species composition and frequency of organisms should only deviate minimally from the type-specific aquatic communities. At present, this target is only met by 10 % of surface waterbodies. This is mainly due to existing structural degradations, as well as pollution with nutrients and pesticides.

The principal water resources management issues that have emerged throughout all 10 river basins are as follows:

- ▶ Reducing discharges of nutrients and selected pollutants from diffuse and a few remaining point sources into surface waters and groundwater.
- ▶ Improving the hydromorphology (e.g. the quality of the waterbed, bank reinforcement, hydrological regime) in surface waters and recreating passability for fish fauna in particular.

A number of other specific regional water management issues have also been identified in selected river basins, for example pollution associated with mining.

Environmental objectives and exemptions

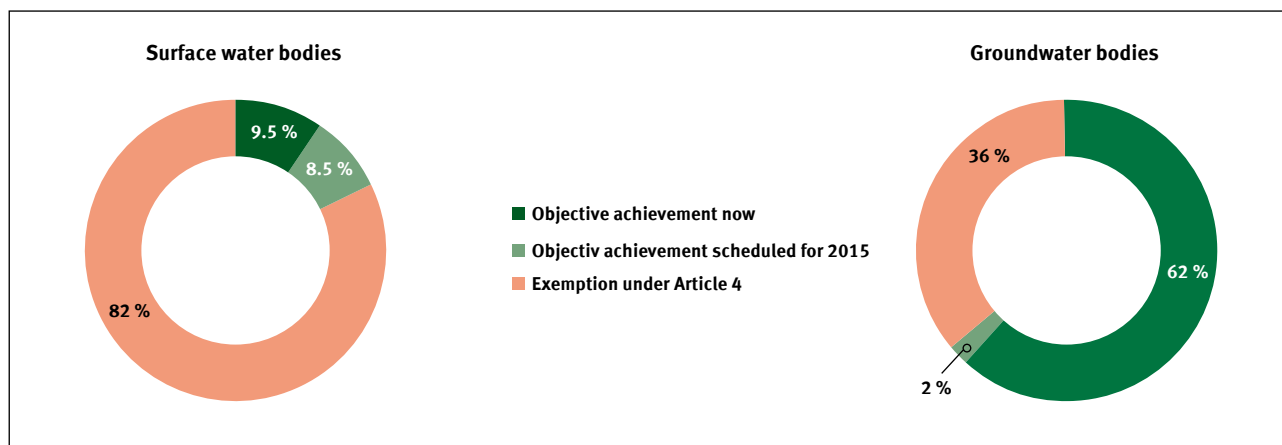
The environmental objectives for waterbodies are set out in Article 4 of the WFD. In justified cases, Member

States may deviate from the original environmental objectives (good ecological status/good ecological potential, good chemical status, good quantitative status) or from target achievement by 2015. Most of the exemptions used by Germany are deadline extensions (until 2021 / 2027). Less stringent environmental objectives are cited as exceptional circumstances if waterbodies are so heavily polluted or so extensively morphologically transformed that an improvement in the status cannot be achieved in the foreseeable future with proportionate measures. This exemption applies to groundwater in mining regions of the Rhine, Maas, Elbe and Oder river basins, for example; and also to surface waters in the Weser river basin, where salts and heavy metals have been discharged into smaller waterbodies from slag heaps, mine pits and abandoned industrial sites.

- ▶ Deadline extensions and exemptions have been utilised for 82 % of all bodies of surface water. This means that by 2015, 18 % of surface waterbodies in Germany will have met the environmental objectives. The current figure is 10 %.
- ▶ Deadline extensions and exemptions have been utilised for 36 % of all bodies of groundwater. 62 % of all waterbodies already indicate a “good status”. A further 2 % of groundwater bodies will achieve a “good status” by 2015.

In many cases, natural conditions were cited as the justification for utilising exemptions. This is because measures often take a long time to develop their full effect in waterbodies and biotic communities before achieving any measurable success. The water residence time in porous groundwater aquifers is relatively long, and as a result, measures to reduce nutrient concentrations will only take effect with a considerable delay. The same applies to the recolonisation and colo-

Figure 11: Achievement of objectives by 2015 and utilisation of exemptions in Germany



Data source: Berichtportal WasserBLICK/BfG, as at 22 March 2010

nisation of waterbodies that have undergone renaturation with typical organisms and flora. Lack of technical feasibility is another reason cited with similar frequency. A third reason is the disproportionately high costs, but this is only cited comparatively rarely in the case of river basins.

Measures and funding

Measures in the areas of “local authorities/households”, “hydromorphology”, “agriculture” and “passability” are planned for surface waters almost everywhere in Germany. Conceptual measures of an administrative, economic or informative nature are often also included (advising farmers etc.). Measures relating to “industry” and “mining” (both also include the remediation of residual pollution and abandoned industrial sites) and “fisheries management”, on the other hand, tend to have only regional significance.

In the case of groundwater, measures to reduce substance discharges from agriculture are planned in almost all regions. These conceptual measures include the preparation of subsidy programmes and advice for farmers.

Measures to minimise pollution cannot be implemented unless there are adequate financial resources available. In Germany, the costs are met from taxes, fees and levies in the majority of cases. Other key sources of finance are the European Union, Federal Government, Länder and local authorities with various funds and subsidies, such as the EA-FRD (European Agricultural Fund for Rural Development) and the GAK (Joint Task for the Improvement of Agricultural Structures and Coastal Protection).

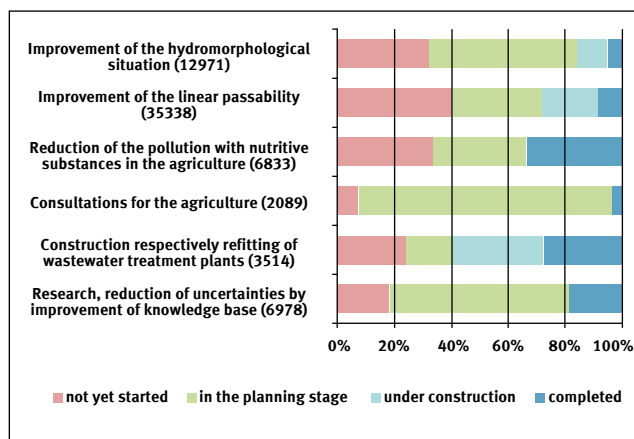
To date, the cost of implementing the measures in Germany during the first management period 2009 to 2015 have been estimated at € 9.4 billion, corresponding to € 20 per inhabitant, per year, to protect our waters.

Facts at the end of 2012

As required by the WFD, in 2012 statistics were compiled on the status of implementation of measures and reported to the European Commission. Measures are planned for each waterbody. Since there are almost 10,000 bodies of surface water and around 1,000 bodies of groundwater, and multiple measures are often needed for each waterbody, the statistics comprise tens of thousands of measures. 16 % of all the planned measures have so far been completed, while 27 % have not yet been started. The majority of measures are at the planning stage (48 %), while some are under construction (7 %). Until now, only a few measures have

been completed to “improve passability” or “improve hydromorphological status” (Figure 12). Most measures to advise farmers are shown as “at the planning stage” in Figure 12, because they are offered on an ongoing basis and as such are never “finished”. Difficulties with the provision of financial and personnel resources, with obtaining acceptance for a measure, and inadequate availability of land surrounding waterbodies are commonly cited as reasons for implementation delays.

Figure 12: Implementation status of measures in Germany (in brackets: Number of measures in the areas cited)



Data source: Berichtsportal WasserBLICK/BfG, as at 31/10/2012

5.1.2 Pollutant Release and Transfer Register (PRTR)

On the basis of the UN-ECE PRTR Protocol signed on 21 May 2003, Germany undertook to establish and operate a national Pollutant Release and Transfer Register. The EU PRTR Regulation⁷¹ of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register was published in the Official Journal of the European Union on 4 February 2006. The PRTR Regulation regulates the reporting requirements and supply of data to the EU for a European Pollutant Register. 2007 was the first reporting year for operators. The national legislation comprises an Act (SchadRegProtAG) implementing the aforementioned PRTR Protocol and PRTR Regulation⁷². This Act entered into force on 12 June 2007.

71 Regulation (EC) No. 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EEC (Reg. (EC) No. 166/2006), OJ L 33, p. 1.

72 Act implementing the Protocol on the Pollutant Release and Transfer Register of 21 May 2003 and executing Regulation (EC) No. 166/2006, Federal Law Gazette (BGBl.) I, p. 1002.

The PRTR aims to provide the general public, industry, academia, non-government organisations and other decision-makers with access to environmental information and to ensure greater transparency. Since the end of 2012, PRTR data has been published in a redesigned format and concept at www.thru.de.

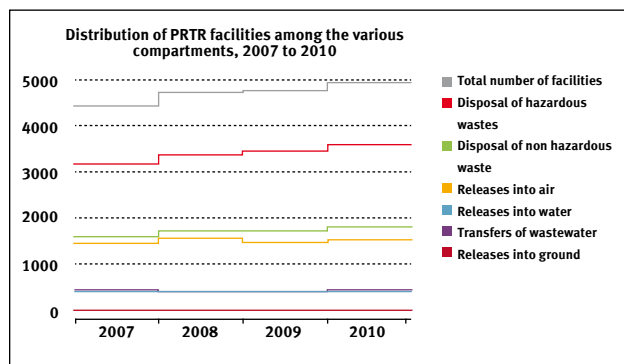
The E-PRTR Regulation stipulates that the PRTR should contain information on releases into the air, water and land, as well as off-site transfers of pollutants contained in wastewater, and off-site transfers of hazardous and non-hazardous waste. Operators of facilities where one or more of the activities listed in Annex I of the E-PRTR Regulation are performed and which exceed the capacity thresholds specified therein are subject to reporting requirements. The operators then report annually to their competent authorities on the relevant releases into air, water and land and off-site transfers of pollutants in wastewater and waste, where these exceed the relevant limits.

Reporting occurs on an annual basis. Data is published on the Internet (www.thru.de/) 16 months after the end of the reporting period. European-wide PRTR data may be found in the European PRTR Register at <http://prtr.ec.europa.eu>.

Between 2007 and 2010, the number of facilities reporting under the PRTR increased from 4,448 to 4,947. **Figure 13** illustrates the distribution of PRTR facilities among the various compartments for the reporting years 2007–2010.

Most of the facilities listed on Thru.de (just over two-thirds) dispose of more than 2 tonnes of hazardous waste each year. Just under 30 % dispose of more than 2,000 tonnes of non-hazardous waste per annum. Slightly fewer release pollutants into the air. Pollutant emissions into waterbodies and pollutant discharges in wastewater (e.g. in public wastewater treatment plants) are reported by around 10 % of facilities in each case. The number of facilities with pollutant emissions into waterbodies has decreased slightly, while the number of facilities with pollutant discharges in wastewater has tended to increase. The proportion of facilities with pollutant emissions into the soil is extremely low, at just 0.1 %. Most facilities belong to more than one category, such as hazardous waste and pollutant emissions into the air, so the percentages given add up to more than 100 %.

Figure 13: Distribution of PRTR facilities among the various compartments, 2007–2010



Source: Federal Environment Agency (UBA), 2012 (<http://www.thru.de/thru/de/auswertung/top-thema/automatisches-archiv/#c1284>)

Most PRTR facilities with emissions into water belong to the “waste and wastewater management” sector. Of those with off-site transfers of pollutants into external wastewater treatment plants, the majority belong to the chemical and food industries.

Detailed information on PRTR facilities and the data reported can be found at www.thru.de. Under “Facilities”, users can search for specific facilities, or research particular sectors or pollutants. The database can be downloaded for an in-depth evaluation. The map search and neighbourhood search options make it easy to locate facilities in a given region. Reports on topical environmental issues relating to the PRTR data are reported under “top topics”.

5.1.3 European policy on the protection of the marine environment

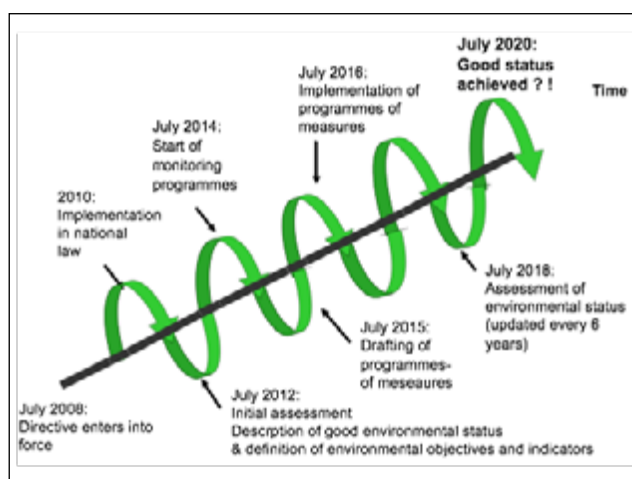
Within the context of implementing the 6th Environmental Action Programme, on 24 October 2005 the European Commission presented a “Thematic Strategy on the Protection and Conservation of the Marine Environment”. This strategy is designed to advance the integrated approach to the protection of the marine environment at European level, and to rectify deficits in the European policy on the protection of the marine environment currently practised by individual countries and/or regions. For the first time, the strategy formulated the requirement for a uniform, comprehensive and targeted European-wide policy on the protection of the marine environment based on the ecosystem approach and aimed at integrating all policy areas. The Marine Strategy Framework Directive (MSFD)⁷³ developed from this strategy entered into force on 15 July 2008.

⁷³ Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for Community action in the field of marine environmental policy, OJ L 164, p. 19.

The thematic strategy and the MSFD represent the “environmental pillar” of the integrated European maritime policy. The overarching objective of the MSFD is to achieve or maintain a good environmental status throughout all European seas by 2020. This status is defined as the “environmental status of marine waters which are ecologically diverse and dynamic oceans and seas being clean, healthy and productive within their intrinsic conditions. The use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations”. The environmental status is to be assessed according to the ecosystem approach, i.e. all the principal elements of marine ecosystems are to be evaluated and protected in their entirety and in their reciprocal interactions. As such, a holistic approach is being applied for the first time which also includes the cumulative effects of anthropogenic impacts on the seas.

The management units to which the MSFD is being applied are the North-East Atlantic (including the North Sea and Wadden Sea), Baltic Sea, Mediterranean and Black Sea. Europe’s littoral states are required to develop regional marine strategies and national action plans for their marine waters within the marine regions in active cooperation with the other Member States in those regions and non-EU Member States (neighbouring countries which border the marine region or lie within its catchment area), in order to achieve the environmental objectives and the overall objective of a good environmental status by means of suitable programmes of measures. **Figure 14** shows the timetable for implementation of the MSFD.

Figure 14: Timescale for implementing the MSFD



Source: Federal Environment Agency (UBA)

Elements of the required regional marine strategies already exist within the context of existing regional marine conventions, or are being drafted by them in order to support the MSFD implementation process. One new feature at European level is the explicit requirement to cooperate on a transboundary basis and to make

use of existing institutional structures, i.e. existing regional cooperation. Relevant work for Germany in this connection is currently ongoing at OSPAR⁷⁴ and HELCOM⁷⁵.

One important aspect of the Directive is the setting of environmental objectives. Environmental objectives are qualitative or quantitative statements on the desired status of the various components of the marine ecosystem, and on admissible pressures and impairments of the marine waters in a marine region. Taken together, these objectives should serve the overarching objective of achieving or maintaining a good environmental status. Whilst the WFD contains extensive and detailed provisions governing the quality components to be measured and the assessment thereof, the MSFD gives Member States considerably more freedom. It prescribes 11 “descriptors”, which must be used to define and assess the good environmental status. It also lists characteristics and pressures/impacts to specify the descriptors.

At European level, the EU Commission’s Decision 2010/477/EU of 1 September 2010 presented proposals for 54 criteria and methodological standards to provide the Member States with a framework for defining the good environmental status. In Germany, the Federal Government and the coastal Länder prepared a first assessment (initial assessment) of the environmental status of the German North and Baltic Seas with the participation of the general public in 2012. It covers the principal pressures and their impacts on the marine environment, and concludes that our oceans currently are not in a good environmental status. The good environmental status can only be achieved if the pressures from fishing, eutrophication, contaminants, marine litter and noise are significantly reduced. Effective measures must be specified in the programme of measures to be prepared by Germany by 2015 and implemented by 2016. Indicators play a key role in the assessment of marine status, the monitoring thereof, and the control of environmental objectives and measures. Defining these indicators is the focus of ongoing work to prepare a monitoring programme in line with the WFD, which must be submitted to the EU Commission in 2014.

One weakness of the MSFD is that the Member States have little influence on key pressures for the marine ecosystems emanating from fishing (overfishing and other adverse ecological effects) and agriculture (including elevated emissions of nutrients into air and waters from the excessive use of fertilisers, slurry from farming, and hazardous substances from the use of pesticides and animal pharmaceuticals). These sectors are to be addressed by the Community and can only be influenced by initiatives on the part of one or more

74 Convention for the Protection of the Marine Environment of the North-East Atlantic (Oslo-Paris Convention, OSPAR).

75 Convention on the Protection of the Marine Environment of the Baltic Sea Area (new Helsinki Convention, HELCOM).

Member States regarding the Common Fisheries Policy (CFP) or Common Agricultural Policy (CAP). To further exacerbate the situation, interpretation of these policy areas is a very controversial topic within the EU, and selected Member States have made it a high political priority, ultimately at the disadvantage of the protection of the marine environment. This makes it difficult to coordinate measures in the EU aimed at reducing the adverse impacts of fisheries and agriculture.

At European level, implementation of the MSFD to date has shown that the definition of good environmental status varies widely among individual Member States. Whereas some set very ambitious targets, others are content with equating a good environmental status to the status quo. Regrettably, the MSFD supports this broad interpretative scope. At present, the EU Commission is working on an analysis for the coherent implementation of the MSFD in accordance with Article 12, which entails reviewing the national reports now available in respect of Articles 8 (initial assessment), 9 (definition of GES) and 10 (specification of environmental objectives) of the MSFD.

Experiences with the implementation of the WFD have shown that important groundwork is being laid at an international level for normative definitions not specified by the Directive itself. The regional sea conventions OSPAR and HELCOM serve as regional coordination platforms for the implementation of the MSFD in the North and Baltic Seas.

5.2 Protecting water resources and aquatic ecosystems

5.2.1 Groundwater

5.2.1.1 An important habitat and part of the hydrological cycle

Groundwater resources close to the surface supply plants with water and create valuable wet biotopes. Groundwater comes to the surface in springs and feeds streams and rivers. The quality and quantity of the groundwater therefore influences the surface waters as well. Around 70 % of our drinking water comes from groundwater and spring water, making it Germany's most important drinking water resource.

However, groundwater is also a habitat in its own right with extensive biological diversity. Living conditions are determined by a number of abiotic factors which make groundwater a unique ecosystem:

- ▶ Only very small organisms live within the spatial confines of the interstitial system of groundwater aquifers,

- ▶ Due to the absence of sunlight, there is no photosynthesis, i.e. oxygen and organic matter which serve as food for organisms are brought in almost exclusively from outside
- ▶ There is generally a severe shortage of nutrients, and the covering soil layers provide a buffer against climatic influences, so that the temperature remains constant at approximately 8–11 °C.

Only a few highly specialized groups of organisms colonize the upper layers of groundwater. Due to the large spectrum of species within these groups, however, the biological diversity is astonishing. Apart from multicellular groundwater animals (metazoa), microorganisms (bacteria, aquatic fungi and monocellular organisms) make up the bulk of the biomass.

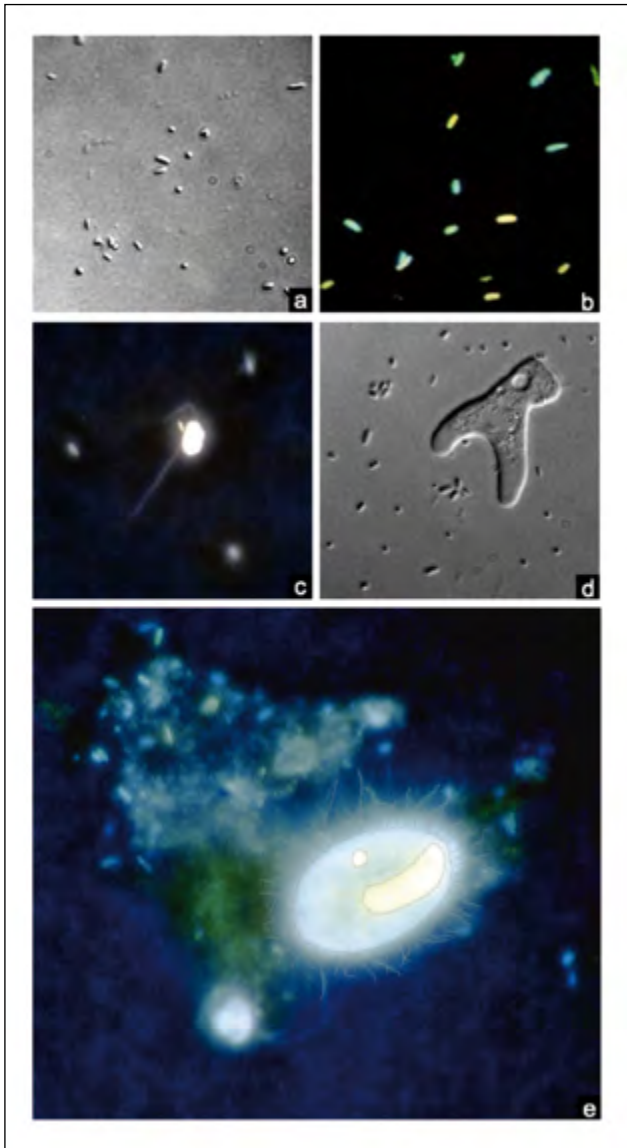
The organisms have adapted to the extreme conditions in a variety of ways. Microorganisms may be independently mobile or attached to microscopic solid particles. They have adapted to low nutrient concentrations with low growth and metabolic rates. They are characterized by their ability to react quickly to changes in the system, such as an increased supply of nutrients.

Groundwater animals also tend to be microscopically small and elongated to enable them to live in the cavities in the groundwater aquifers. Eyeless, with no body pigments and equipped with plenty of sensory organs, they are adapted to darkness and a lack of nutrients as well as to a reduced metabolism and slower life and reproductive cycles.

Hydrological, physical and geochemical influences control the sensitive balance of the biosphere. The activities and functions of the individual organisms are closely coordinated with one another. They influence the substance and energy flows and permeability of the interstitial systems, and contribute to the quality of groundwater via the degradation of pollutants and purification services. In this way, groundwater organisms contribute a significant portion of the so-called ecosystem services of groundwater systems. The term ecosystem services covers all the natural processes occurring in a system without any human intervention. The broad spectrum of services in groundwater ecosystems creates the foundations for many areas of life:

- ▶ Physico-chemical and biological purification procedures transform infiltrated rainwater and surface water into drinking water and service water, thereby facilitating the various uses of groundwater.
- ▶ Microbiological degradation and conversion processes enrich the water with salts and trace elements, which we then use as mineral water or curative waters.

Figure 15: The microbial community in groundwater ecosystems: (a, b) Bacteria (0.5–3 μm), (c) Heterotrophic nano-flagellate (5 μm), (d) Amoeba (30 μm), (e) Peritrichous ciliate (25 μm) grazing on an aggregate of bacteria (a, d – phase contrast images; b, c, e – fluorescence microscopy images; e – graphically reworked)



Photographs: C. Griebler and K. Euringer, Helmholtz Zentrum München, Institut für Grundwasserökologie (Institute of Groundwater Ecology)

- ▶ Intact groundwater systems store usable water over long periods and stabilise the water balance during periods of both drought and flooding by emitting water to surrounding systems and absorbing surplus moisture.
- ▶ The quality and quantity of groundwater influences the status of groundwater-dependent terrestrial ecosystems and watercourses through to the coastal and marine regions, as well as the fertility of agricultural and forestry locations.

Figure 16: Microscopic, translucent groundwater fauna



Photographs: Karsten Grabow and Heide Stein, Landau University

- ▶ As a habitat for specialised organisms and home to a broad spectrum of species, the underground systems make an important contribution to the biological diversity of waterbodies.

If the sensitive groundwater environment is disturbed, this will adversely affect the performance of groundwater organisms, and ultimately also the quality of underground waterbodies. In order to permanently preserve the services and functions of groundwater organisms, we must protect groundwater from adverse anthropogenic influences and preserve natural qualities that offer optimum living conditions to groundwater organisms.

5.2.1.2 Groundwater quality

Apart from regional exceptions, there are no problems in terms of the volume of groundwater in Germany. However, the quality of groundwater is a different matter. In the past, groundwater was regarded as well-protected from anthropogenic pollution compared with surface waters. However, this assumption overestimates the purification and retention capacity of the overlying soil layers. The systematic monitoring of groundwater quality by the Länder reveals that the good quality of our groundwater is under threat in many locations. A substantial number of groundwater monitoring sites have recorded anthropogenic substance discharges and significant levels of pollution in some cases. In addition to point sources such as legacy sites, old deposits, accidents involving substances hazardous to water or leaks in sewers, groundwater is polluted or at risk primarily as a result of diffuse inputs from agriculture, industry, and transport.

Groundwater monitoring

In the Federal Republic of Germany, the monitoring of groundwater quality is the responsibility of the Länder. The aims of groundwater monitoring are:

- ▶ To promptly detect any adverse changes in quality,
- ▶ To develop targeted remediation and minimisation strategies depending on the causes of pollution, and
- ▶ To assess the effectiveness of such protective measures.

To this end, in recent decades, the Länder have systematically developed groundwater monitoring networks.

Groundwater monitoring networks to implement the WFD

A surveillance monitoring network and an operational monitoring network have been established in order to assess the chemical status of groundwater. Surveillance monitoring, similar to that used for surface waters, must take at least once per management cycle, whereas for operational monitoring, measurements are carried out once a year.

Additionally, a monitoring network has been set up to monitor the quantitative status of groundwater, with the aim of identifying short-term and long-term fluctuations caused by groundwater recharge, groundwater abstraction or discharges. The monitoring network should also be designed in such a way that it is capable of identifying natural changes in water volume (e.g. as a result of climate change).

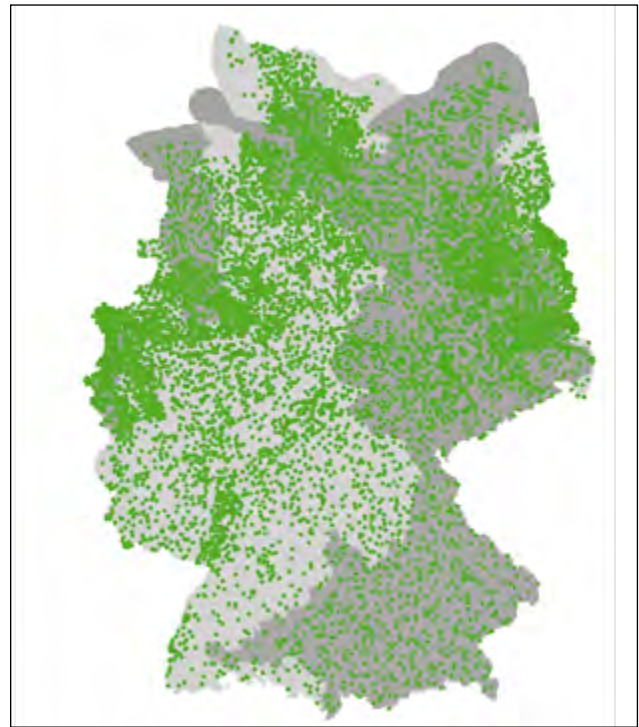
The majority of monitoring sites were designed to measure the quantitative status of groundwater (volume monitoring network 6,800), followed by the surveillance monitoring network (5,500) and the operational monitoring network (4,000). Some of these monitoring sites are multi-functional, i.e. they serve as both surveillance, operational and/or quantitative monitoring sites. For the quantitative monitoring network, the average density of monitoring sites in Germany is 25 per 1,000 km².

Groundwater monitoring networks for reporting to the EU

In addition to the various monitoring networks devised for the requirements of specific Länder, two national networks have now also been created (Figure 18). These generally draw on existing monitoring sites in the Länder networks.

Both networks supply the data basis for reports by the Federal Republic of Germany to the European Union (EU) and the European Environment Agency (EEA).

Figure 17: Groundwater monitoring sites in Germany



Data source: Berichtsportal WasserBLICK/BfG, as at 22 March 2010

The EEA monitoring network (red)

This monitoring network supplies the essential data for Germany's reporting to the EEA in Copenhagen. It was compiled using the following criteria: It is intended as a representative monitoring network providing an overview of the quality of groundwater throughout the whole of Germany.

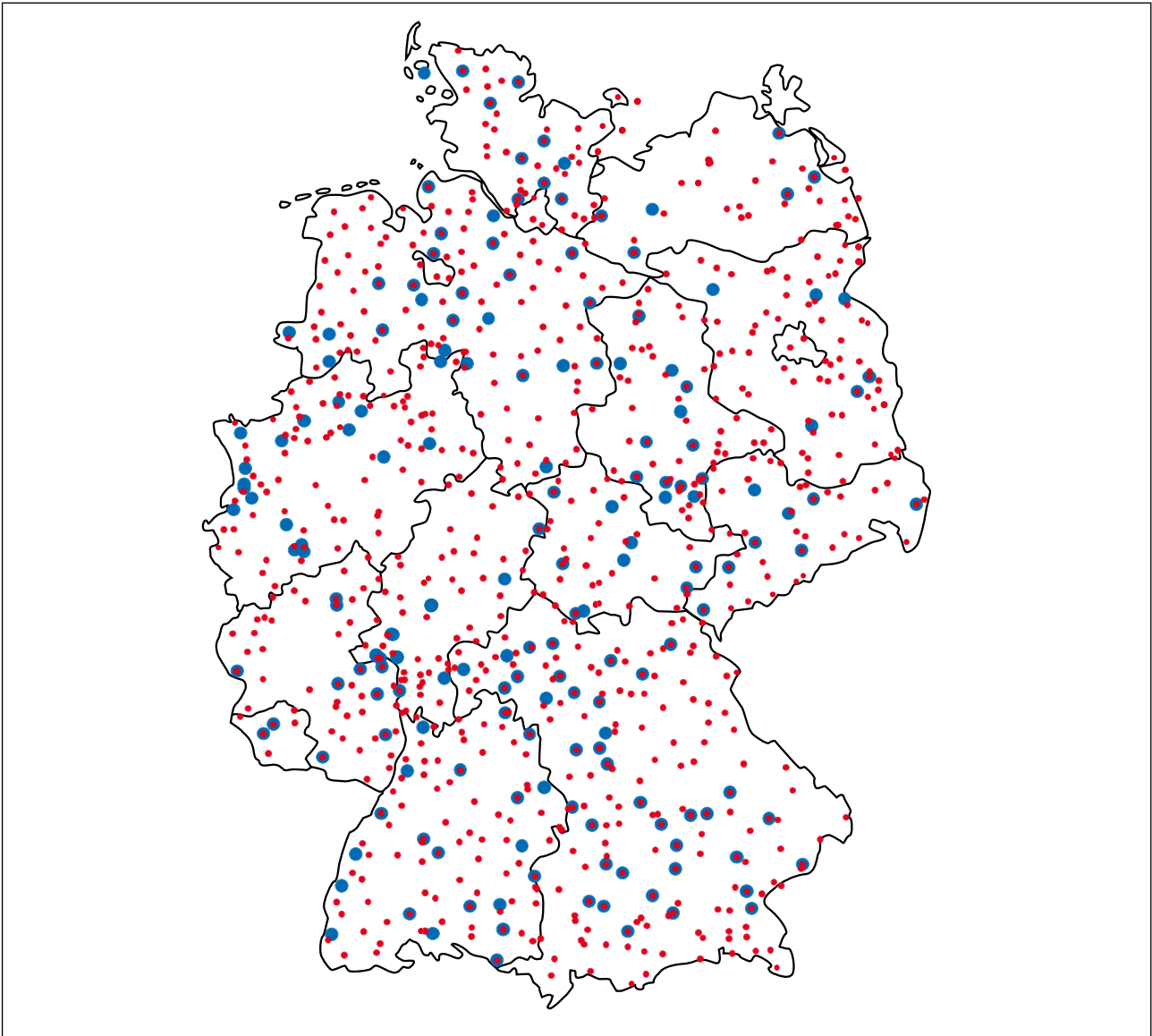
- ▶ The Länder have stipulated that it should be comprised of approximately 800 monitoring sites
- ▶ These monitoring sites should be evenly distributed throughout the entire territory of the Federal Republic of Germany, and
- ▶ Should be located primarily in the uppermost main groundwater aquifers.

The Länder supply the Federal Environment Agency (UBA) with the monitoring results from this network on an annual basis. At the end of each year, the UBA compiles the data from the Länder in accordance with the EEA requirements and submits it to Copenhagen.

The EU nitrate monitoring network (blue)

This monitoring network was designed by the Länder with the sole purpose of fulfilling the specific monitoring requirements of the EU Nitrates Directive. The 1991 Nitrates Directive requires Member States to carry out action programs to minimise water pollution caused

Figure 18: Monitoring sites in the EEA monitoring network (red) and the EU nitrate monitoring network (blue)



Source: Federal Environment Agency (UBA)

by nitrate from agricultural sources. The monitoring data is intended to demonstrate how the action programmes have affected groundwater quality. Reports must be prepared every four years and submitted to the European Commission. The following criteria apply to the selection of monitoring sites:

- ▶ The monitoring sites should be in the groundwater aquifer close to the surface. Analysis focuses primarily on the uppermost aquifer.
- ▶ The monitoring sites should indicate significantly elevated nitrate levels (>50 mg/l, but at least >25 mg/l NO₃).

- ▶ The elevated nitrate levels must be clearly traceable to agricultural discharges.
- ▶ The selected monitoring sites should be representative of the largest possible catchment area, i.e. they should demonstrate the impacts of diffuse substance discharges.

The monitoring network comprises around 180 monitoring sites, from which samples are generally taken two to four times each year. The nitrate monitoring network selectively records groundwater pollution in contaminated areas, and unlike the EEA monitoring network, is not representative of groundwater pollution in Germany.

Status of groundwater

Damage to the groundwater is not usually immediately apparent. Remediation, if at all possible, is very costly in terms of financial and technical resources, and is a lengthy process. Rigorous application of the precautionary principle is therefore of paramount importance. This also necessitates systematic, regular monitoring of groundwater to allow early identification of threats to the groundwater, so that suitable action can be taken promptly. In view of its important ecological functions, nationwide protection of the groundwater is essential, as laid down in the Federal Water Act (WHG). In addition, the Länder may designate water protection areas, and impose additional conditions in these areas to protect the groundwater. In addition to the WHG, the WFD and the Groundwater Directive are also decisive for groundwater protection. The WFD requires Member States to achieve a good quantitative status and a good chemical status in all bodies of groundwater by 2015.

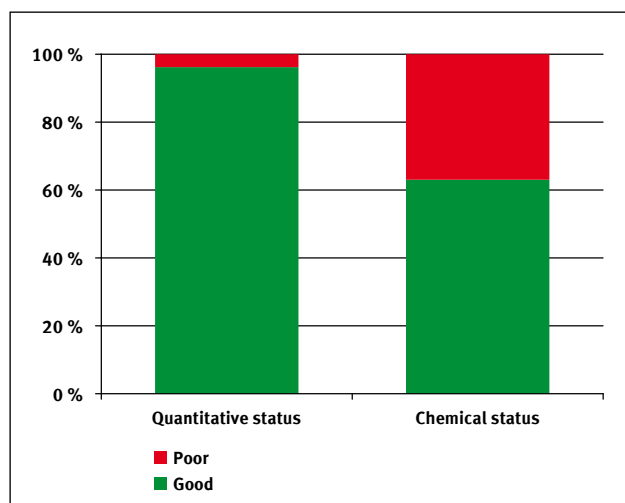
A good quantitative status means that there is a balance between groundwater abstraction and groundwater recharge. Furthermore, changes in the groundwater level due to water abstractions must not cause significant damage to surface waters or terrestrial ecosystems that are linked to the groundwater, and must not cause a significant deterioration in the quality of the surface waters themselves. Moreover, the water abstraction must not result in the inflow of salt water or other contaminants into the groundwater (intrusions).

The term good chemical status is defined in the Groundwater Directive in the form of quality objectives and threshold values. The Directive specifies uniform European-wide quality standards for nitrate (50 mg/l) and pesticides (plant protection products including their relevant metabolites and biocides) (0.1 µg/l). Additionally, the Member States must specify threshold values for the parameters/substances which have led to the groundwater body's classification as "at risk" following analysis in accordance with Article 4 of the WFD. However, a certain set of minimum parameters has been prescribed. As well as classifying the groundwater body's status, the Directive also outlines provisions for the identification, assessment and treatment of rising pollution trends and for limiting and preventing the input of pollutants into groundwater.

The first assessment of groundwater status in accordance with the provisions of the WFD occurred within the context of an analysis in 2004. Over the years that followed, further selective studies and assessments of the quantitative and chemical status of groundwater were carried out. These have recently revealed that around 96 % of the 1,000 or so groundwater bodies assessed now exhibit a good quantitative status. The situation with regard to chemical status is rather different: Around 63 % of assessed waterbodies currently exhibit a good chemical status (Figure 19).

Overall, 62 % of groundwater bodies achieved a "good (overall) status", comprised of chemical and quantitative status.

Figure 19: Quantitative and chemical status of groundwater in Germany



Data source: Berichtsportal WasserBLICK/BfG, as at 22 March 2010

Quantitative problems can arise, for example, in conjunction with mining activities, particularly open-cast lignite mines. In such regions, the groundwater level has often been lowered substantially over a period of several decades. Even after mining has been discontinued, it will take many decades for the groundwater to return to its natural levels. In regions where salt is mined on a large scale, there is an increased occurrence of man-made salt intrusions, which will lead to the affected groundwater body's classification as having a "poor status". If saltwater pollution is attributable to high levels of water abstraction, for example, the groundwater body is considered to have a poor quantitative status. On the other hand, if the salt levels are caused e.g. by wastewater discharges from salt mining, the groundwater body is considered to have a poor chemical status. The applicable assessment can only be determined on a case-by-case basis. Here too, it is likely to take a long time for the groundwater body to attain a natural state and return to a "good status".

A "poor chemical status" of groundwater bodies (Figure 21) is primarily attributable to increased nitrate emissions on intensively farmed land. Nitrate enters the groundwater via seepage through the soil, leading to high nitrate concentrations above the 50 mg/l quality standard specified in the EU Groundwater Directive.

Nitrate levels in groundwater

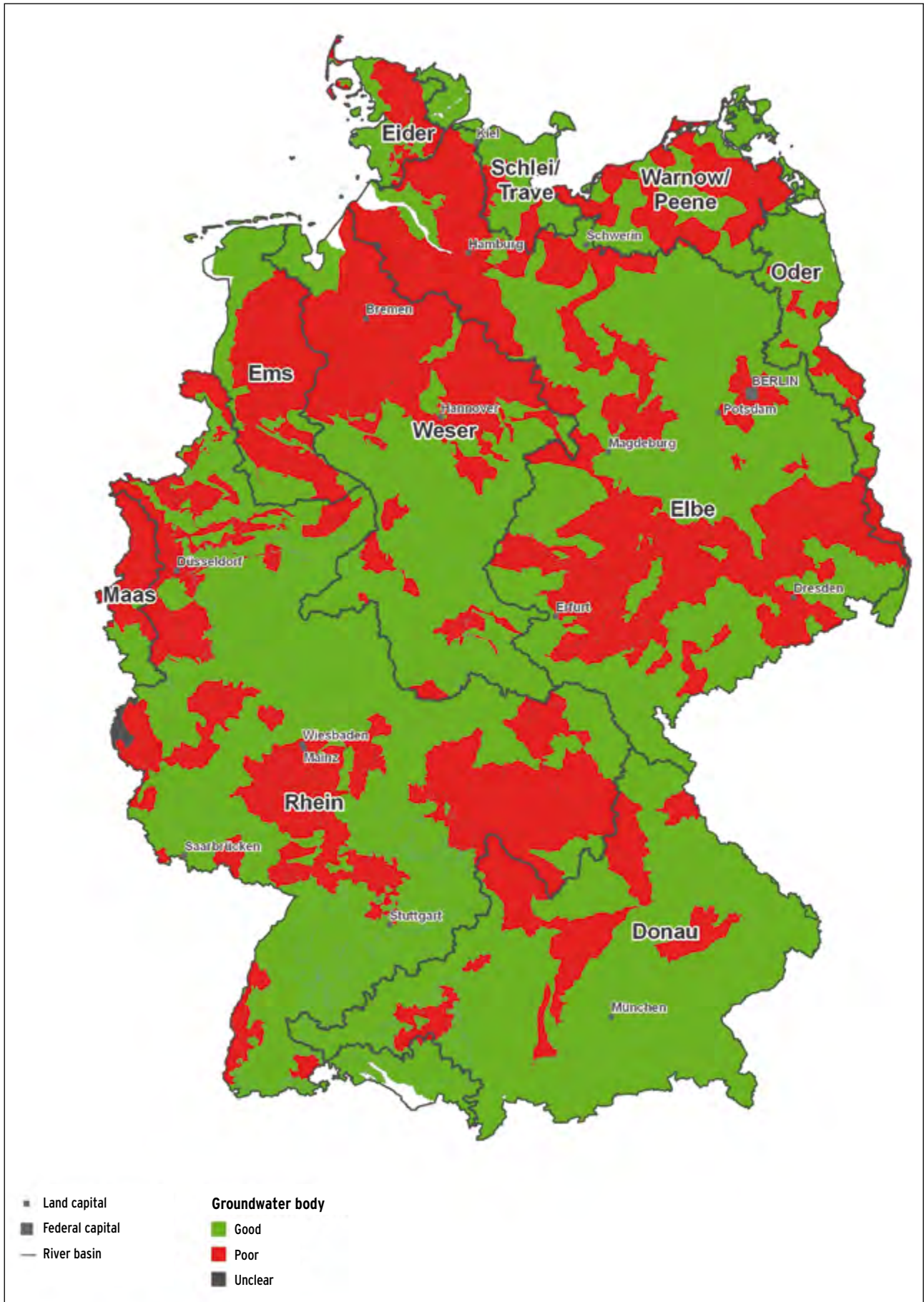
For decades, there have been reports on the contamination of groundwater with nitrate. This observation is of particular importance because drinking water in Germany is extracted predominantly from groundwater, and drinking water is subject to a nitrate limit

Figure 20: Quantitative status of groundwater bodies in Germany



Data source: Berichtsportal WasserBLICK/BfG, as at 22 March 2010

Figure 21: Chemical status of groundwater bodies in Germany



Data source: Berichtsportal WasserBLICK/BfG, as at 22 March 2010

of 50 mg/l. Groundwater with higher nitrate contents must undergo time-consuming, costly processing before it may be used as drinking water. Elevated nitrate levels in groundwater are also critical for surface waters, and particularly for the North and Baltic Seas, because they lead to eutrophication.

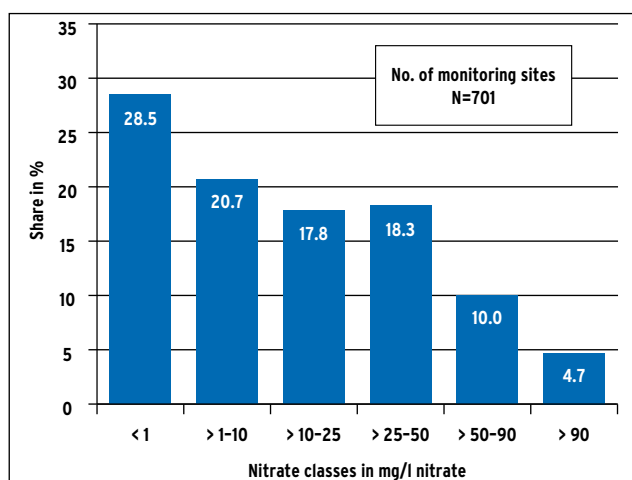
Based on the new EEA groundwater monitoring network, the following picture has emerged regarding nitrate pollution of groundwater in Germany:

Half of all monitoring sites indicate nitrate concentrations of between 0 and 10 mg/l and are therefore not polluted at all, or only minimally. In around 35 % of monitoring sites, nitrate levels are between 10 and 50 mg/l, which means, that the groundwater is significantly too heavily polluted with nitrate. The remaining 14 % of monitoring sites are so heavily polluted with nitrate that the water cannot be used for drinking water abstraction without further treatment, because the Drinking Water Ordinance limit of 50 mg/l is exceeded, in some cases significantly. For details of emission sources, please refer to [chapter 6.6.2](#) Water pollution from agriculture.

Pesticide findings in groundwater

In 2010, LAWA in collaboration with the UBA published the Third LAWA Pesticide Report on the pollution of groundwater with pesticides. According to the latest data from the Länder, the number of monitoring sites where the pesticide limit of 0.1 µg/l is exceeded was reduced significantly during the period from 1990 to 2008 ([Figure 23](#)). However, this reduction in groundwater pollution is primarily attributable to decreasing levels of atrazine, desethyl atrazine and several other active ingredients and metabolites, the use of which has been banned for years or even decades.

Figure 22: Overview of nitrate levels in groundwater in the Federal Republic of Germany, 2010



Source: Federal Environment Agency (UBA)

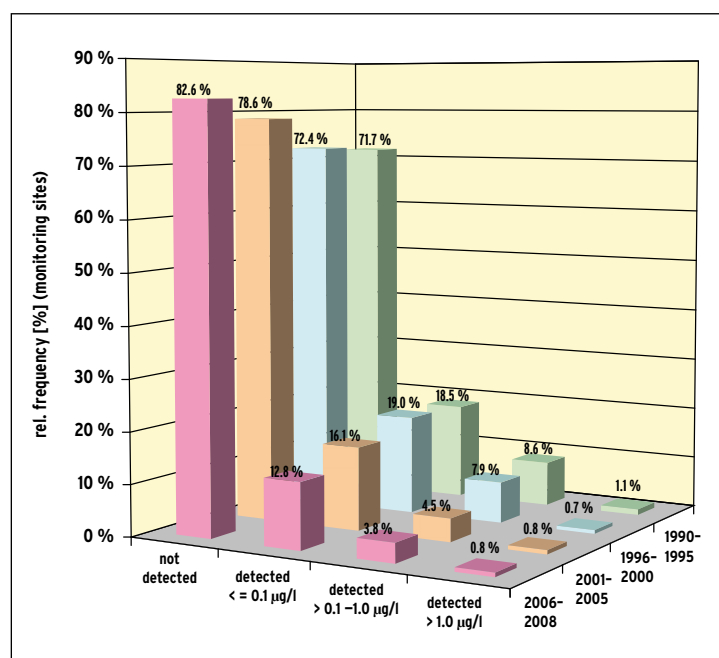
Whereas in the first reporting period 1990–1995, some 9.7 % of all analysed monitoring sites in groundwater close to the surface still exceeded the limit of 0.1 µg/l, this had fallen to 4.6 % by the period 2006–2008.

The overall reduction in the frequency of pesticide findings in groundwater is attributable to the fact that certain active ingredients and their metabolites (e.g. atrazine and desethyl atrazine) are no longer licensed. Over the past 20 years, the licensing procedures for pesticides, and in particular, bans and restrictions on the use of certain critical ingredients, have therefore been successful in preventing or limiting the use of critical substances to such an extent that overall, a significant reduction in the pollution of groundwater with pesticides has been achieved.

In order to ascertain which active ingredients and degradation products of pesticides are most frequently responsible for the contamination of groundwater, each year the Federal Environment Agency (UBA) evaluates the measurement results supplied by the Länder. The results of the current evaluation for 2011 are shown in [Table 5](#).

More detailed information on the status of groundwater bodies in Germany, particularly with regard to their chemical status, can be found in [chapter 4](#) of “Water resources management in Germany – Part 2”.

Figure 23: Frequency distribution of pesticide findings in filtered groundwater monitoring sites close to the surface in Germany, 1990–1995, 1996–2000, 2001–2005 and 2006–2008



Source: Data from the Länder

Table 5: Overview of active pesticide ingredients and pesticide degradation products (metabolites) most frequently responsible for the

Grade	active substance/metabolite	parameter	no. of monitoring sites	difference	reviewed sum (right)	no. of monitoring sites < limit of quantification (LQ)	no. of monitoring sites > LQ until 0.1 µg/l	no. of monitoring sites > LQ until 0.05 µg/l	no. of monitoring sites > 0.05 bis 0.1 µg/l
1	Desethylatrazine*	22341	7396	0	7396	6459	717	451	266
2	Atrazine*	22311	7228	0	7228	6596	534	415	119
3	Bentazone	22901	6711	0	6711	6415	208	154	54
4	Bromacil*	22891	5380	0	5380	5265	42	18	24
5	Mecoprop*	22551	6347	0	6347	6241	73	58	15
6	Diuron*	22301	7008	0	7008	6906	69	45	24
7	Simazine*	22421	7444	0	7444	7120	298	266	32
8	Desisopropylatrazine	22621	5084	0	5084	4827	241	210	31
9	Hexazinone*	22611	5712	0	5712	5678	20	9	11
10	Isoproturon	22511	7017	0	7017	6963	42	33	9
11	AMPA	21381	1303	0	1303	1285	8	2	6
12	Desethylterbutylazin*	22671	5894	0	5894	5757	129	113	16
13	Propazine*	22431	6115	0	6115	6001	106	95	11
14	Ethidimuron*	22761	1662	0	1662	1647	7	2	5
15	1,2,4-Trichlorbenzene	20601	836	0	836	826	2	0	2
16	Metazachlor	22491	7313	0	7313	7292	14	11	3
17	Dichlorprop*	22541	5444	0	5444	5427	10	8	2
18	Desethylsimazine*	21281	1488	0	1488	1474	7	6	1
19	Glyphosate	21371	1661	0	1661	1649	5	4	1
20	Terbutylazine	22481	7315	0	7315	7248	61	54	7
21	MCPA	22531	5655	0	5655	5646	3	2	1
22	Metolachlor*	22501	5342	0	5342	5322	15	13	2
23	Oxadixyl*	21291	793	0	793	781	7	5	2
24	Fenuron*	22391	788	0	788	779	4	3	1
25	Chloridazon	22881	4253	0	4253	4240	9	9	0
26	d-Hexachlorcyclohexane	21171	1458	0	1458	1452	3	2	1
27	Prometryn*	22451	2860	0	2860	2846	11	8	3
28	Lenacil*	26301	1798	0	1798	1787	8	4	4
29	Chlortoluron	22351	4922	0	4922	4913	6	4	2
30	Ethofumesat	23671	2200	0	2200	2193	4	3	1
31	Methabenzthiazuron*	22381	3690	0	3690	3684	3	2	1

Source: Federal Environment Agency (UBA), 2013

76 The column "No. of Länder" indicates the number of Länder that performed tests for the relevant active ingredient/metabolite in the groundwater.

contamination of groundwater; analysis results 2011⁷⁶

no. of monitoring sites > 0.1 µg/L	%	no. of monitoring sites > 0.1 bis 1.0 µg/l	no. of monitoring sites > 1.0 bis 3.0 µg/l	no. of monitoring sites > 3.0 bis 10.0 µg/l	no. of monitoring sites > 10.0 µg/l	year	substance class (plant protection product = PPP)		no. of the Länder
220	2.97	210	9	0	1	2011	PPP	PPP/metabolit	14
98	1.36	91	6	1	0	2011	PPP	PPP	15
88	1.31	75	4	7	2	2011	PPP	PPP	16
73	1.36	63	3	4	3	2011	PPP	PPP	12
33	0.52	31	0	2	0	2011	PPP	PPP	15
33	0.47	25	2	6	0	2011	PPP	PPP	15
26	0.35	25	1	0	0	2011	PSM	PPP	16
16	0.31	16	0	0	0	2011	PPP	PPP/metabolit	13
14	0.25	14	0	0	0	2011	PPP	PPP	13
12	0.17	8	3	1	0	2011	PPP	PPP	14
10	0.77	8	2	0	0	2011	PPP	PPP/metabolit	8
8	0.14	8	0	0	0	2011	PPP	PPP/metabolit	14
8	0.13	8	0	0	0	2011	PPP	PPP	12
8	0.48	5	1	2	0	2011	PPP	PPP	7
8	0.96	7	0	0	1	2011	PPP	PPP/metabolit	4
7	0.10	5	1	0	1	2011	PPP	PPP	15
7	0.13	7	0	0	0	2011	PPP	PPP	14
7	0.47	7	0	0	0	2011	PPP	PPP/metabolit	3
7	0.42	7	0	0	0	2011	PPP	PSM	11
6	0.08	6	0	0	0	2011	PPP	PPP	14
6	0.11	5	1	0	0	2011	PPP	PPP	14
5	0.09	5	0	0	0	2011	PPP	PPP	13
5	0.63	4	1	0	0	2011	PPP	PPP	7
5	0.63	4	1	0	0	2011	PPP	PPP	8
4	0.09	3	1	0	0	2011	PPP	PPP	12
4	0.27	3	0	1	0	2011	PPP	PPP-component	9
3	0.10	3	0	0	0	2011	PPP	PPP	13
3	0.17	2	1	0	0	2011	PPP	PSM	10
3	0.06	2	1	0	0	2011	PPP	PPP	12
3	0.14	2	0	1	0	2011	PPP	PPP	7
3	0.08	3	0	0	0	2011	PPP	PPP	11

5.2.2 Inland waters

Inland surface waters are likewise affected by multiple uses such as wastewater discharges, inputs from agriculture, and structural alterations to the banks and riverbed. Surface waters are regularly analysed to check for pressures and assess the impacts. The purpose of waterbody status monitoring is to

- ▶ identify the impacts of anthropogenic influences on aquatic ecosystems,
- ▶ document the current status with regard to waterbody pollution,
- ▶ gauge the effectiveness of water protection measures on the basis of quality data
- ▶ prevent potential danger to human health.

Monitoring

Under the WFD, monitoring has been redesigned and uniformly regulated throughout the Federal Republic of Germany by the Surface Waters Ordinance (OGewV)⁷⁷. This distinguishes three different types of monitoring for surface waters:

- ▶ Surveillance monitoring
- ▶ Operational monitoring and
- ▶ Investigative monitoring.

Surveillance monitoring assesses the overall status in any catchment area or sub-catchment area of a river basin district, and provides an insight into long-term changes. The Länder in Germany have defined almost 400 monitoring sites for this form of monitoring. The monitoring network is relatively wide-meshed, but the catchment area per monitoring site must not exceed 2,500 square kilometres. Most of the monitoring sites have been set up in the main flows of the major rivers and the mouths of major tributaries.

Overview monitoring sites usually measure all the quality elements (QEs) of ecological status, i.e. biological, hydromorphological, chemical and physico-chemical QEs. Chemical QEs include river basin-specific pollutants which must be monitored if discharged in significant quantities. Furthermore, priority substances for the classification of chemical waterbody status must also be measured if discharged into the respective waterbody.

Operational monitoring serves to monitor the status of those waterbodies that do not meet or might not meet the environmental objectives. Hence it is also a tool for monitoring the success of any measures implemented. To this end, the Länder in Germany have defined a total of 7,855 monitoring sites in surface waters. Operational monitoring therefore constitutes the main focus of surface water monitoring. On average, watercourses have a monitoring site every 20 kilometres. Operational monitoring analyses those quality elements that respond most sensitively to existing pressures in the waterbodies being assessed. In Germany, the operational monitoring sites are analysed at least once a year, 21 % are sampled and evaluated monthly, and 2 % daily.

Investigative monitoring becomes necessary if the reasons for a high level of water pollution are unknown, or in order to determine the scale and impacts of unintentional contamination. It is also used in the event of incidents with unforeseen pollutant discharges or sudden fish mortality in waterbodies. There are currently comparatively few such sites (375) installed in river basins.

Figure 24: Monitoring sites in surface waters in Germany



Data source: Berichtsportal WasserBLiCK/BfG, as at 22 March 2010

77 Ordinance on the Protection of Surface Waters (Surface Waters Ordinance – OGewV) of 20 July 2011 (Federal Law Gazette (BGBl.) I, p. 1429).

Table 6: Overview of the number of monitoring sites for the various monitoring types and waterbody categories among surface waters in Germany

Monitoring type	River	Lakes	Transitional waters	Coastal waters
Surveillance monitoring	290	67	5	32
Operational monitoring	7,288	447	20	100
Investigative monitoring	375	0	0	0

Datasource: Berichtsportal WasserBlick/BfG, as at 22 March 2010

Status

The WFD provides for a comparable European-wide method for determining the ecological and chemical quality of surface waters. This was transposed into German law by the OGeWV⁷⁸. For surface waters, this requires a consideration of ecological status and chemical status. The overall status of surface waters is determined from the worst of these two values, in other words, in order to achieve a “good” status, both the ecological status and the chemical status must at least be classified as “good”.

Ecological status

Ecological water quality is defined primarily via the biology, since the composition of the aquatic community in a given water type reflects the totality of all influencing factors and disturbance variables. The biological assessment is supplemented by environmental quality standards for river basin-specific synthetic and non-synthetic pollutants, where these are not already on the valid European-wide list of priority and priority hazardous substances for the assessment of chemical status (WFD, Annex X; OGeWV, Annex 7), and by general physico-chemical parameters such as temperature, oxygen and nutrients. When assessing a very good ecological status, the so-called hydromorphological quality elements must additionally be taken into account. The results of the ecological assessment are graded in a 5-stage classification system.

The requirements imposed by the WFD and OGeWV with regard to the biological status classification of flora and fauna in rivers, lakes, transitional waters and oceans allow a waterbodies ecological status to be classified in the totality of all anthropogenic pressures. Waterbody type-specific reference conditions were defined as the reference scale for assessment, which are derived from the biological, physico-chemical and hydromorphological properties of the respective waterbody type. The ecological status class reflects the degree of deviation from these reference conditions. Assessment procedures are now available for all the biological quality elements (QEs) required by the WFD (macrozoobenthos, macrophytes/phytobenthos,

fish fauna, phytoplankton, macroalgae/angiosperm). As the organism groups prescribed for assessment purposes have different habitat requirements and indication properties, we can assume that the (often highly complex) effects of individual pressures will be determined far more effectively in future via the biology.

Heavily modified and artificial waters are distinguished from natural waterbodies. These were either created artificially (e.g. a canal), or else their structure has been modified so extensively that a “good ecological status” can no longer be achieved without significantly impairing an existing, economically significant water use that cannot be achieved by other means. For such waters, an equally ambitious environmental objective of a “good ecological potential” has been defined, which requires improvements to be made to the hydromorphological pressures without impairing non-substitutable water uses. However, chemical status applies in exactly the same way as for natural waterbodies. The status of artificial or heavily modified waterbodies is considered “good” if the ecological potential and chemical status are both rated “good”.

The ecological status of surface waters (rivers, lakes, transitional and coastal waters) in Germany is illustrated below:

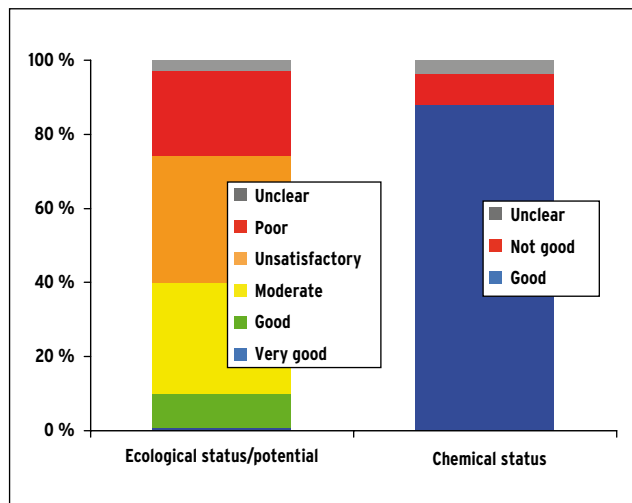
There are some 9,900 bodies of surface water. 37 % of them have been designated “heavily modified”. 15 % are artificial. Just under half of surface waters (48 %) are therefore “natural”. Only 10 % of all waterbodies achieve a “very good” or “good ecological status”.⁷⁹ The ecological status of 87 % of surface waterbodies is assessed as “moderate” (30 %), “unsatisfactory” (34 %) and “poor” (23 %). A small proportion of surface waterbodies (3 %) has yet to be assessed (“unclear”).

If watercourses in Germany fail to achieve a “good ecological status”, this is generally due to a radical change in the hydromorphology and excessive nutrient loads. In the case of lakes, transitional and coastal waters, increased nutrient emissions are responsible for failing to meet the objective.

78 Ordinance on the Protection of Surface Waters (Surface Waters Ordinance – OGeWV) of 20 July 2011, Federal Law Gazette I page 1429.

79 This summary does not distinguish between ecological status and potential; for simplification purposes, both are referred to as “ecological status”.

Figure 25: Ecological and chemical status of surface waters in Germany



Data source: Berichtsportal WasserBLICK/BfG, as at 22 March 2010

Below, we outline the development of nutrient loads in the major rivers:

Throughout all major rivers, total phosphorus concentrations have decreased significantly over the period 1982–2011. A small decrease has also been observed for nitrate nitrogen concentrations. The biggest problem for lakes continues to be the excessive inputs of nutrients and the resulting over-fertilisation. As nutrients are stored in the sediment of standing water and may be re-released under certain conditions, lakes only respond very slowly to a reduction in nutrient inputs. One example of successful nutrient reduction is Lake Constance, whose eutrophication in the in the 1950s to 1980s has now been halted, and for the most part reversed, thanks to international efforts.

Oxygen conditions in watercourses in Germany are now assessed within the framework of determining ecological status. In the past, these pressures were determined according to the Saprobic System, the results of which were published every five years between 1975 and 2000 by LAWA in the form of a biological water quality map. The Saprobic System uses macrozoobenthos (= invertebrates visible to the naked eye which live on or in the river bed) to describe the oxygen balance of watercourses. This is decisively affected by organic, biodegradable pollutants causing oxygen depletion. A comparison of the biological water quality maps for 1975 to 2000 shows that the measures taken since the 1970s to improve and extend wastewater treatment are now reflected in a marked improvement in the oxygen balance. The proportion of mapped watercourses with quality class II or above increased to 65 % in 2000. The overall length of the mapped rivers is approximately 30,000 km (Table 7).

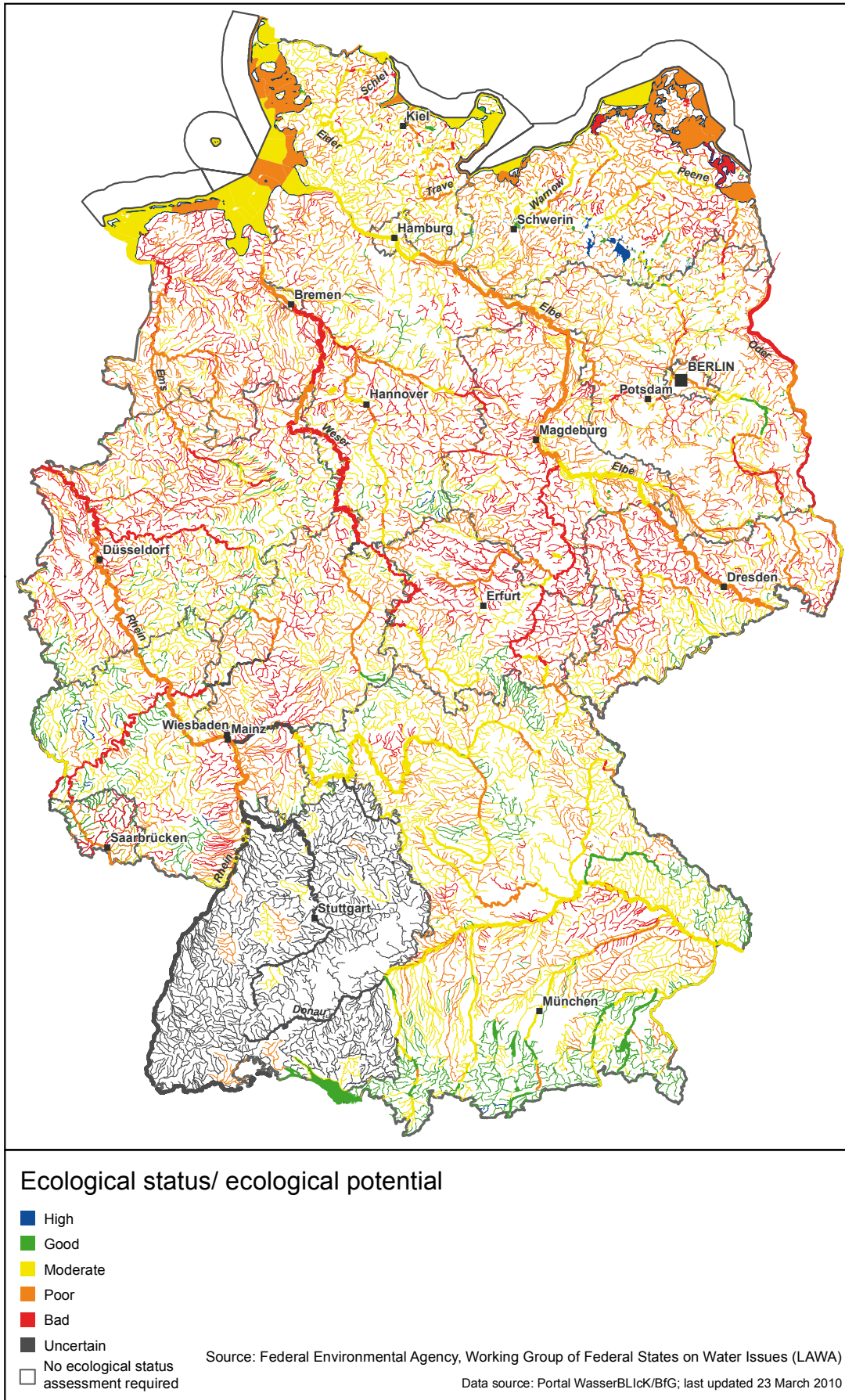
Observations of the biotic communities and oxygen balance in waterbodies have been recorded since at least the beginning of the last century. Figure 30 illustrates the conditions in the German sections of the Rhine and Elbe rivers. According to species lists from various authors, in the early 20th century the Rhine was inhabited by some 165 species of macrozoobenthos, while in around 1930 the Elbe was inhabited by 120 or so species. As wastewater pollution increased and oxygen levels fell, the numbers of species have declined dramatically since the mid-1950s. The aquatic insect species (mayflies, stoneflies and caddis flies) were particularly affected. By 1971, only 5 species out of a total of more than 100 remained in the Rhine, and in the Elbe only a few more. Improved oxygen conditions associated with the construction of industrial and public wastewater treatment plants in the Rhine led to a turnaround from the mid-1970s onwards, while

Tabelle 7: Biological quality classification – Proportion of river kilometres in the waterbody network (approx. 30,000 km)

Quality class	Degree of pollution	1995	2000
I	unpolluted to slightly polluted	0.7 %	0.8 %
I-II	slightly polluted	3.8 %	6.5 %
II	moderately polluted	42.7 %	57.8 %
II-III	critically polluted	43.6 %	31.4 %
III	heavily polluted	7.4 %	2.8 %
III-IV	very heavily polluted	1.1 %	0.3 %
IV	excessively polluted	0.7 %	0.4 %

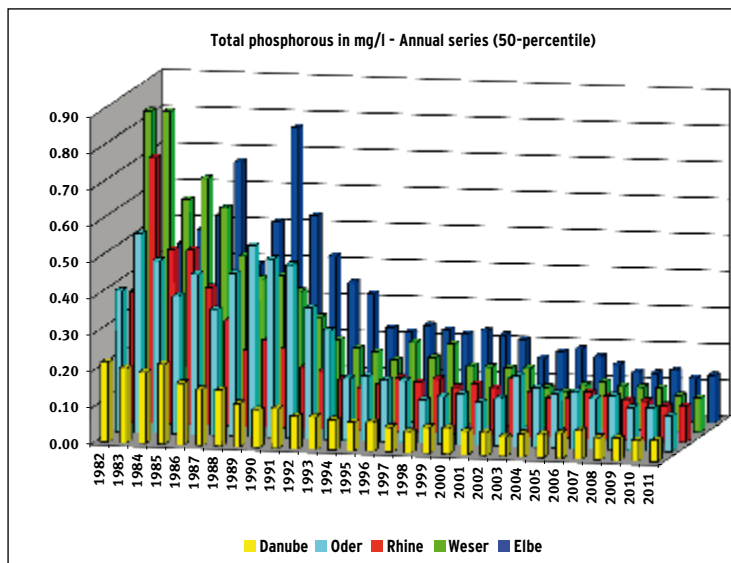
Source: Compiled by the Federal Environment Agency (UBA) from data supplied by LAWA

Figure 26: Ecological status of surface waters in Germany



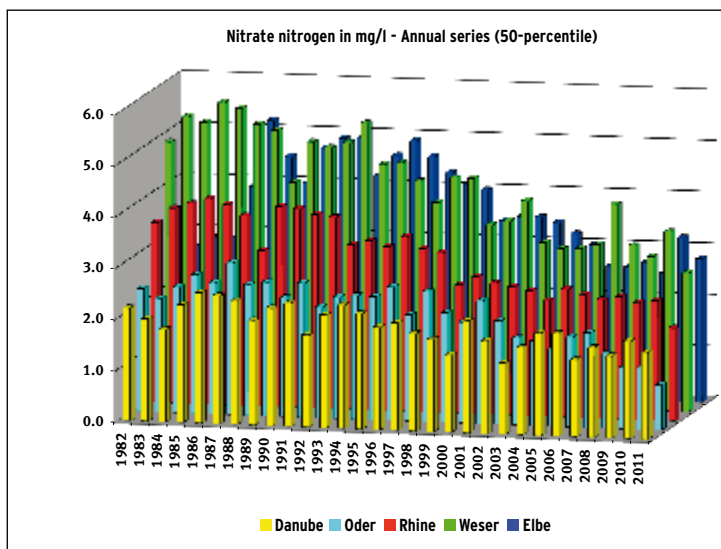
Data source: Berichtsportal WasserBLiCK/BfG, as at 22 March 2010

Figure 27: Total phosphorous concentration – Danube (Jochenstein), Oder (Hohenwutzen), Weser (Bremen), Rhine (Kleve-Bimmen) and Elbe (Schnackenburg)



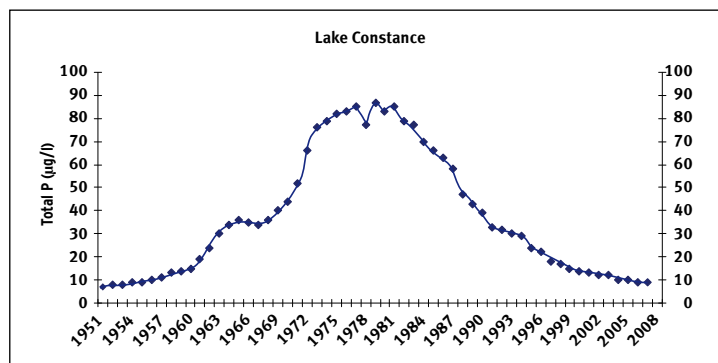
Source: Federal Environment Agency (UBA), data supplied by LAWA

Figure 28: Nitrate nitrogen concentration – Danube (Jochenstein), Oder (Hohenwutzen), Weser (Bremen), Rhine (Kleve-Bimmen) and Elbe (Schnackenburg)



Source: Federal Environment Agency (UBA), data supplied by LAWA

Figure 29: Total phosphorous concentration in Lake Constance (Upper Lake) during the intermixing period (1951–2008)



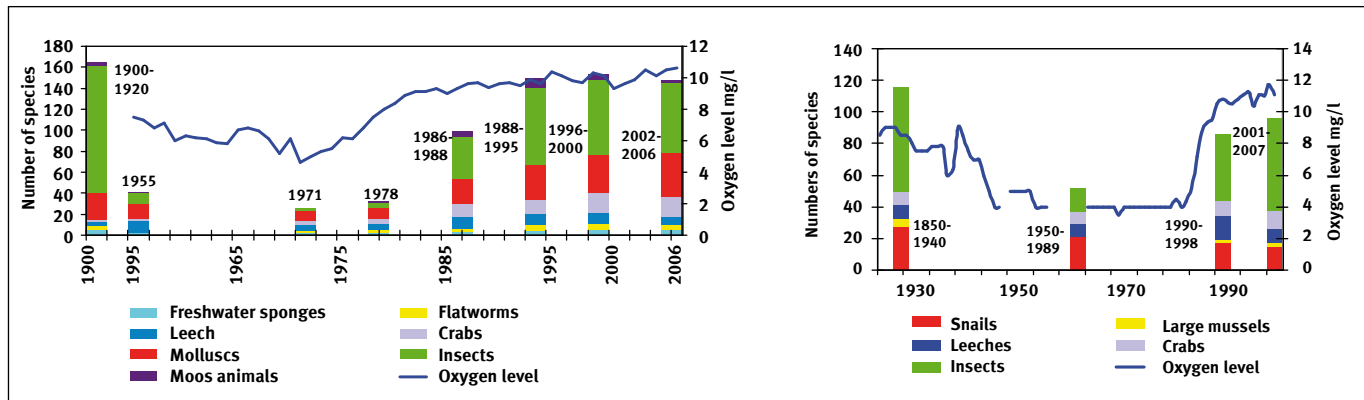
Source: International Commission for the Protection of the Waters of Lake Constance

in the Elbe, the situation did not improve until after German reunification in the early 1990s. Some of the characteristic river species that had been considered extinct or heavily decimated have now returned, but a large number of typical species remain absent, no doubt partly due to the fact that their habitats no longer exist due to structural impoverishment. Additionally, large numbers of non-native (neobiota) and ubiquitous species (species with a high degree of adaptability) which are better able to withstand anthropogenic influences such as increased water temperatures, structural measures and water constituents, have now become established⁸⁰.

Morphological changes in watercourses are recorded directly for an assessment of structural waterbody quality. The reference (class 1) represents the potential natural status, i.e. the status which would occur if current uses and obstructions were to be reversed. Under these conditions, the type-specific biotic communities would be present in their entirety (reference status). The further stages ranging from slightly modified (class 2) to completely modified (class 7) characterize the degree of anthropogenic structural changes. Under these conditions, different biotic communities from those in the reference status will emerge. As shown by the 2001 water structure quality map prepared by LAWA in collaboration with the Federal Environment Agency (UBA), morphological deficits with structure class 4 or below exist in around 79 % of cases (**Figure 31**). Only 21 % of Germany's rivers and streams, predominantly in less populated regions, are still in a semi-natural state, i.e. with little to moderate modification by humans (structure classes 1 to 3). The 2001 water structure quality map impressively illustrates the existing hydromorphological deficits of our waterbodies. According to the WFD's philosophy, however,

80 Schöll, F. (2009a): Rhein-Messprogramm Biologie 2006/2007, Teil II-D, Das Makrozoobenthos des Rheins 2006/2007, Bericht 172, 39 p. Published by: IKSR Schöll, F. (2009b): Elbe, Macroinvertebrates (Chapter 14.3.4.3) in: Tockner, T. Uelinger, U. & Robinson, C.T. (publishers): Rivers of Europe. 700. p. Elsevier.

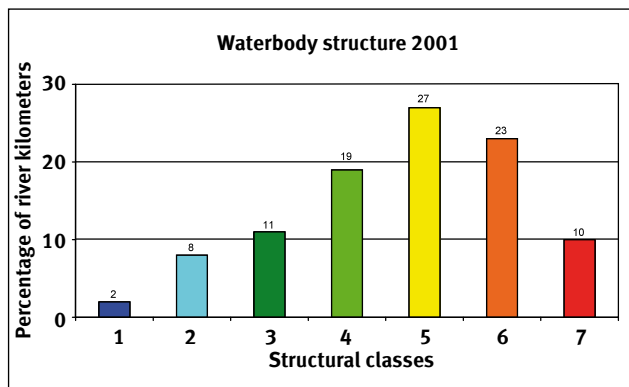
Figure 30: Historical development of the biotic community (selected species groups) and average oxygen levels of the Rhine near Emmerich (left) and the German Elbe near Magdeburg (right)



Source: According to Schöll 2009a, 2009b⁸¹

hydromorphological degradation is only used to determine whether the ecological status can be classed as “very good”, while the classes good, moderate, poor and bad are only measured and classified via the biological quality elements.

Figure 31: Structural quality classification – River kilometres as a percentage of the waterbody network (approx. 33,000 km)



Source: LAWA

Chemical status

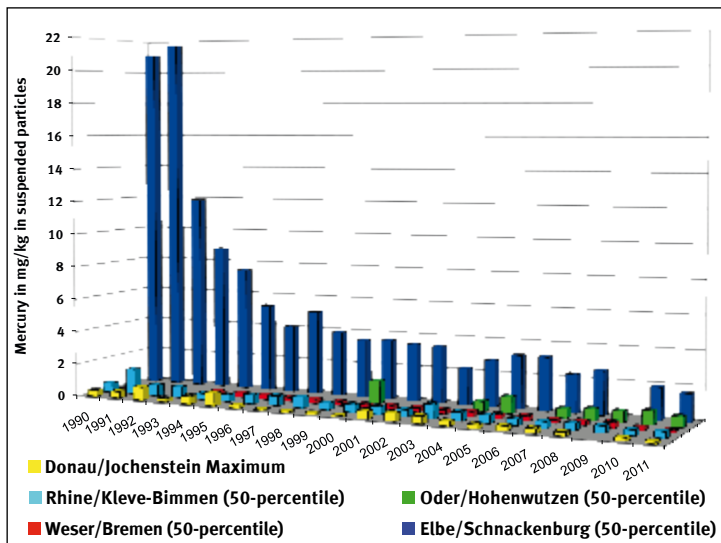
Chemical water quality is influenced by wastewater discharges and diffuse inputs from the land, e.g. from agriculture. Therefore, the derivation of environmental quality standards for problem substances such as organic micro-contaminants and the regular monitoring thereof represents therefore an important water protection instrument. It helps to identify pollution hotspots and monitor the effectiveness of measures taken to reduce the pollution load of our waterbodies. In Germany, the objectives and classification of chemical waterbody quality have traditionally provided the basis for assessing the pollution load of inland surface

waters. 2001 saw the introduction of legally binding quality objectives with the Quality Objective Ordinance implementing the Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community. Further legally binding environmental quality standards were introduced with the WFD, and transposed into German law by the OGewV. The Directive distinguishes three different groups of material quality elements; the first comprises environmental quality standards for priority substances that are regulated on an EU-wide basis as well as certain other pollutants which determine the chemical status of waterbodies throughout Europe. The second group contains environmental quality standards for river basin-specific synthetic and non-synthetic pollutants for classifying ecological status, which are defined at national level. The third group comprises “threshold values” for the general physico-chemical quality components which are designed to ensure the proper functioning of waterbody type-specific ecology and compliance with the values for biological quality elements such as temperature and nutrient conditions.

The chemical status of waters is determined via compliance with environmental quality standards (EQS) for pollutants with European-wide significance. 88 % of surface waters in Germany achieved a “good chemical status” under valid national law in force after 2009. In applying the EQS from the Environmental Quality Standards Directive 2008/105/EC, 100 % of water bodies are expected to fall short of the target of a “good chemical status”.

⁸¹ Schöll, F. (2009a): Rhein-Messprogramm Biologie 2006/2007, Teil II-D, Das Makro-zoobenthos des Rheins 2006/2007, Bericht 172, 39 S. Hrsg.: IKSR Schöll, F. (2009b): Elbe, Macroinvertebrates (Chapter 14.3.4.3) in: Tockner, T. Uelinger, U. & Robinson, C.T. (Hrsg.): Rivers of Europe. 700. S. Elsevier.

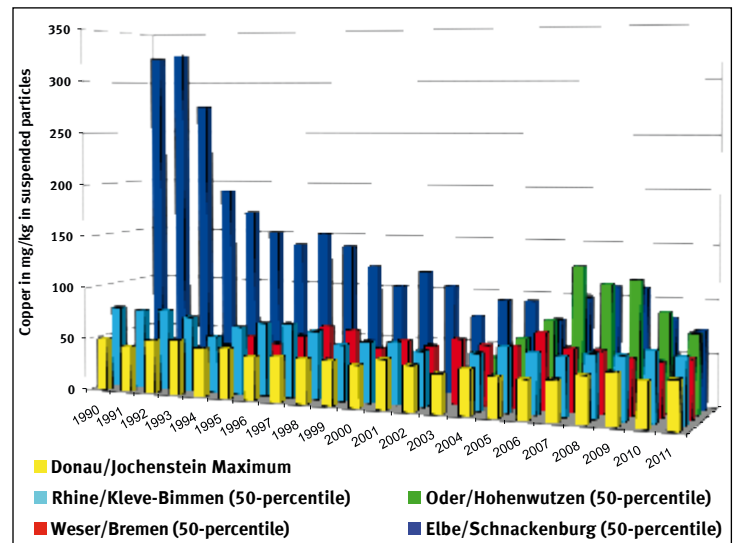
Figure 32: Mercury concentration – Danube/Jochenstein (maximum), Rhine/Kleve-Bimmen (50-percentile), Weser/Bremen (50-percentile), Oder/Schwedt (mean) and Elbe/Schnackenburg (50-percentile)



Source: Federal Environment Agency (UBA), data supplied by LAWA, ARGE Elbe and the BfG

In the period 2009–2011, isolated cases of the EQS being exceeded were ascertained for the metal cadmium, polycyclic hydrocarbons (PAH, combustion products), benzo[b]fluoranthene and benzo[k]fluoranthene, the pesticides DDT, diuron, isoproturon, and the industrial chemicals nonylphenol, octylphenol and hexachlorobenzene. The EQS are exceeded more frequently in the cases of the PAHs benzo[g,h,i]perylene & indeno[1,2,3-cd]pyrene, as well as the pesticide tributyl tin. The maximum allowable concentrations are exceeded in isolated cases by nonylphenol, benzo[a]pyrene, fluoranthene, hexachlorobenzene, the pesticide hexachlorocyclohexane and isoproturon, and more frequently in the case of tributyl tin. Initial measurements in biota indicate that despite a substantial reduction in mercury emissions over the past 20 years, the EQS for mercury in biota of 20 µg/kg wet weight is exceeded by fish in Germany nationwide, and by mussels at polluted locations.

Figure 33: Copper concentration – Danube/Jochenstein (maximum), Rhine/Kleve-Bimmen (50-percentile), Weser/Bremen (50-percentile), Oder/Schwedt (mean) and Elbe/Schnackenburg (50-percentile)



Source: Federal Environment Agency (UBA), data supplied by LAWA, ARGE Elbe and the BfG

Convention on Biological Diversity⁸²

The Convention on Biological Diversity (CBD) of 5 June 1992, which was signed within the context of the Rio Conference, has been in force since 29 December 1993. The Convention represents the central, most comprehensive, internationally binding regulation on the protection and sustainable use of biological diversity.

The aim of the Convention is, firstly, to protect all components of biological diversity such as the conservation of genetic resources and the preservation of biotopes and entire ecosystems. Secondly, however, it also concedes the sustainable use of such biodiversity elements. Accordingly, one of the main aims of the Convention is to achieve a balance between the conservation and use of biological diversity.

The Convention obligates the Contracting Parties to set up protected areas (such as protected areas for aquatic ecosystems). At the 9th Conference of the Parties in Bonn from 19–30 May 2008, scientific and ecological criteria were adopted for this purpose.

⁸² Convention on Biological Diversity (CBD), Federal Law Gazette (BGBl.) 1993 II, p. 1741.

The WFD supports the attainment of the objectives of the Biodiversity Convention. Once the objectives of the Directive are achieved, there will also be greater diversity of habitats and species in waterbodies. In terms of species population, the required “good ecological status” may only deviate minimally from the near-natural state. If the chemical status is additionally good, waterbody organisms should not be affected by chemicals.

Convention on Climate Change and Kyoto Protocol⁸³

Climate change is one of the key challenges facing current environmental policy. The United Nations Framework Convention on Climate Change of 9 May 1992, which was signed at the Rio Conference, and the Kyoto Protocol of 11 December 1997, have major significance for surface waters.

The Framework Convention on Climate Change aims to stabilise the concentrations of greenhouse gases in the atmosphere at a level which will prevent dangerous anthropogenic interference with the climate system. Despite climate protection efforts to date, emissions of greenhouse gases continue to rise.

In addition to the contributions made to reduce emissions and thereby limit global warming, the water resources management industry must also proactively prepare for climate change so as to minimise the risks and keep economic damage to a minimum. One task, which can only be planned and implemented within the framework of medium- to long-term programmes, is to identify future changes in the hydrological regime as a consequence of potential climate change, provide the water resources administrations with information on the associated quantitative and qualitative hydrological impacts, and develop sustainable action strategies for implementing these in line with the precautionary principle.

Changes in climate variables influence hydrological processes and the hydrological regime. The effects vary according to region, which in turn makes it difficult to give general projections. Regional consideration of climate change and assessment of its impacts on the hydrological regime must be continued and intensified. Changes in both mean and extreme values are relevant here. Given the change in the precipitation and evaporation regime (long-term changes in the mean status, seasonal distribution, variation and extreme events), impacts on the groundwater balance and surface outfall are likely in future. Changes in these factors have a direct influence on key sub-sections of water resources management, such as

- ▶ Flood protection, due to the changes in the level, duration and frequency of extreme flooding, and the increased risk of damage
- ▶ Water supply, due to changes in groundwater recharge, groundwater properties and groundwater management, and also, in some cases, the management of reservoirs
- ▶ Water protection, due to changes in the seasonal discharge and temperature conditions affecting the balance of materials in the rivers and lakes and the biocoenosis. In particular, organisms that have adapted to today’s constant temperatures in coastal waters and lakes and organisms in the cooler highland waters are expected to lose their habitats.
- ▶ Waterbody development, due to changes in the dynamics of watercourses and lakes, their morphological conditions, their thermal regime and their ecosystems, and
- ▶ The use of waters, especially as a result of changes in the operating methods for flood and drinking water reservoirs, hydropower use, the navigability of waters, cooling water use, and agricultural irrigation.

5.2.3 Coastal and marine waters

Seas and oceans cover four-fifths of the earth’s surface, are independent from territorial boundaries, and encompass the entire globe. As such, protection of the marine ecosystems can only succeed within the context of international agreements and cooperation, since the world’s oceans are also used on a trans-boundary basis. For regional seas such as the North and Baltic Seas, the cooperation of the affected countries is also needed.

5.2.3.1 International marine protection

At international level, the following international conventions are particularly relevant for the marine sector:

- ▶ Convention on the Law of the Sea (UNCLOS)
- ▶ Convention on Biological Diversity (CBD)
- ▶ Convention on Climate Change and Kyoto Protocol
- ▶ Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)

Additionally, in 1995, a Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities⁸⁴ was agreed in Washington.

83 <http://unfccc.int/resource/docs/convkp/kpeng.pdf>

84 Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (Washington, 1995).

“The constitution of the seas” – the United Nations Convention on the Law of the Sea

The most important legal foundation is the United Nations Convention on the Law of the Sea (UNCLOS) of 1982⁸⁵, which entered into force in 1994. UNCLOS, also known as the “constitution of the seas”, obligates the Contracting Parties to protect the marine environment, and therefore provides the basis for international action relating to the protection and sustainable development of the marine and coastal environment and its resources. UNCLOS requires the Contracting Parties to cooperate on a national, sub-regional, regional and global level in order to achieve effective protection of the marine environment. The cooperative concepts must be integrative in content and preventive and precautionary in effect. UNCLOS applies both to the sovereign marine areas of the Contracting Parties (territorial seas and exclusive economic zones) and on the high seas. It also contains provisions for the seabed and the subsoil thereof beyond national jurisdiction, which it considers the “common heritage of mankind”. The exploration and mining of resources from the deep seabed is administered by an international authority in Kingston, Jamaica, set up by UNCLOS. As such, the obligation to protect the marine environment applies comprehensively to all seas.

Protecting diversity in the oceans – the Convention on Biological Diversity (CBD)

The provisions of the 1992 CBD⁸⁶ (cf. also 5.2.2) apply to ecosystems and habitats (and other elements of biological diversity) within the national sovereign territories of each Party, including the exclusive economic zone and the continental shelf. On the high seas and on the seabed and the subsoil thereof beyond national jurisdiction, the provisions of the CBD only apply to actions by citizens of a Party. For provisions concerning the protection of ecosystems beyond national jurisdiction, Article 5 of the CBD introduces a broad-based obligation to cooperate on the conservation and sustainable use of biodiversity. By giving preference to the conservation of local natural habitats, the CBD reinforces the conservation concept via a system of protected areas. At Conferences of the Parties, the Parties have repeatedly addressed issues relating to the conservation of marine biodiversity. At the 9th Conference of the Parties in 2008 in Bonn, the Parties adopted scientific and ecological criteria for the establishment of marine protected areas.

In Europe, the conservation of biological diversity in line with the CBD is supported by a range of instruments. As well as implementing the Habitats Directive, conservation of the marine ecosystems should currently be implemented by measures according to MSFD.

85 Act on the United Nations Convention on the Law of the Sea of 10 December 1982, Federal Law Gazette (BGBl.) II 1994, p. 1798.

86 Federal Law Gazette (BGBl.), 1993 II, p. 1741, Convention on Biological Diversity (CBD).

The ocean in a greenhouse – the Convention on Climate Change and the Kyoto Protocol

Only intact marine ecosystems have the requisite strength to be resilient to the effects of climate change. Due to this, the United Nations Framework Convention on Climate Change of 9 May 1992, which was signed at the Rio Conference, and its additional Kyoto Protocol of 11 December 1997, are of particular relevance to coastal and marine areas. The Framework Convention on Climate Change aims to counteract the feared impacts of climate change on the marine environment. The oceans store around 50 times the volume of carbon dioxide contained in the atmosphere, and will have to act in the long term as the principal carbon dioxide sink. Rising carbon dioxide concentrations in the upper marine strata have been measured for several decades now, leading to acidification (cf. also chapter 2.3). This can have wide-ranging ecological impacts; calcifying organisms (such as coral reefs) are particularly affected. The water temperature is also rising as a result of climate change. As well as the physical effects of warming, the distribution of species has also been shown to be affected, as they may migrate into warmer areas or retreat to colder regions.

The Convention calls on the Parties both to reduce emissions of climate-relevant greenhouse gases, and to prepare measures to adapt to the adverse impacts of climate change, such as the development of integrated management plans for coastal regions and the strengthening of coastal protection. In keeping with the precautionary principle anchored in the Framework Convention on Climate Change, all activities in coastal and marine regions must be considered from the aspect of preventive climate protection.

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention⁸⁷)

The London Convention of 29 December 1972 was supplemented in 1996 by an ambitious Protocol. Since its entry into force in 2007, this Protocol has replaced the Convention for all Contracting Parties of the Protocol. While the London Convention of 1972 only envisages bans on the import of certain substances (black list), a general ban is anchored in the Protocol of 1996. Exceptions to this ban are only admissible for certain waste categories.

These exceptions are:

- ▶ Dredged material
- ▶ Sewage sludge
- ▶ Fishing waste
- ▶ Waste from vessels, platforms and other man-made structures at sea

87 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Federal Law Gazette (BGBl.) 1977 II, p. 165, 180; most recently amended by the Act of 11 February 1987, Federal Law Gazette (BGBl.) 1987 II, p. 118.

- ▶ Inert, inorganic, geological materials
- ▶ Organic materials of natural origin
- ▶ Bulky items made of steel, iron, concrete or similar materials leading primarily to physical environmental impacts (only applies to locations with no other options for disposal, such as islands), and
- ▶ CO₂ streams, where these are sequestered in sub-seabed geological formations.

The exemption for CO₂ streams was incorporated into Annex I to the London Protocol in 2006, with the aim of facilitating measures for the separation and storage of CO₂ streams in the sub-seabed. However, the storage of CO₂ streams in the water column is prohibited (see **chapter 6.7** for further details). The Contracting Parties have also adopted specific guidelines to be taken into account when approving CO₂ storage projects in the sub-seabed.

The Convention also includes a general worldwide ban on the incineration of waste at sea, which had already been discontinued in the Federal Republic of Germany since 1989.

On 18 October 2013, the Contracting Parties to the London Protocol unanimously agreed a binding new regulation for marine geo-engineering measures. The new regulation prohibits commercial activities in the area of marine fertilisation, and introduces the requirement for the mandatory licensing of research activities in this connection. The Contracting Parties must verify that the project is in fact a research activity, and that any adverse effects on the marine environment are excluded. The assessment criteria are derived from the legally binding “Generic Assessment Framework” and the non-binding “Ocean Fertilization Assessment Framework” (see **chapter 6.7** for further details). The new regulation allows the Contracting Parties to put other marine geo-engineering measures under a control regime.

This is the first internationally binding regulation on geo-engineering measures. The regulatory concept for marine fertilisation, which envisages a general ban with the reserved right to grant permits for research activities and a future proofed regulatory mechanism (listing principle), could serve as a role model for other areas. Legally binding distinguishing criteria for research and deployment have been defined in international law for the first time. The amendment will not enter into force until it has been ratified by two-thirds of the Parties to the London Protocol.

Global Programme of Action for the Protection of the Marine Environment from Land Based Activities

The UNEP Global Programme of Action (GPA) for the Protection of the Marine Environment from Land Based Activities is aimed at preventing any deterioration

in the status of the marine environment as a result of land-based activities. The Parties recognise their obligation to preserve and protect the marine environment. The following areas of international cooperation are particularly significant in this respect: Wastewater treatment, persistent organic pollutants (POPs), radioactive substances, heavy metals, hydrocarbons, nutrients, the mobilisation of sediments, (household) waste, and the alteration and destruction of habitats.

5.2.3.2 Regional marine protection

At regional level, marine protection in Germany’s seas, i.e. the North and Baltic Seas, is regulated by the following conventions:

Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) of 1992

The OSPAR Convention has been in force⁸⁸ at international level since 25 March 1998. The OSPAR Convention replaced the following earlier conventions:

- ▶ Convention for the Prevention of Marine Pollution from Land-Based Sources (Paris Convention) of 6 April 1974, covering the North Sea and North-east Atlantic;
- ▶ Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (Oslo Convention) of 15 February 1972, covering the North Sea and Northeast Atlantic.

The OSPAR Convention was extended in 1998 with the addition of Annex V, on the protection and conservation of the ecosystems and biological diversity of the maritime area and a corresponding appendix of criteria.

The Contracting Parties (Belgium, Denmark, Germany, Finland, France, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Sweden, Switzerland, Spain, United Kingdom of Great Britain and Northern Ireland, and the European Community) must all take every action possible to prevent and eliminate pollution. Furthermore, they must take all steps necessary to protect the marine environment from the adverse effects of human activities in order to protect human health, preserve marine ecosystems, and where possible, restore impaired marine areas. In doing so, they must apply the precautionary and polluter-pays principles, as well as “best available technology” and “best environmental practice”. In particular, the OSPAR Convention also applies to land-based pollution.

In 1989/99, the OSPAR Commission adopted five strategies which are decisive for the Commission’s long-term work, covering the following areas:

⁸⁸ Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) of 1992, Federal Law Gazette (BGBl.) 1994 II, p. 1360, most recently amended by the Act of 18 June 2001, Federal Law Gazette (BGBl.) 2001 II, p. 646 ff.

- ▶ Hazardous substances
- ▶ Radioactive substances
- ▶ Eutrophication
- ▶ Biological diversity and ecosystems
- ▶ Offshore oil and gas industry.

In 2003, the Commission added a strategy for a joint assessment and monitoring programme.

At the 2010 Ministerial Meeting in Bergen, OSPAR adopted the North-East Atlantic Environment Strategy. The strategy underlines the parties' commitment to an ecosystem-based approach, and defines the primary objectives based on the vision of a clean, healthy, biologically diverse North-East Atlantic that is used sustainably. The Bergen Statement also agreed coordination work in conjunction with the MSFD. The OSPAR vision of regionally coordinated implementation of the MSFD by Parties who are also EU Member States also includes the development of joint OSPAR indicators, as an essential basis for regionally coordinated monitoring programmes in accordance with Article 11 of the MSFD. OSPAR also plays a key coordinating role in the development of programmes of measures pursuant to Article 13 of the MSFD.

The 2007 decision to permit the storage of CO₂ streams in the sub-seabed while at the same time prohibiting the storage of CO₂ streams in the water column is pivotal to marine conservation. In 2010, the OSPAR Contracting Parties designated the world's first ever network of marine protected areas on the high seas beyond national jurisdiction. It comprises six protected areas and covers some 443,000 square kilometres.

1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention⁸⁹)

The new Helsinki Convention (HELCOM) entered into force at international level on 17 January 2000, replacing the original Helsinki Convention of 9 April 1974. The Contracting Parties (Denmark, Germany, Estonia, Finland, Latvia, Lithuania, Poland, Russian Federation and Sweden plus the European Union) shall, individually or collectively, to take all suitable measures to prevent and eliminate pollution in order to promote ecological recovery and the preservation of ecological balance. The Convention covers every possible source of pollution:

- ▶ Pollution from land-based sources
- ▶ Pollution from ships
- ▶ Dumping and waste incineration at sea
- ▶ Pollution from offshore activities and
- ▶ Marine pollution caused by accidents.

⁸⁹ 1992 Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention), Federal Law Gazette (BGBl.) 1994 II, page 1397.

The Convention also incorporates marine nature conservation and biological diversity measures. The key principles are application of the precautionary and polluter-pays principles and the application of "best available technologies" for all point sources and "best environmental practice" for all pollution sources.

HELCOM also operates as a regional platform to support implementation of the MSFD in the Baltic Sea region for those Contracting Parties that are also EU Member States, and contributes extensively to the coordination of reports by Member States to the European Commission. The HELCOM Baltic Sea Action Plan (BSAP), adopted in 2007 and defined and updated by Ministerial Declarations in 2010 and 2013, therefore serves as a dedicated, Baltic Sea-specific guideline.

Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil and other Harmful Substances (Bonn Agreement⁹⁰ of 1983)

The protection of the North Sea is the subject of the Bonn Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil and other Harmful Substances. The Contracting Parties are the European Union, Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, and the United Kingdom of Great Britain and Northern Ireland.

The Convention applies

- ▶ If the pollution or potential pollution of the sea by oil or other harmful substances in the North Sea territory presents a grave or imminent danger to the coast or related interests of one or more Contracting Parties, and
- ▶ To surveillance conducted in the North Sea territory, which is used to identify and tackle pollution and prevent violations of provisions.

EU Directives affecting marine protection

The Marine Strategy Framework Directive (MSFD) of 2008, together with the EU's Thematic Strategy on the Protection and Conservation of the Marine Environment of 2005, forms the environmental pillar of European maritime policy (see **chapter 5.1.3** for further details).

There are several EU Directives aimed directly at marine conservation, whose scope at least extends to the territorial seas and covers at least direct impacts on the marine environment (including the WFD, Nitrates Directive, Bathing Waters Directive, Directive concerning urban wastewater treatment, Groundwater Directive and Environmental Quality Standards (EQS) Directive).

⁹⁰ Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil and other Harmful Substances (Bonn Agreement of 1983), Federal Law Gazette (BGBl.) 1990 II, p. 71, most recently amended on 22 September 1989, Federal Law Gazette (BGBl.) 1995 II, page 180.

5.2.3.3 National marine protection

The regional, European and international regulations only become effective at national level as “national marine protection” if implemented in a legal and technical sense. This includes implementation of the WFD, the MSFD, the Nitrates Directive and the Acts implementing the OSPAR and Helsinki Conventions, together with the resolutions and recommendations adopted under these Conventions. In addition to the aforementioned Conventions, marine protection is also promoted via implementation of the EU Habitats Directive and the Birds Directive. The protection of marine ecosystems from the adverse impacts of human uses such as fishing, shipping, energy industry etc. is regulated via the expansion of the Federal Regional Planning Act to include the Exclusive Economic Zone (EEZ) (beyond the 12 nm zone up to a maximum of 200 nautical miles) and the licensing procedures of the Federal Maritime and Hydrographic Agency pursuant to Article 2a of the Offshore Installations Ordinance for installations to be constructed within the EEZ. The Act on the Dumping of Waste on the High Seas prohibits the disposal of litter at sea (with the exception of dredged material and urns for sea burials).

5.2.3.4 Maritime spatial planning

With rising density of usage and a growing number of conflicts in marine areas (e.g. in the areas of raw materials extraction, wind energy production, shipping and marine protection), maritime spatial planning focuses on preventive action to facilitate sustainable development and regulate the marine area in line with environmental and ecological concerns.

The statutory foundations for spatial planning in Germany are the Federal Spatial Planning Act (ROG) and the planning laws of the Länder. The ROG defines the basic principles of spatial planning (e.g. water- and environment-related principles in Article 2, paragraph (2), no. 6), which must then be concretised in the form of spatial development plans. The regulations of development, organisation and protection of the areas include binding objectives and besides that principles which must be taken into account in subsequent discretionary decisions. The ROG defines the spatial planning tools used by the Länder and Federal Government.

The 2004 amendment to the Spatial Planning Act extended the scope of application of spatial planning to include the German Exclusive Economic Zone (EEZ), and transferred competence for planning in the EEZ to the Federal Government. Article 17, paragraph (3) of the ROG states that the regional plan should contain provisions regulating commercial and scientific use, ensuring the safety and ease of shipping, and protecting the marine environment. Specific areas may also be defined for these uses and functions. The spatial plan for the EEZ is published by the responsible Ministry of Transport, as a statutory ordinance. Article 9 of the ROG also requires the performance of a strategic

environmental assessment. The general public and the public agencies whose interests are affected are to be notified and given the opportunity to voice their opinions on the draft plan.

Spatial planning also applies to the territorial sea (12 nautical mile zone). Following a 2001 resolution by the German Ministerial Conference on Spatial Planning, the German coastal Länder extended the scope of validity of their spatial plans to include the territorial sea.

The spatial planning ordinances in the German EEZ of the North and Baltic Seas entered into force in late 2009. They contain the respective spatial development plan with a text and map section, together with the environmental report. The following action areas are addressed:

- ▶ Shipping
- ▶ Extraction of raw materials
- ▶ Pipelines and submarine cables
- ▶ Scientific marine research
- ▶ Energy production, particularly windpower
- ▶ Fishing and marine aquaculture
- ▶ Marine environment.

The regional plans currently in force for the German EEZ of the North and Baltic Seas define priority areas for windpower, and at the same time exclude the construction of wind farms in NATURA 2000 areas (shown in the plan for information purposes). At the same time, the plans define target corridors in the transitional area to the territorial sea and for crossing the sea transport corridors, to aid the combined management of submarine cables that supply energy. One mandatory requirement of the plan is that offshore wind farms must be dismantled once use has been discontinued. The spatial plans for the German EEZ in the North and Baltic Seas are to be updated based on an evaluation of future demand requirements (cf. also the Federal Government’s energy concept of 2010).

A directive establishing a framework for maritime spatial planning, presented by the EU Commission in March 2013, is upcoming to be adopted by the European Council and the European Parliament.⁹¹

5.2.3.5 Pressures on protected marine assets

The current use and pollution situation in the North and Baltic Seas is far beyond sustainable exploitation. In many cases, this “overuse” of the seas and coasts

⁹¹ Further information can be found at:
<http://www.umweltbundesamt.de/themen/nachhaltigkeit-strategien-internationales-planungsinstrumente/planung-entwicklung-der-meeres-kuestengebiete>
http://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning/index_en.htm
<http://ec.europa.eu/environment/iczm/home.htm>
<http://www.ikzm-strategie.de>

places an excessive burden on the stability and resilience of the marine ecosystems.

When considering the following list of selected stress factors, it should be taken into account that – as a result of economic and/or social developments – some factors will lose significance in future while others will gain in significance:

- ▶ Structural measures (in connection with industrial settlements and infrastructure such as harbour construction and development, hydraulic engineering and maintenance measures (e.g. dredging, deepening of navigation channels))
- ▶ Eutrophication (excessive nutrient inputs from point or diffuse sources via watercourses, both directly and from the air, and the resultant effects such as exceptional algal bloom, turbidity and oxygen deficiency)
- ▶ Fishing (direct impacts from the catch, indirect impacts from the by-catch, beam trawls etc.)
- ▶ Coastal protection (technical flood prevention measures)
- ▶ “Neo-industrialisation” of the seas (pipelines, electricity and telecommunications cables and wind farms)
- ▶ Mining of raw materials (including oil and gas exploitation and extraction of sand and gravel)
- ▶ Pollutant inputs (from point or diffuse sources via watercourses, directly and from the air)
- ▶ Tourism (mass tourism and marine leisure activities)
- ▶ Transport (ships, cars, planes).

At present, the “neo-industrialisation” of the seas and coasts is highly expedited. Numerous oil and gas pipelines, electrical and telecommunications cables are being laid on or in the sea bed, the effects of which on the marine ecosystem are not always fully researched. Similarly, it is impossible to predict the individual and cumulative effects on the marine ecosystem of constructing large offshore wind farms. Individually or collectively, these stress factors may cause various types of hazards. Alongside the well-known dangers, the increasing underwater noise especially associated with shipping, pile-driving work for offshore wind farms, seismic testing, the use of sonar by the military and fishing vessels, dredging and construction activities and acoustic deterrents all cause stress to marine species, particularly marine mammals, and more intensive research is needed. In particular, techniques and methods have to be made available to effectively mitigate the noise created, or prevent it occurring altogether. Another increasingly pressing topic is human waste, which arises as a result of many of the aforementioned activities on land and at sea and which enters the oceans (cf. [chapter 6.7.8](#)).

Protection of the marine environment from the input of substances

Both the North Sea and the Baltic Sea are polluted by inputs of nutrients and hazardous substances (heavy metals, organic pollutants, oil and radioactive substances). Inputs of substances originating from inland areas, including those from non-littoral states, enter the seas via major river systems and via the atmosphere. Some river catchment areas are densely populated, highly industrialised and intensively farmed. In the majority of cases, elevated inputs of nitrogen originate from diffuse sources, primarily from the fertilisation of agricultural land and the keeping of farm animals, as well as from atmospheric inputs from ships’ and factory fumes. The bulk of elevated phosphorus levels likewise originate from agriculture, but also from point sources, such as the discharge of public and industrial wastewater. In particular, hazardous substances enter marine ecosystems via atmospheric transport and via riverine inputs. In relation to the marine environment, especially those substances are to be called hazardous which slowly biodegrade (persistent), accumulate in living organisms (bio-accumulative) and which are poisonous (toxic), known as PBT substances.

North Sea

Concerned by high levels of inputs of substances via rivers, at the International North Sea Conferences (INSC) in 1987 (London) and 1990 (The Hague), the Environment Ministers of all states bordering the North Sea adopted measures to reduce the inputs of nutrients and harmful substances by 50 %, and of the most harmful substances (such as Cd, Hg) by 70 %, in the period from 1985 to 1995. For those substances which failed to meet the reduction targets by 1995 (4th INSC in Esbjerg), the deadline was extended to 2000. One objective which remains valid to this day was adopted by the Ministerial Declaration at the 4th INSC, namely, to prevent pollution of the North Sea by continuously reducing discharges, emissions and losses of hazardous substances, with the aim of eliminating all such inputs in the course of a generation. The ultimate goal is to achieve concentration levels close to background levels for geogenic substances, and near-zero concentrations for industrially produced/synthetic substances, in the marine environment by 2020. The WFD which entered into force in 2000 also takes into account the INSC objectives and the hazardous substances identified in the Conventions for the protection of the marine environment. The MSFD, which entered into force in 2008, addresses i.a. eutrophication and hazardous substances, including pollutant levels in marine organisms that are placed on the market.

The 5th International North Sea Conference (INSC) in Oslo (Norway) in 2002 conducted an audit of the reduction target of halving nutrient inputs. On average, emissions into the surface waters of Germany’s North Sea catchment area in the period 1983 to 2008 were

reduced from approximately 804,038 t/a nitrogen and approximately 67,164 t/a phosphorus to about 51,516 t/a nitrogen and about 2,066 t/a phosphorus. This means that Germany has met its target for phosphorus with a reduction of around 70 %, but fell short of the agreed target for nitrogen, with a reduction of around 44 %. The substantial reductions in both phosphorus and nitrogen were achieved primarily by means of targeted measures in public and industrial wastewater treatment plants. There is still scope for reducing excessive levels of agricultural emissions.

In the North Sea, the eutrophication problem especially concerns the continental coastal region, a water belt approximately 50 to 100 km wide with a reduced salt content due to freshwater inflows. This was the finding of the harmonised eutrophication assessment for the OSPAR Convention area (North-East Atlantic). The results were presented in summer 2003 at the OSPAR Ministerial Conference in Bremen⁹². The second eutrophication assessment in 2008 revealed that the strategic objective of a healthy marine environment with no eutrophication will only be partially met by 2010⁹³. Of the 204 areas assessed in the North-East Atlantic, OSPAR classified 106, mainly coastal waters, as problem areas. Approximately 50 % of the nutrient concentrations occurring in continental coastal waters are due to anthropogenic influences. Inputs in the North Sea originate primarily from rivers, in Germany's case the rivers Eider, Ems, Weser, and in particular the river Elbe. In 2011, a total of 211,500 tonnes of nitrogen and 8,132 tonnes of phosphorus were discharged by Germany into the North Sea, primarily via rivers. A significant portion of nitrogen (33 % of total inputs) additionally enters the North Sea via the atmosphere. This input amounted to 457,282 tonnes for the extended North Sea, in 2004. Eutrophication in the North Sea is not a regional problem, as currents distribute the nutrients along the entire coastline. The southern North Sea, Kattegat and Skagerrak are the most heavily eutrophied regions. In the German North Sea, the entire German Bight region is affected, particularly, the shallow Wadden Sea and the estuaries.

Emissions of heavy metals into the North Sea were likewise sharply reduced over the period 1985–2008. Among all the heavy metals analysed, the required INSC reduction targets of 50 % (Cr, Cu, Ni, Zn) and 70 % (Cd, Hg, Pb) respectively had been met by 2008. These results are primarily attributable to the dramatic reduction in direct industrial discharges (point source).

Baltic Sea

The Baltic Sea was originally a low-nutrient sea and has evolved into a eutrophic sea over the past 100 years as a result of human activities. In the Baltic Sea region, the Helsinki Commission on the Protection of the Baltic Marine Environment (HELCOM) and its Contracting Parties have been working on measures to reduce nutrient inputs into the Baltic Sea since 1988. The HELCOM Baltic Sea Action Plan (BSAP) identified eutrophication as the greatest challenge in more than 90 % of the areas monitored. In its most recent assessment (2001–2006) of the status of eutrophication of the Baltic Sea, only 13 of the 189 areas examined were classified by HELCOM as “non-eutrophied”⁹⁴.

Between 1985 and 2008, Germany reduced its phosphorus inputs into the Baltic Sea by 32 % (from 81 kilotons to 26 kilotons) and its nitrogen inputs by 58 % (from 1,030 kilotons to 594 kilotons). The reductions are primarily due to the introduction of phosphate-free detergents and improvements in wastewater treatment in public and industrial plants. Inputs from agriculture have likewise been reduced, although there is still scope for further reductions. In order to move closer to the vision of a healthy Baltic Sea without eutrophication, national programmes to reduce nutrient inputs are to be developed by 2010 and their effectiveness assessed by 2013. The Baltic Sea Action Plan of 2007 sets initial reduction targets of 240 tonnes of phosphorus and 5,620 tonnes of nitrogen for Germany. [These targets were scientifically reviewed by the Swedish Baltic Nest Institute, and new target values adopted at the HELCOM Ministerial Meeting on 3 October 2013 in Copenhagen. For the first time, these targets also incorporated atmospheric nitrogen inputs. In this Ministerial Declaration, Germany undertook to reduce its nitrogen emissions by 7,670 tonnes by 2016, and its phosphorus emissions by 170 tonnes. Alongside the reduction commitments of the HELCOM Contracting Parties, for the first time the Ministerial Declaration also formulated specific reduction requirements for non-Contracting Parties and for shipping.]

Measures for reducing nutrient inputs include the reduced use of fertilisers and slurry in agriculture, the cultivation of intercrops to prevent soil erosion, the establishment of wetlands and buffer zones to collect nutrients, improved wastewater treatment, and minimising exhaust gas emissions from shipping.

Between 1985 and 2005, inputs of heavy metals into the surface waters of Germany's Baltic Sea catchment area decreased significantly, primarily due to the dramatic reduction in inputs from industry. Measures prompted by a tightening of statutory requirements for industry, coupled with the scaling down of industrial

92 OSPAR integrated report 2003 on the eutrophication status of the OSPAR Maritime Area based upon the first application of the Comprehensive Procedure. Ospar Commission 2003. http://www.ospar.org/documents/dbase/publications/p00189_Eutrophication%20Status%20Report%202003.pdf

93 Second OSPAR Integrated Report on the Eutrophication Status of the OSPAR Maritime Area. OSPAR Commission 2008. http://www.ospar.org/documents/dbase/publications/p00372_Second%20Integrated%20report.pdf

94 Eutrophication in the Baltic Sea – An integrated thematic assessment of nutrient enrichment in the Baltic Sea region. Baltic Sea Environment Proceedings No.115 http://meeting.helcom.fi/c/document_library/get_file?p_l_id=79889&folderId=377779&name=DLFE-36818.pdf

activities especially in the new German Länder since 1990, have made a decisive contribution to reducing these pressures on the marine environment.

Status of the marine environment

Apart from a few exceptions, the chemical status in the North and Baltic Seas is good. This does not apply to the ecological status of transitional and coastal waters.

In 2008, Germany's coastal and transitional waters underwent an ecological status assessment⁹⁵, which revealed that the vast majority of coastal water bodies are in a moderate to poor condition, with the Baltic Sea's assessment being significantly worse than that of the North Sea. The main reasons for failing to achieve a good ecological status are changes in the composition and frequency of phytoplankton (tiny algae suspended in water) and macrophytes (large algae, seagrass). As always, this is due to the excessive levels of eutrophication in marine ecosystems.

The regional conventions on the protection of the marine environment of the North-East Atlantic (OSPAR) and the Baltic Sea (HELCOM) have long been concerned with the assessment of the environmental status, and more recently have also considered a holistic, overarch-

ing assessment of the marine waters in their respective Convention territory. These holistic assessments indicate that both seas remain severely impaired by human pressures. In particular, intensive fishing continues to seriously impact fish stocks and habitats. Eutrophication remains one of the main pressures in both the North and Baltic Seas. In the North Sea, there are additional problems associated with large quantities of marine litter. In future, these problems are very likely to intensify as the pressures from human uses (shipping, offshore wind power) increase. Furthermore, the effects of climate change will be increasingly felt.

The first assessment of environmental status (initial assessment under the MSFD) of the entire German North and Baltic Seas was published in 2012, within the required deadline. It includes an assessment of the principal characteristics and pressures, together with an analysis of socio-economic aspects. Qualitative and semi-quantitative analyses were conducted on the basis of work for the WFD, the Habitats Directive and the Birds Directive, together with current assessments by the OSPAR Convention, the trilateral Wadden Sea cooperation and the Helsinki Convention. These indicate that Germany's North and Baltic Sea regions currently fall short of a good environmental status (cf. <http://www.meeresschutz.info/index.php/berichte.html>).

95 Voß, J.; Knaack, J.; Von Weber, M.: Ökologische Zustandsbewertung der deutschen Übergangs- und Küstengewässer. Indikatorbericht. Meeresumwelt aktuell Nord- und Ostsee 2010/2. Bund-Länder Messprogramm. 2010. http://www.blmp-online.de/PDF/Indikatorberichte/2010_02_s.pdf.

Figure 34: Summarising overview of the initial assessment under the MSFD of Germany's marine waters, conducted in 2012. Green = GES achieved. Red = failed to achieve GES

Characteristics, pressures and impacts	North Sea		Baltic Sea	
Biotope types	GES is not achieved		GES is not achieved	
Phytoplanktion	GES is not achieved		GES is not achieved	
Zooplankton	not assessed		not assessed	
Macrophytes	GES is not achieved		GES is not achieved	
Macrozoobenthos	GES is not achieved		GES is not achieved	
Fish	GES is not achieved		GES is not achieved	
Marine mammals	GES is not achieved		GES is not achieved	
Seabirds	GES is not achieved		GES is not achieved	
Smothering with sediment	not assessed		not assessed	
Sealing	not assessed		not assessed	
Changes in siltation	not assessed		not assessed	
Abrasion	not assessed		not assessed	
Selective extraction	GES is not achieved		not assessed	
Underwater noise	not assessed		not assessed	
Marine litter	not assessed		not assessed	
Changes in thermal regime	not assessed		not assessed	
Changes in salinity regime	not assessed		not assessed	
Introduction of synthetic and non-synthetic substances	WFD	OSPAR	WFD	HELCOM
Introduction of radio-nuclides	GES achieved		GES achieved	
Contaminants in food	GES is not achieved		GES achieved	
Systematic and/or intentional release of substances	WFD	OSPAR	WFD	HELCOM
Nutrient and organic matter enrichment	GES is not achieved		GES is not achieved	
Introduction of microbial pathogens	GES achieved		GES achieved	
Introduction of non-indigenous species	not assessed		not assessed	
By-catch	GES is not achieved		not assessed	
Cumulative and synergetic effects	not assessed		not assessed	
Overall environmental status	GES is not achieved		GES is not achieved	

Source: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, 2012

5.3 International cooperation on the management of waters

Integrated management of transboundary surface waters and groundwater takes place within the framework of international or bilateral commissions for river basins, lakes or (for example) boundary waters.

Germany is a member of the

- ▶ International Commission for the Protection of the Rhine against Pollution (IKSR),
- ▶ International Commissions for the Protection of the Moselle and the Saar against Pollution (IKSMS),
- ▶ International Commission for the Protection of the Elbe (IKSE),
- ▶ International Commission for the Protection of the Danube River (IKSDR),
- ▶ International Commission for the Protection of the Oder against Pollution (IKSO)
- ▶ International Commission for the Protection of the Maas (IMK)
- ▶ International Commission for the Protection of Lake Constance

and maintains close relations with the Netherlands, Poland, the Czech Republic and Austria in bilateral commissions, primarily in respect of boundary waters.

In the Ems river basin, Germany cooperates with the Netherlands on multiple levels on the basis of correspondence between Ministers.

Cooperation with Denmark to implement the EU Directives on water protection is likewise based on the exchange of correspondence.

The international river basin commissions address issues of waterbody management, flood protection and flood forecasting, as well as warnings and alarms in the event of incidents impacting waterbodies. They coordinate implementation of the WFD and the Floods Directive at international level. All of them have prepared international parts of the WFD management plans.

The river basin commissions can achieve significant success in terms of improving water quality and water ecology. Through action programmes, for example, contamination levels in the Rhine and the Elbe have been reduced to such an extent that a large number of fish species are now once again indigenous to both river basins. In the Rhine, the return of the salmon has been a particular milestone, and this should be consolidated through implementation of the Master Plan for Migratory Fish of the Rhine.

Even before the Floods Directive, the Commissions often had ambitious flood action programmes or plans in place which will now be incorporated into future flood risk management plans.

They now face new challenges, such as the impacts of climate change, as indicated by the adaptation strategy of the International Commission for the Protection of the Danube, which manages the world's most international river basin district.

The work of these Commissions serves as an excellent example to other regions of the world. In 2013, the IKSR, now more than 60 years old, won the newly created European Riverprize, while the IKSD was awarded the international Thies Riverprize back in 2007.

Germany continues to play an active part in

- ▶ the Central Commission for Rhine Navigation (ZKR)
- ▶ the Moselle Commission (shipping)
- ▶ the Danube Commission (shipping),
- ▶ the Commission for the Hydrology of the Rhine Basin,
- ▶ the UNECE Convention for the Protection and Use of Transboundary Watercourses and International Lakes
- ▶ the UNECE Convention on the Transboundary Effects of Industrial Accidents.

6 Water uses and water pressures

6.1 Water abstraction and water supply

Industry, agriculture and private households meet their water demands in a variety of ways, and from a range of different resources.

Through effective and economical water use, water abstractions in all sectors have decreased tangibly over the past 20 years. Technological developments, multi-use and circulatory systems have led to reductions of more than 30 % in water abstraction compared with 1991. In 2010, in total, some 33,1 billion cubic metres of water were abstracted, which equates to less than 20 % of Germany's available water resources, calculated at 188 billion m³. Half of water abstractions are attributable to cooling water for power plants, the bulk of which is returned directly to the river. Strictly speaking, therefore, only around 10 % of Germany's available water resources are used.

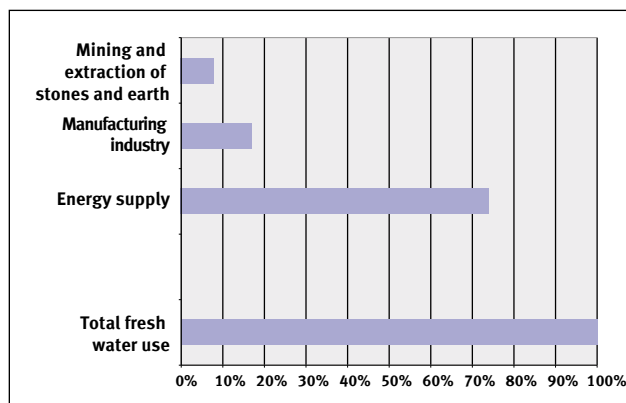
Industry and agriculture

The water needed for agricultural irrigation is taken primarily from groundwater reserves. However, water abstractions are minimal, accounting for less than 1 % of total water consumption; irrigation farming therefore plays a subordinate role in Germany. Only 560,000 ha, or 3.3 % of all agricultural land, is equipped with irrigation systems. Germany is located in a moderate climate zone, which is characterised by year-round precipitation. As a result, German farmers enjoy a relative advantage, as indicated by comparison with other regions. In Europe, water abstractions by the agricultural sector account for 35 %, while globally the figure is around 70 %. Almost 40 % of all food-stuffs are produced from irrigation farming, and nearly 20 % of all cultivated land is irrigated for this purpose.

The manufacturing and processing sectors and the mining industry and energy sector are the largest water users in Germany. In 2010, industrial demand accounted for 83 % of total water abstractions, corresponding to 27.5 billion m³ of water per annum. More than 90 % of the water is abstracted from surface waters by own plants.

Within the industrial sector, energy supply is by far the greatest water user. Power plants for the generation of electricity and heat abstract 20.6 billion m³ of water almost exclusively from surface waters. The water is primarily used for cooling purposes, and after use is returned almost in its entirety to the waterbody from which it was taken.

Figure 35: Sector-specific shares of the total water used by businesses



Source: Federal Statistical Office 2013

Public water supply

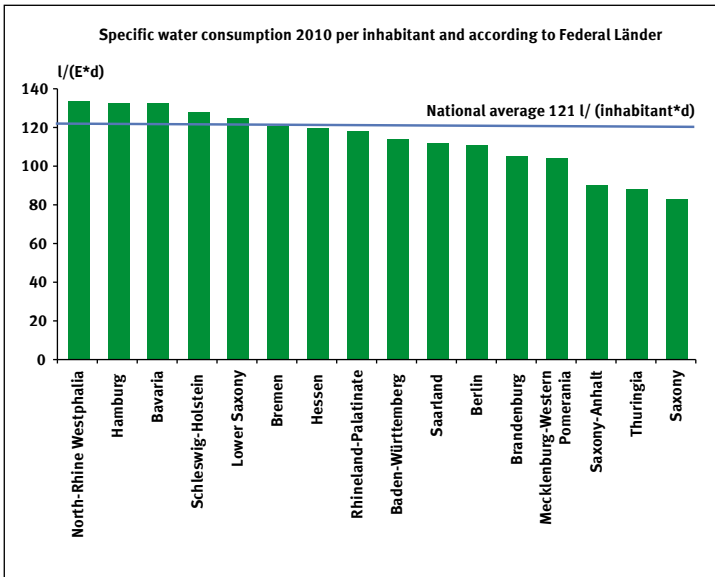
The 6,000 plus companies involved in public water supply primarily provide drinking water for private households, local authority institutions such as schools, authorities and hospitals, and small commercial enterprises. In 2010, over 81.1 million residents were supplied with drinking water.

Nearly all households are connected to the distribution system of a public water utility: 99.2 % of the population is supplied with drinking water in this way. Private supply e.g. from a domestic well is rare in the private sector. In Germany, more than 70 % of drinking water supply is covered by groundwater and spring water. Around 30 % of drinking water is abstracted from surface waters, i.e. from reservoirs, or via groundwater recharge and bank filtration.

In order to safeguard the supply of drinking water, around 5,1 billion m³ of water was abstracted in 2010, some 3.6 billion m³ of which was delivered to households and small businesses by the water utilities. The remaining 1.5 billion m³ is shared between commercial enterprises, public institutions, consumption by the water works themselves, and pipeline losses.

In 2010, the per capital consumption of drinking water totalled 121 litres per day. This means that daily water consumption in the private sector decreased by 23 litres per person between 1991 and 2010, primarily due to modified consumer behaviour and the use of water-saving household appliances and fittings. There were, however, sizeable differences in average household consumption between individual Länder, with figures ranging from around 134 litres in North Rhine-Westphalia, Hamburg and Schleswig-Holstein, to 84 litres in Saxony. One reason for this might be that in east Germany, water use from local wells is more prevalent than in west Germany.

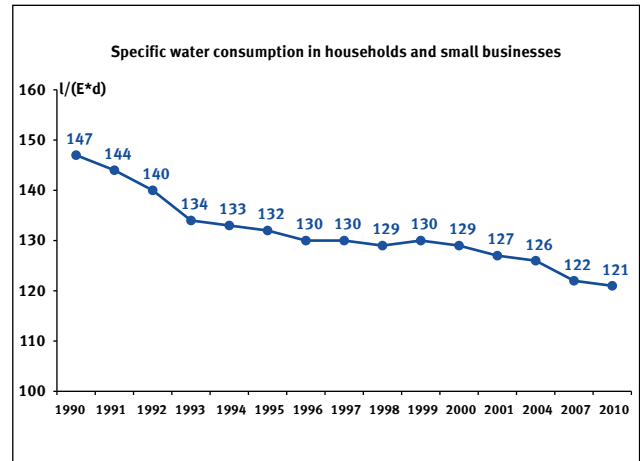
Figure 36: Water consumption according to Länder (2010)



Source: Federal Statistical Office 2013

The suppliers' technical infrastructure ensures a high level of supply reliability in terms of both timing and location, with an adequate water quality and quantity. This enables them to supply areas with water shortages and limited groundwater supplies, which do exist in Germany despite adequate water resources overall. Especially in urban agglomerations, water demand exceeds the local supply. A long-distance supply system creates a balance between areas of water shortage and those with a surplus of water. Long-distance water supply systems exist in particular in Bavaria, Baden-Wuerttemberg, Lower Saxony, Saxony, Saxony-Anhalt, Thuringia, the Ruhr region and the Frankfurt/Main region. There are also some 311 reservoirs whose water resources are available, both for drinking water supply and flood mitigation, and for raising low water levels, as well as for energy supply.

Figure 37: Average water consumption and water use in households and small businesses



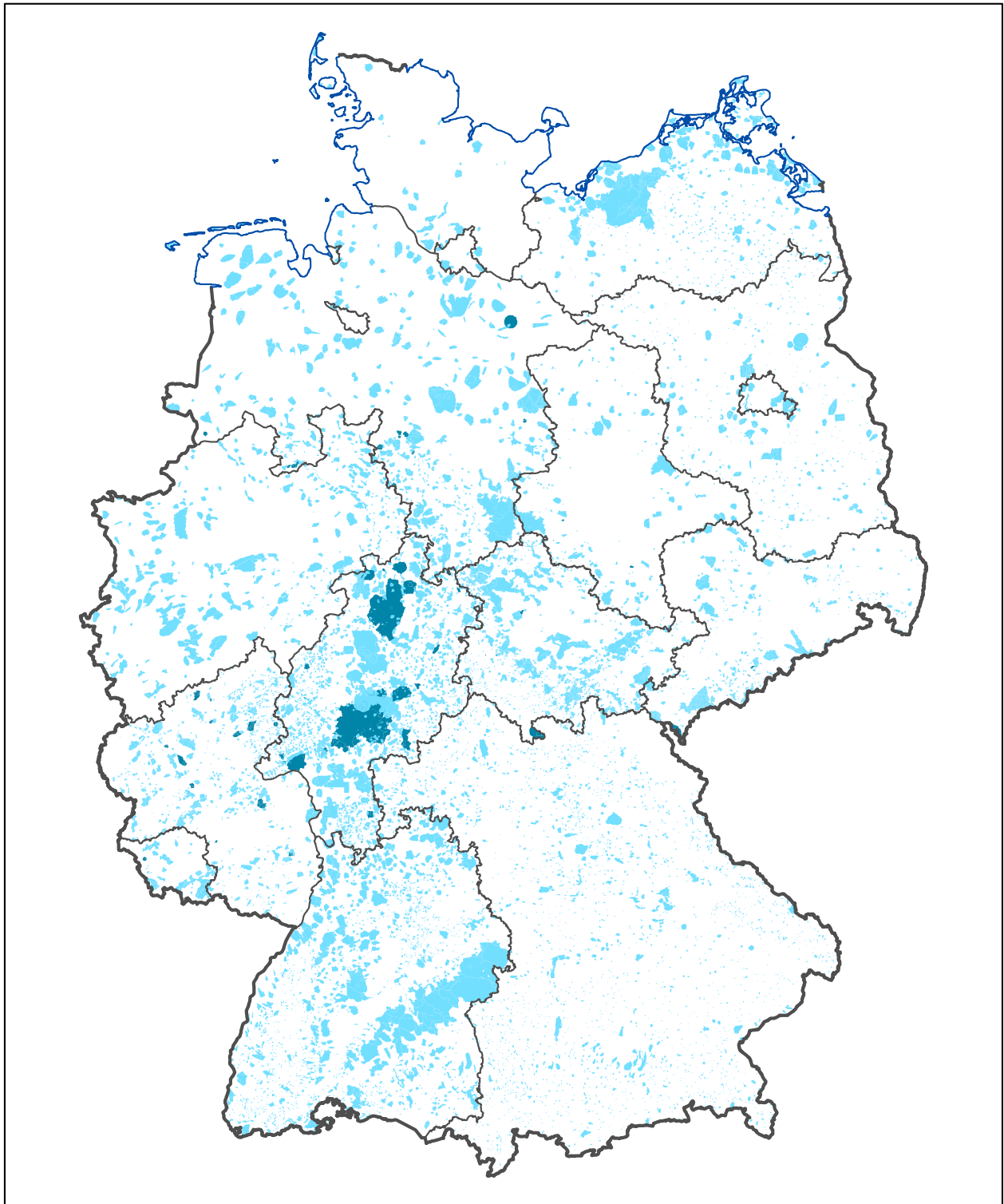
Source: Federal Statistical Office 2013

6.2. Drinking water supply

6.2.1 Legal framework and organisation of drinking water supply in Germany

The organisation of drinking water supply in Germany has essentially been in place for more than 100 years, but is continually updated in line with technical and hygiene requirements. The aim of public water supply is to ensure that the population has access to an adequate volume of drinking water at all times which satisfies the high quality requirements stipulated by law. Water protection areas are designated in Germany in order to protect the drinking water supply. In 2013, there were 30,045 water protection areas covering a total area of around 50,400 km², equivalent to 14.1 % of the total territory of the Federal Republic of Germany.

Figure 38: Water protection areas (WPA) in Germany



water protection areas (WPA) in Germany

map legend

- S=Spa (Heilquelle)
- T=Drinking (Trinkwasser)

Bearbeitung: FG | 1.5-SG
Source: WasserBlick/2010

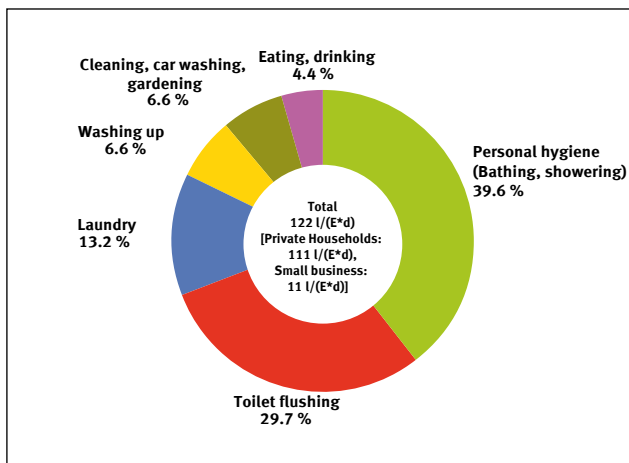
statistics

number WPA - 30,045
 area WPA (absolut) - 50,400 km²
 Germany's total territory - 357,837 km²
 area of WPA in % to Germany's total territory - 14.08 %
 size of WPAs: Ø - 1.68 km²
 min. - 0.00000048 km²
 max. - 814 km²

	area WPA [km ²]	% to Germany's total territory	area WPA [km ²]	% to Germany's total territory
BB	1,588	5.35	NI	7,253
BE	211	23.66	NW	3,996
BW	9,043	25.28	RP	2,168
BY	3,543	5.02	SH	505
HB	29	7.29	SL	441
HE	11,542	54.71	SN	1,510
HH	96	12.70	ST	1,393
MV	3,697	15.88	TH	3,378

Source: WasserBlick 2010

Figure 39: Average water consumption and water use in households and small businesses



Sources: Federal Statistical Office (2013) Fachserie 19 Reihe 2.1.1 “Öffentliche Wasserversorgung und öffentliche Abwasserbeseitigung – öffentliche Wasserversorgung”

Figure 40: Water Protection Areas Zone 1



Photograph: Jörg Rechenberg, Federal Environment Agency

In accordance with the constitutions and/or water legislation of the Länder, drinking water supply is essentially the responsibility of local government, within the context of its public service mandate pursuant to Article 28, paragraph (2) of Germany’s Basic Law (GG). The municipalities and local authorities may exercise this duty in a sovereign capacity or else appoint private companies to do so on their behalf. In many cases, smaller towns and communities in rural areas form special-purpose organisations which often cooperate with similar organisations for both water supply and wastewater disposal. The basic aim of these special-purpose associations is to join forces and thus create more favourable business conditions combined with the necessary technical expertise in the management and execution of their work. These associations formulate targets for the water supply companies in their area and operate as supervisory bodies. Respon-

sibility under public law therefore remains with local government.

In order to ensure a reliable supply and adequate drinking water hygiene, there is essentially a system of compulsory connection and use regulated in local statutes. This means that each individual citizen and commercial company is obliged to connect to and utilise the public drinking water supply and sewers of the local government or responsible special-purpose association. The requirement for mandatory connection and use is that this must be in the general public interest. Water supply and wastewater disposal is usually in the public interest. A regulated water supply is needed in order to protect public health (quality of drinking water) and wastewater disposal by the local authority serves both to protect public health (risk of epidemics) and to protect the groundwater. In selected cases of exceptional hardship, the local by-laws provide for exceptions.

Building regulations ensure that no residential buildings may be constructed without a proper drinking water supply. The qualitative requirements for drinking water are laid down in the Drinking Water Ordinance (TrinkwV 2001⁹⁶) (see **Chapter 4.2**). As in-house installations are also considered water supply facilities under the TrinkwV 2001, home owners are subject to the same regulations as all other companies and other owners of a water supply installation. With regard to quality assurance in the construction, operation and maintenance of water supply systems, parallel with and supplementary to the administrative regulations relating to construction and drinking water, an important role is also played by the technical regulations of private-law associations or federations such as the “German Association of Gas and Water Experts – DVGW” or the “German Institute for Standardisation – DIN”, which outline the technical specifications and document the current best available technology. *Inter alia*, these regulations also stipulate the minimum required qualifications for employees in water works, the requirements for pipelines including the materials of which they are made, the conditions for pipe-laying, and the required qualifications for pipe installation enterprises.

The monitoring of drinking water quality by government bodies is also laid down in the TrinkwV 2001. Monitoring is the responsibility of the Länder and, at local authority level, the public health departments. The public health departments supervise the internal control and quality assurance measures taken by the water utilities, including the prescribed documentation. They also carry out their own checks. The public health authorities also monitor trends in water quality, as the water utilities are required to

⁹⁶ Drinking Water Ordinance (TrinkwV) in the version promulgated on 2 August 2013, Federal Law Gazette (BGBl.) I, p. 2977, amended by Article 4, para. (22) of the Act of 7 August 2013, Federal Law Gazette (BGBl.) I, p. 3154.

notify the competent public health department immediately of any cases of non-compliance with the prescribed parameter values (limits). As a precaution, the water utilities are required to prepare plans of measures in case of temporary non-compliance with the requirements and limits. Furthermore, water utilities have a duty to guarantee adequate water supplies and to make drinking water available in adequate quantity and quality by other means in the rare event of a failure in the drinking water supply system (for technical or hygienic reasons), for example by importing water from a different water works or by means of mobile water supply facilities (e.g. water trucks).

The required levels of supply reliability and drinking water quality also apply to small facilities. The definition of small facilities in the Drinking Water Ordinance makes no distinction between installations for personal use and installations for supplying third parties, e.g. guests in an isolated woodland restaurant or holiday home tenants. Small facilities and – under certain circumstances – in-house installations and installations for the use of rainwater are subject to monitoring by the public health authorities as provided for in the TrinkwV 2001.

6.2.2 Water treatment

The requirements governing drinking water quality must be based on the guiding principles of DIN 2000 and DIN 2001. Groundwater is particularly suitable as a source of untreated water. The groundwater must be obtained from a sufficient depth in the natural hydrological cycle after passage through adequate filtering strata and must not be impaired in any way. Drinking water should be appetising and inviting to drink. It must be colourless, clear, cool, and perfect in taste and smell. Drinking water must be low in bacteria.

Untreated water that does not meet the requirements for drinking water must be purified in such a way that life-long consumption of it will not have any harmful effects on human health. It may also be necessary to treat the drinking water in such a way that it will not suffer any adverse changes during transport from the water works to the consumer. Such changes relate not only to the quality of the drinking water itself, but also to possible changes as a result of the materials with which it comes into contact in the supply company's distribution network and the consumer's home installation. For this reason, the materials that come into contact with drinking water must be inspected and assessed for suitability. Only materials that are suitable for the present drinking water composition may be used. The Drinking Water Ordinance tasked the Federal Environment Agency (UBA) with assessing the suitability of materials that come into contact with drinking water.

Present knowledge indicates that a central public drinking water supply system offers the greatest safety and reliability for the supply of perfect drinking water in adequate quantities and with the pressure required for technical purposes. Over time, the requirements placed on water treatment technology have adapted in line with changing conditions. Higher standards are necessary, *inter alia*, in view of the increasing size of distribution systems and hence the longer times taken by the treated drinking water for the journey from the water works to the consumer. As such, the treatment of raw water to produce drinking water is based primarily on health, aesthetic and technical considerations.

In the field of health protection, a distinction must be made between microbiological pathogens and toxic chemical substances in drinking water. Microbiological impurities in the untreated water are prevented, firstly, by means of appropriate selection and protection of the raw water, and secondly (if necessary) by appropriate treatment, and finally by disinfection, which may if required be carried out in the distribution network.

From an aesthetic point of view, the issues here are improving acceptance of drinking water and its suitability for consumption. Impairments to the smell, taste and appearance of drinking water, although they may be immaterial from a health point of view, are always a deficit that must be remedied by means of appropriate treatment technology in conjunction with resource protection or, ultimately, by switching to a different source of raw water.

The composition of drinking water changes to a greater or lesser extent as a result of distribution in fixed pipelines to the consumer. Such changes in water composition after treatment are caused by interaction with surfaces that come into contact with water, e.g. pipeline materials, both in public distribution networks (problems: iron, asbestos cement, biofilms) and in domestic installations (problems: lead, copper, nickel, plastics, biofilms). The interior surfaces of drinking water tanks in the water supply system or of water heaters in the household may also cause adverse changes in water composition. The following **Tables 8 and 9** list the main objectives of treatment and the techniques used.

The generally accepted best available technology offers a large number of technical options for achieving these treatment objectives. The methods are distinguished primarily by their action:

- ▶ Filtration or separation methods
- ▶ Precipitation and flocculation methods
- ▶ Biological methods
- ▶ Substance exchange at interfaces
- ▶ Metered admixture of additives
- ▶ Irradiation methods.

When processing raw water into drinking water, the addition of treatment chemicals (which are never entirely free of contaminants) may lead to an increase in the concentration of pollutants in the drinking water. The Drinking Water Ordinance states that only those treatment substances and disinfection techniques contained in a positive list held by the Federal Environment Agency (UBA) may be used. This positive list helps to ensure that during drinking water treatment, any additional increase in pollutants that may occur is less than 10 % of the drinking water limit of a health-relevant parameter, which in turn means that the quality standards achieved are exemplary by European comparison.

6.2.3 Water distribution

The water distribution system refers to the totality of technical installations for the transportation of drinking water, from the time it leaves the water treatment facility (e.g. waterworks) until it reaches the consumer's tap.

During its journey, the drinking water comes into contact with a wide range of different materials and components. The intensity of this contact depends in particular on the relationship between the wetted surface of the component in relation to the water volume it encloses, and on the duration of contact between the drinking water and the respective material surface. Whether and to what extent the water quality is altered in the distribution system also depends on the material itself and in the case of some materials on the water quality (e.g. corrosion in metals) as well as on the temperature.

The Drinking Water Ordinance (TrinkwV 2001) distinguishes six different types of water supply installations, which are each subject to different inspection, notification, action, monitoring and reporting requirements. Article 17, paragraph (1) stipulates that facilities for the abstraction, treatment and distribution of drinking water must, as a minimum requirement, be planned, constructed and operated in accordance with generally accepted technical standards. The materials

used in the construction or maintenance of water supply installations must be safe to human health, must not adversely alter the smell or taste of the water, and must not emit any substances into the drinking water in quantities that are technically avoidable. In order to further define these requirements, the Federal Environment Agency (UBA) stipulates mandatory evaluation criteria which must be met by the products made from such materials, e.g. pipelines or sanitary fittings. This can be confirmed by a certification agency accredited for the drinking water sector following tests and analyses defined in the mandatory evaluation criteria. The Federal Environment Agency decides which groups of materials will be subject to such assessment principles. The mandatory evaluation criteria get binding validity two years following publication.

The current high standard of drinking water supply is based on an extensive collection of technical rules comprised of worksheets and test regulations from the DVGW, VDI, ZVSHK and DIN standards, and to an increasing extent harmonised European standards (DIN EN). Minimal water losses (Figure 41), rare incidences of pipe fractures and interruptions to operation, coupled with a high degree of hygiene safety, are the characteristic features of water supply in Germany.

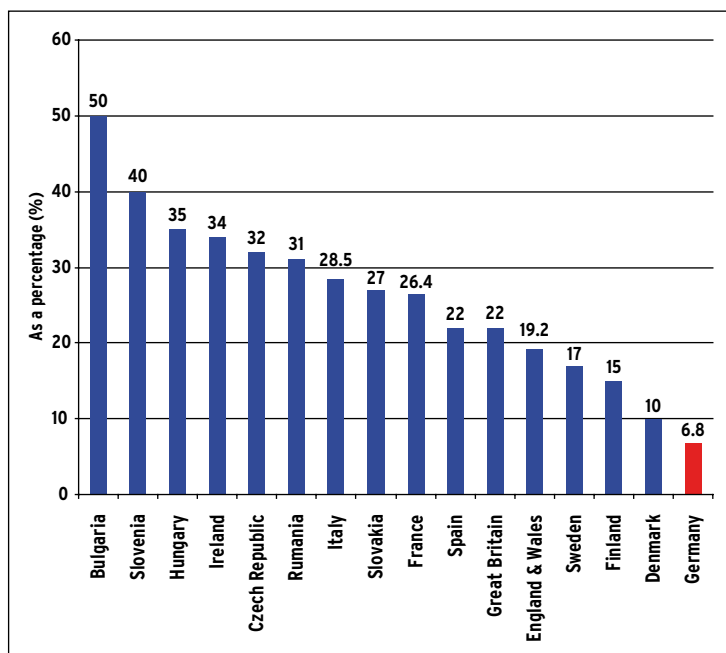
The domestic installation is the most sensitive part of the water distribution system from a hygiene viewpoint. The high surface-to-volume ratio of the small-scale pipelines, frequent and lengthy stagnation periods of drinking water in buildings, coupled with higher ambient temperatures, support corrosion processes, substance migration and microbial growth. As a result, samples taken from the tap more frequently exceed the parameters in the Drinking Water Ordinance (2001) than is the case for samples taken from the waterworks or central water supply installations. The growth of Legionella in drinking water installations and the unfortunate persistence of elevated lead concentrations in drinking water in old buildings are the most difficult problems facing water distribution in Germany. For this reason, increased attention is devoted to building installations. In this sector of the water distribution system, uncompromising observance of the valid re-

Table 8: Treatment objectives and focal areas for specific action

Treatment objective	Focal areas for specific action
Removal of geogenic substances	Iron, manganese, turbidity, smell, taste, arsenic, nickel, fluoride, uranium
Removal of anthropogenic substances	Nitrate, dissolved organic carbon (DOC), microbiology, pesticides, micropollutants
Protection of distribution network	Inhibiting corrosion; preventing deposits; preventing bacterial growth
Technical usability	Softening; miscibility of water from different sources; hardening after application of membrane technologies
Support correct technical operation of water distribution	Search for leakage

Source: Federal Environment Agency (UBA)

Figure 41: Comparison of water losses



Source: Branchenbild der deutschen Wasserwirtschaft 2008

quirements is particularly important. The lead limit of 0.010 mg/l, in force since 1 December 2013, can only be met by removing the remaining lead pipes from the distribution network and drinking water installations.

6.2.4 Drinking water prices

The calculation of water prices in Germany is based on the actual costs incurred to companies in connection with every aspect of water supply. This concerns all costs associated with water abstraction, treatment, storage and distribution, as well as investments in maintenance and waterbody conservation. As such, the cost recovery principle has already been widely introduced in Germany; under the WFD this principle was adopted with European-wide validity in the year 2000. Under the cost recovery principle, in addition to on-going operating costs, the water rates must also cover all the capital costs incurred.

However, the existing structural and natural framework conditions for water abstraction and supply, such as settlement density, geographical location and hydrology, vary widely from one location to the next. This leads to different cost levels for the companies, which must be covered by locally valid water rates.

The public water supply is seen as a public service (Article 50, paragraph (1) of the WHG), which is organised by the local authority within the context of its constitutionally guaranteed self-administration. Depending on whether the supply companies are publicly or privately organized, their fees are subject to price supervision by local government law or cartel law. In the case of public water utilities, water prices are based on the princi-

Table 9: Summary of techniques used and treatment objectives⁹⁷

Principle	Procedures	Suitable targets/parameter
A	Ion exchange	Calcium, magnesium, nitrate, heavy metals, uranium
A	Adsorption	DOC, organic substances
A, D	Corrosion inhibition	pH
B	Bioreactors	Iron, manganese, nitrate
BS	UV irradiation	microbiologie
D	Aeration	Oxygen concentration, pH
D	Oxidation	DOC, microbiologie
D	Reduction	Excess of chlorine
D	Inhibition/stabilisation	Scale deposits (lime scale), corrosion
F	Precipitation	Phosphate, arsenic
F	Flocculation	Turbidity, microbiologie
S	Flotation	Turbidity
S	Evaporation	Desalination
S	Reverse osmosis	All targets
S	Degasification/stripping	Methane, hydrogen sulphide, volatile halogenated hydrocarbons
S, B	Langsamsandfiltration	DOC, microbiologie
S, D	Softening / hardening	Calcium, manganese

Source: Federal Environment Agency

⁹⁷ A = exchange at interfaces; F = precipitation/flocculation; S = separation; B = biological methods; D = metered admixtures; BS = irradiation.

ples of local government fee legislation (cost coverage, equality of treatment, equivalence).

The Federal Court of Justice has ruled that in the case of private water utilities, the cartel authorities may compare the water prices of one utility with those of a similar utility, since water supply constitutes a natural monopoly. To this end, the cartel authority must determine and compare the supply density (metered volume), the client density (network length per house connection), the number of residents supplied, the fee structure (household and small commercial clients), differences in procurement and treatment costs, and the overall yields of the water division.

The utility must provide evidence of any other significant cost factors such as topography (land structure), increased maintenance costs for the pipeline network or other special precautionary expenses for environmental protection and hygiene, should they wish to justify higher prices than other suppliers in selected cases. In future, it will be important to formulate these evidence requirements in such a way that the water utilities are still able to provide the full range of vital water protection and hygiene services.

Prices are generally calculated from two fee components: The consumption-related price per cubic metre, and a basic monthly charge designed to cover the fixed costs for maintaining the supply infrastructure. These price components vary between municipalities, with the result that actual water prices vary considerably from the calculated average of € 1.65/cubic metre, plus a basic monthly fee of € 5.46. The majority of all households pay a price per cubic metre and a basic charge. The following chart summarises the fee categories:

Table 10: Drinking water prices 2013

	Minimum	Maximum
Price per annum	160 Euro	286 Euro
Price per m ³	1.23 Euro	2.17 Euro
Basic charge per annum	26 Euro	114 Euro

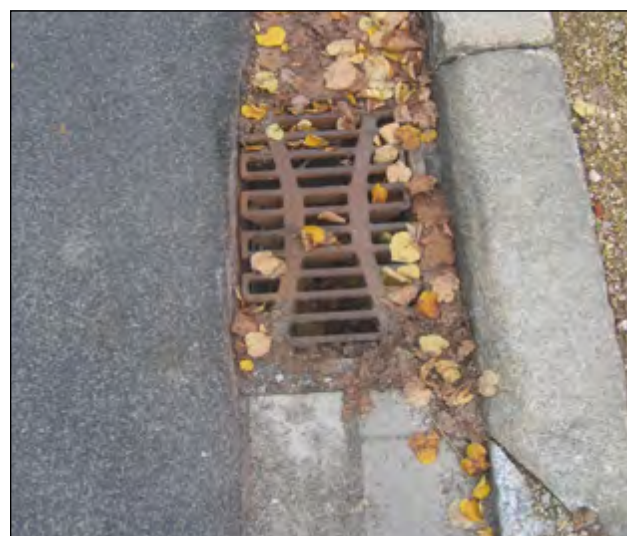
Source: Federal Statistical Office, 2013

We can use a simplified calculation for a model household to illustrate the costs. For this standardised two-person household with a water consumption of 80 cubic metres, the annual expenditure would be € 206/annum, i.e. the cost of drinking water is € 103 per person, per year. In other words, the daily consumption of 121 litres of drinking water is covered by a charge of € 0.28 per day.

6.3 Rainwater management

Rainwater usually infiltrates into the ground as it falls. As part of the natural hydrological cycle, it makes a significant contribution to groundwater recharge. During infiltration, the water passes through various layers of soil which purify it, and is then collected in the groundwater-saturated soil zone. In most developed or impervious covered areas, only part of the rainwater now reaches the water cycle by a natural route; a significant portion is discharged via the sewer system.

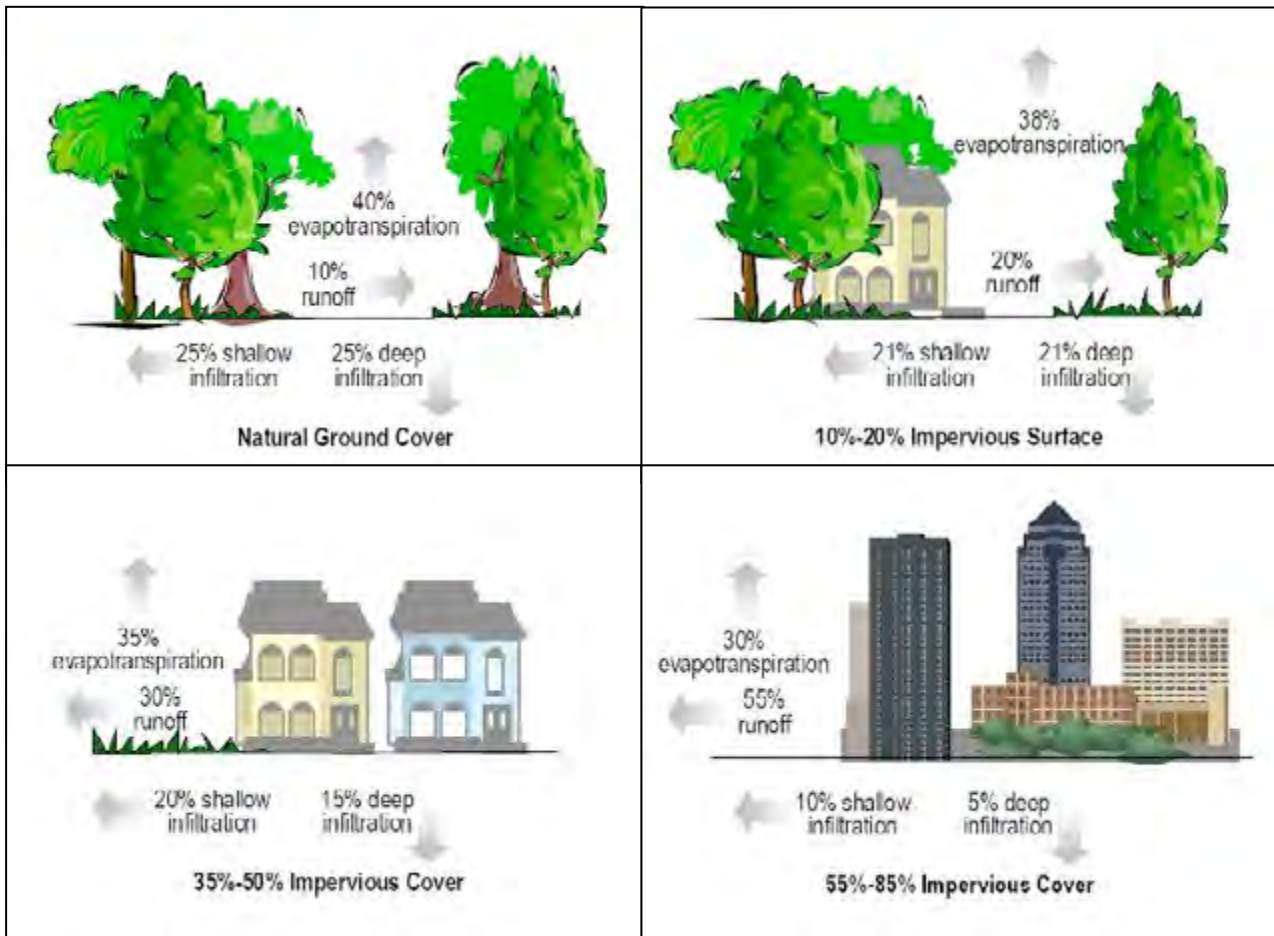
Figure 42: The bulk of precipitation in towns is discharged via sewers



Photograph: Bernd Kirschbaum, Federal Environment Agency (UBA)

This form of stormwater disposal is based on the principle of discharging rainflow as quickly and comprehensively as possible via the sewer system, coupled with a high standard of disposal reliability and drainage convenience. In Germany, two different sewer systems are used: The combined discharge of precipitation together with wastewater (mixed system), and discharge in two separate sewers (separate system). However, precipitation discharges from separate sewer systems have led to quality problems in waterbodies in the past. Over the past 40 years, these adverse impacts of water management have been addressed primarily via the construction of more than 45,000 rainwater treatment plants, at high investment and operating costs, the majority of which are only used in the rare event of heavy rainfall. To date, almost 24,000 stormwater overflows and reservoir sewers in the mixed system, almost 18,500 stormwater retention facilities in the mixed and separate system, and less than 3,200 rainwater purification basins in the separate system have been built in Germany.

Figure 43: Changes in the natural water balance



Source: US-EPA, 2004

Pollution of water resources

For a number of pollutants, pollution loads from precipitation discharge exceed those from wastewater treatment plants, despite every effort taken. Studies indicate that discharges from urban systems account for around 40 % of total discharges of heavy metals into our waterbodies⁹⁸. The principal discharge routes are sewer systems, erosion, and groundwater inflow. Assessments during the course of implementing the EU WFD indicate that:

Mixed water discharges and precipitation outflows from separate systems account for between 10 and 40 % of overall emissions. The proportions are particularly high in the case of the metals zinc, lead and copper⁹⁹. Nutrient loads from precipitation discharges are also relevant. The eutrophication of surface waters caused by nutrient discharges from human settlements is one of the main reasons for failing to achieve a good ecological status in waterbodies.

⁹⁸ For further details, cf.: Umweltbundesamt (Federal Environment Agency) (2014): *Water Resources Management in Germany – Part 2 – Water Quality*.

⁹⁹ Hillenbrand et al. (2005): UBA Texte 19/05 Einträge von Kupfer, Zink und Blei in Gewässer und Böden, Umweltbundesamt (Federal Environment Agency, UBA).

Rainwater management

Decentralised rainwater management is an ecological and economically expedient alternative to central municipal drainage, and can now be described as the best available technology. It consists of a combination of various complementary individual measures, aimed at ensuring reliable drainage while at the same time conserving the natural hydrological cycle as far as possible. In urban areas, too, the hydrological regime can approximate that of undeveloped areas thanks to an expedient combination of rainwater management techniques such as green roofs, rainwater use and decentralised infiltration plants.

The first step toward semi-natural rainwater management on a plot of land should always be to review the need for sealed and stabilised land. In many cases, a certain form of usage no longer applies or a planned usage has failed to materialise, and these areas may be reconverted into grassland. In cases where stabilisation is essential, there are various opportunities for minimising the extent of sealing. For example, paths, roads, parking spaces and terraces may be stabilised with water-permeable coverings. **Figure 43** illustrates

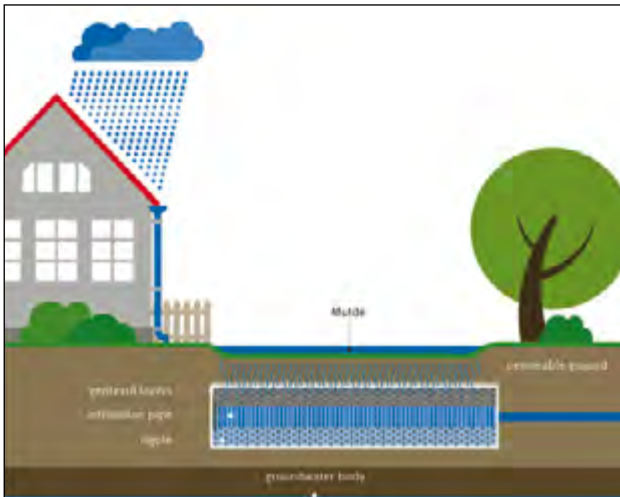
the changes in evaporation, run-off and infiltration as the level of development rises.

Aspects such as reducing contamination with pollutants, minimising the hydraulic load of water resources, land sealing, climate change and demographic change modifies the way we handle rainwater today. In this connection, local rainwater management will help to make the treatment of precipitation more efficient in future, and thereby cut costs.

Rainwater infiltration

Returning precipitation to the natural water cycle as close as possible to the site where it falls is a modern, sustainable and eco-friendly concept for dealing with rainwater in developed areas, and is also economically attractive. Infiltration via the unsaturated soil zone helps to significantly reduce the pollutant load and minimise the run-off volume.

Figure 44: Diagrammatic representation of a trough-trench system for the decentralised infiltration of rainwater



Source: Federal Environment Agency (UBA), 2011

This has many benefits: Underground sewers and storm overflows that are expensive to build may be replaced with cost-effective, semi-natural retention systems. The reduction in overflows from mixed sewers resulting from stormwater infiltration may help to significantly improve water quality.

This in itself is reason enough to change the way we handle stormwater in developed areas. The amendment to the Federal Water Act (WHG) in 2009 incorporated the principle of the local infiltration of precipitation (Article 55, paragraph (2) of the WHG), which already had been adopted in the water legislation of the Länder. The formulation of this provision is quite broad and open (target requirement), in order to make allowance for the varying local conditions (e.g. existing mixed sewers in residential developments). It

only applies to the construction of new installations; existing mixed sewers may still be operated as before.

Rainwater use

There are various expedient applications of rainwater, particularly in the commercial and industrial sector. Examples include cooling of buildings, green roofs and building facades, and rainwater as process water in industry. In facilities such as airports and football stadiums, where water is used in very large quantities just for irrigation purposes and for flushing toilets, this can likewise be achieved with rainwater. The use of rainwater in the cooling of buildings can make an important contribution to the efficient use of energy within Germany's transformation of energy systems. Whereas conventional systems for cooling of building operate according to the heat pump principle and thereby consume electricity, a system based on the evaporation of rainwater for cooling of buildings can significantly reduce electricity consumption. Figure 45 illustrates the planting of glass facades at the Institute of Physics at Humboldt University in Berlin. As well as providing shade, evaporation of water from the climbing plants also helps to cool the building.

Figure 45: Facade planting in the courtyard of the Institute of Physics at Humboldt University, Berlin-Adlershof



Photograph: Marco Schmidt, www.gebäudekuehlung.de, 2006

The use of rainwater in private households should be decided on a case-by-case basis from an economic viewpoint to determine whether rainwater is actually a cheaper alternative to the public water supply, with due regard for the local conditions, required resources and local water availability. An installation for the use of rainwater must be reported to the competent water utility, and must be constructed and operated in accordance with the best available technology. When laying rainwater pipelines to households, it is very important to ensure strict separation between the rainwater network and the drinking water network. The Drinking Water Ordinance (TrinkwV 2001) prohibits

the connection of pipelines carrying drinking water to other pipelines carrying water of an inferior quality. Water for washing household laundry need not be of drinking water quality, as confirmed by the Federal Administrative Court¹⁰⁰. The Drinking Water Ordinance leaves it up to the discretion of each individual whether they choose to use drinking water or water of inferior quality to wash laundry in their own home. Well water or rainwater from an independent supply system which is used alongside the public drinking water connection in a private household need not be of drinking water quality.

6.4. Wastewater disposal

6.4.1 Legal framework

Since 1976, minimum nationwide requirements have applied to the discharge of wastewater into waters and hence to the incidence, avoidance and treatment of wastewater. Under the old Federal Water Act (WHG), these minimum requirements were outlined in Article 7a. These regulations have since been replaced and extended by Article 57 (input of wastewater into waters – so-called direct discharge) of the 2010 WHG. Since 1996, these minimum requirements have been based on the best available technology (Article 3, no. 11 of the WHG); the permissible pollutant load depends on each industry's ability to minimise emissions into water by complying with technically and economically practicable, progressive processes.

These requirements are defined in the Wastewater Ordinance¹⁰¹ of 17 July 2004. The Wastewater Ordinance contains provisions and emission limits and also defines the best available technology.

The minimum requirements for domestic and public wastewater and for wastewater from commercial and industrial plants are defined in sector-specific Annexes to the Wastewater Ordinance. To date, some 57 industry-specific annexes have been added to the Wastewater Ordinance. Annex 1 to the Wastewater Ordinance applies to domestic and public wastewater (**Table 11**), while the other Annexes concern individual sectors of commerce and industry. For example, Annex 38 regulates the requirements pertaining to wastewater from textile manufacturing and textile finishing plants.

The licensing requirements and conditions for the discharge of wastewater into public and private waste-

water installations (known as indirect discharges) are regulated by the provisions of Articles 58 and 59 of the WHG in conjunction with the Wastewater Ordinance. The Länder may also adopt their own statutory provisions, e.g. containing more stringent licensing conditions, for the indirect discharge of wastewater.

The Wastewater Ordinance also serves to implement the technical requirements of EU law¹⁰² pertaining to wastewater. Implementation of the Industrial Emissions Directive (IE Directive), which replaced the IPPC Directive, has had particular impacts. One of the key improvements over the IPPC Directive is the strengthening of BAT reference documents (BREFs) containing provisions on Best Available Technology for industrial installations with particular environmental relevance, prepared in the so-called "Seville process". In water legislation, the material requirements of the so-called "BAT conclusions" are primarily transposed into German law via the Wastewater Ordinance and its Annexes.

6.4.2 Organisation of wastewater disposal in Germany

With between 7,000 and 8,000 local authority wastewater management enterprises (the exact figure varies according to the data source), the German wastewater sector is divided into extremely small units.

Public wastewater management in Germany is a state duty that is performed by communities and cities as a local authority responsibility. The entity responsible for wastewater management may guarantee the performance of wastewater disposal, or may entrust this to third parties, while retaining local authority supervision. Local authorities have various operational forms at their disposal for the autonomous and effective disposal of wastewater.

- ▶ Publicly owned enterprise: Operated by the community within the context of general community administration
- ▶ Municipal utility: Operated by the community as a special asset with separate book-keeping
- ▶ Company in its own right: Enterprise under private law owned by the community.
- ▶ Operator model/cooperation model: Plant operation is transferred to a private contractor, whereby responsibility for the completion of tasks remains with the community. In Germany, a particular role is played by (usually) voluntary, in some cases Land-regulated, cooperation between local authorities in associations, in order to ensure the

¹⁰⁰ Federal Administrative Court (BVerwG) 8 C 16.08 – ruling of 31 March 2010.

¹⁰¹ Ordinance concerning requirements for the discharging of wastewater into waters (Wastewater Ordinance – AbwV) in the version promulgated on 17 June 2004, Federal Legal Gazette (BGBl.) I, p. 1108, recast p. 2625, most recently amended by Article 6 V of 2 May 2013, Federal Law Gazette (BGBl.) I, p. 973.

¹⁰² Such as the Dangerous Substances Directive (2006/11/EC, which codifies Directive 76/464/EEC), the Urban Wastewater Treatment Directive (91/271/EEC), the IE Directive (2010/75/EU) and the Waste Incineration Directive (2000/76/EC).

efficiently structured organisation of water supply, wastewater treatment and waterbody maintenance from a technical and financial viewpoint, also with regard to water protection. These associations vary in terms of the task assigned to them, regional coverage and organisational form:

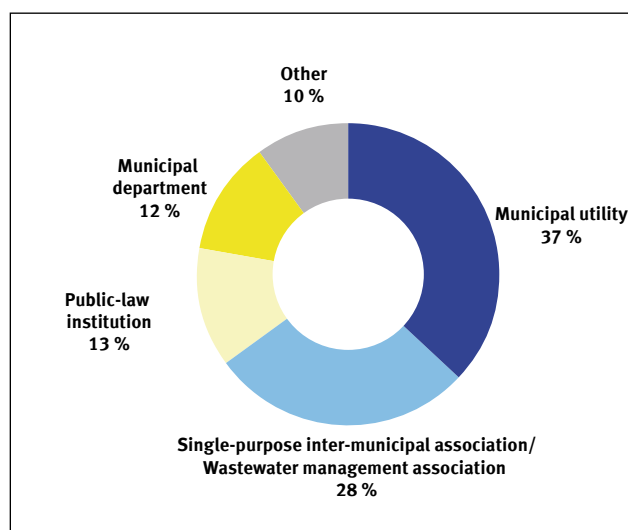
- Special-purpose organisations as associations under public law
- Water associations as defined by the Water Association Act or on the basis of special legislation (e.g. Ruhrverband (Ruhr Association)).

Based on the number of residents served, municipal utilities are the most common operational form for wastewater management tasks, accounting for 37 %, followed by water associations on behalf of several local governments (single-purpose association/wastewater association) with 28 %. Public-law corporations account for a further 13 %, which primarily concern the cities of Berlin and Hamburg¹⁰³. Publicly-owned enterprises account for 12 %.

Wastewater disposal essentially comprises two main tasks: wastewater discharge via the sewer networks or wastewater pumping trucks (so-called rolling sewers), and wastewater treatment in plants. Both tasks may be mandated to various companies by the local authority.

¹⁰³ Due to almost total coverage, the public-law corporation is over-represented in the ATV/BGW survey, which means that this figure cannot be applied to the Federal Republic of Germany in general with regard to responsibility for and performance of wastewater disposal functions.

Figure 46: Organisational forms of wastewater disposal in relation to the number of inhabitants served



Source: Profile of the German Water Sector, 2011

Table 12: Connection of the population to the public sewer system (%)

	Number of public wastewater treatment plants	Connection to sewers
1995	10,270	92
1998	10,312	93
2001	10,188	95
2004	9,994	96
2007	9,933	96
2010	9,632	97

Source: Federal Statistical Office 2009

Table 11: Minimum requirements for the discharge of public wastewater under Annex I to the Wastewater Ordinance

Size categories of wastewater treatment plants	Chemical oxygen demand	Biochemical oxygen demand over 5 days (BOD ₅)	Ammonium nitrogen	Total nitrogen as sum of ammonium, nitrite and nitrate-N	Total phosphorous (P _{total})
Population equivalent	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*
Less than 1,000	150	40	---	---	---
from to 1,000 to 5,000	110	25	---	---	---
Greater than to 5,000 to 10,000	90	20	10	---	---
Greater than to 10,000 to 100,000	90	20	10	18	2
Greater than 100,000	75	15	10	13	1

1 Population equivalent = 60g BOD₅/d in untreated wastewater

* Qualified random example or 2-hour composite sample

Source: Federal Environment Agency (UBA)

6.4.3. Impacts of the legal requirements

According to the 2007 water management survey by the Federal Statistical Office, the total number of public wastewater treatment plants in Germany is 9,933. 96 % of the general public are connected to the public sewer system, 95 % to public wastewater treatment plants, and 3 % of the population treat their wastewater in individual small treatment plants.

In 2007, a total of 10 billion m³ of wastewater was treated in public wastewater treatment plants. The volume of wastewater treated annually is comprised of 50 % urban sewage, approximately 20 % sewer infiltration water, and the remainder comes from precipitation. In 2007, 99.9 % of the wastewater in treatment plants was purified biologically. Around 98 % of biologically purified wastewater is purified with additional processes, 99 % with nitrification, 97 % with denitrification, and 93 % with the selective removal of phosphorus.

The reorganisation of the wastewater regulations and the implementation of extensive wastewater remediation measures (among other things, funds from earmarked wastewater charges are used to improve wastewater treatment) has already led to considerable success, as reflected in an improved biological quality in particular.

Contributory factors include the development of wastewater treatment plants and the high level of connection to the public sewer system and to municipal mechanical/biological plants and plants with selective nitrogen and phosphate elimination (implementation of Annex 1 to the Wastewater Ordinance (AbwV) and the Urban Wastewater Treatment Directive).

By European comparison, the local authority wastewater disposal system in Germany is exemplary. Around 90 % of the phosphorus and around 81 % of the nitrogen incurred are removed in public wastewater treatment plants. The Urban Wastewater Treatment Directive requires a reduction of 75 % for both these substances.

Table 12: Connection of the population to the public sewer system (%)

	Number of public wastewater treatment plants	Connection to sewers
1995	10,270	92
1998	10,312	93
2001	10,188	95
2004	9,994	96
2007	9,933	96
2010	9,632	97

Source: Federal Statistical Office 2009

In recent years, the majority of plants which did not yet meet the valid requirements of the Wastewater Ordinance have been upgraded. The trend for improving local authority wastewater treatment technology, particularly for the optimum reduction of nutrients and a holistic approach to the optimisation of wastewater systems (reducing drinking water consumption, treatment of substreams for further use, recovery of usable wastewater constituents), will continue in future.

6.4.4 Current challenges and problem-solving approaches

6.4.4.1 Integrative wastewater management – Option for a new Wastewater Ordinance

As a result of the WFD and following the adoption of the objectives of the Industrial Emissions (IE) Directive and the Environmental Impact Assessment (EIA) Directive into the Federal Water Act (WHG), the requirement range of the Wastewater Ordinance has been significantly extended in favour of integrative environmental protection requirements. The aim here is to give greater consideration to the overall effects emanating from wastewater treatment within the context of overall emissions.

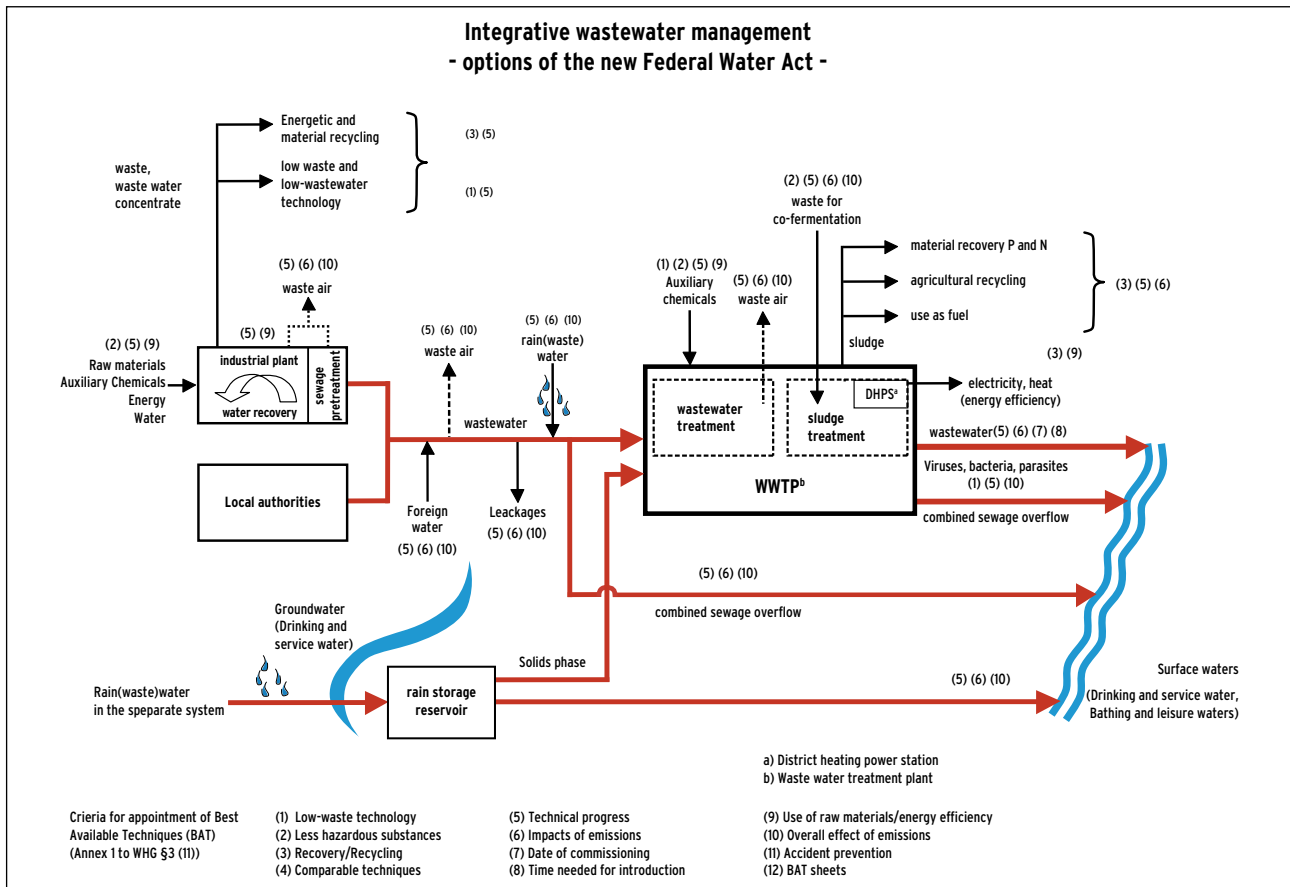
The integrated approach pursued by the IE and EIA Directives is generally superior to the media-based approach with its “narrow” interpretation of protected assets. However, the existing structures of environmental legislation and administration in Germany did not fully reflect the requirements of an integrative, sustainable wastewater management system.

In the old version of the WHG, thanks to the uniform cross-media definition of the best available technology and the holistic approach, the integrative approach was already more firmly anchored by 2009.

The new WHG in 2010 was standardised on the basis of the Federal Government’s concurrent legislation, and provides the basis for redesigning the Wastewater Ordinance with a holistic, cross-media approach. Several industry-based working parties are currently drafting proposals for Annexes 28 (paper/board) and 40 (electroplating), and focusing their attention on the required integrative approach. Working parties have also been set up for implementation of the BAT conclusions in the iron and glass industries, and proposals have been drawn up in particular for amendments to Annexes 29 (iron/steel) and 41 (glass).

With due regard for the current legal framework, **Figure 47** shows all mass flows in the wastewater sector which must be taken into account, and where applicable regulated, against the background of the integrated, cross-media approach.

Figure 47: Massflow in the wastewater disposal chain based on the integrative approach



Source: Federal Environment Agency (UBA) 2005, revised 2010

These include:

- ▶ Reviewing the 57 Annexes to the Wastewater Ordinance for possible simplification and the need for adaptation in line with the best available technology
- ▶ Requirements for stormwater management
- ▶ The specification of indicators for the energy efficiency of wastewater treatment plants
- ▶ The recovery of raw materials (e.g. phosphorus and nitrate) from wastewater and sewage sludge
- ▶ The more widespread consideration of all emissions when considering the water pathway.

6.4.4.2 Industrial and commercial wastewater

Wastewater avoidance

Avoiding wastewater by using wastewater-free techniques as far as possible is a demanding and often complex technical option for effectively reducing emissions into waterbodies. There are a large number of manufacturing processes and examples which completely or largely avoid the discharge of wastewater with a raft of measures, thereby preventing harmful effects from occurring in the waterbodies. For example,

the following sectors and activities may lend themselves to wastewater-free production:

- ▶ Wastewater-free paper manufacturing (e.g. packaging paper)
- ▶ Wastewater-free flue gas scrubbing (e.g. in lignite combustion)
- ▶ Wastewater-free vehicle cleaning
- ▶ Wastewater-free metal finishing (e.g. galvanizing)
- ▶ Wastewater-free cleaning of reusable bottles
- ▶ Wastewater-free screen printing
- ▶ Water-free substance syntheses
- ▶ Wastewater-free powder-coating

Technologies which are not necessarily wastewater-free but which can significantly reduce wastewater volumes and pollutant loads should likewise be considered in this context. Examples include membrane technology, which has made substantial development leaps in recent years, so that plant operators now have access to a broad range of application options with the various wastewater treatment techniques. Membrane techniques often have multiple advantages

over conventional techniques such as precipitation/flocculation and biological techniques. For example, they facilitate:

- ▶ The production or derivation of hygienically faultless wastewater
- ▶ Extensive wastewater purification for virtually all wastewater parameters, and
- ▶ Multiple reuse options for water as a production resource.

Challenges associated with the more widespread use of such technology in plants include cost aspects, the need for wastewater pre-treatment adapted to each individual case, the requisite expertise among operator personnel, and in some cases, more extensive inspection and measuring work if membrane techniques are to be integrated into a factory's process water circuits.

Recovery of water as a raw material

The Industrial Emissions Directive, which regulates the licensing, operation and decommissioning of industrial facilities in Europe, views the economical handling of water as an important criterion (alongside many others) when determining the best available technology. This aspect has been incorporated into the definition of best available technology in the WHG (cf. no. 9, Annex 1 of the WHG). As such, reduced water consumption has acquired a separate status. Wastewater is no longer seen merely as a source of pollution for the "environment resource water", but also as a production resource with its own intrinsic value.

Best available technology for indirect dischargers

The best available technology for the 220,000 or more indirect dischargers is comparable with that for direct dischargers in respect of in-house water management and for a limited number of pollutants. However, unlike direct dischargers, it is far more difficult for indirect dischargers to achieve integrated cross-media wastewater disposal, since the downstream treatment steps after discharging into the sewer are generally beyond their sphere of influence, and are performed by other players. A holistic, substance flow-based approach to wastewater disposal must therefore make allowance for the anticipated emissions arising during wastewater forwarding and final treatment when considering indirect discharges. Leaking sewers pose a major potential threat in the case of industrial and commercial locations when handling hazardous substances if these substances enter the subsoil via leakages in the in-plant network or the public sewer system. At present, the existing regulations in relation to indirect discharges in particular fail to make adequate allowance for emissions from sewer systems.

Implementation of Articles 58 and 59 of the WHG facilitates harmonisation of the regulations for direct and indirect dischargers.

6.4.4.3 Public wastewater

In the area of public wastewater disposal, implementation of the integrated approach and the use of low-waste technology, the use of less hazardous materials, the recovery and reuse of materials and waste, the use of raw material-conserving and energy-efficient techniques and procedures, and the overall effects of emissions throughout the entire wastewater disposal chain, should likewise be analysed and taken into account. This should also incorporate the disposal of domestic, commercial and industrial wastewater, the public sewer system, local authority wastewater treatment, as well as sludge treatment and recovery.

Figure 48 Community wastewater treatment plant, Bitterfeld-Wolfen

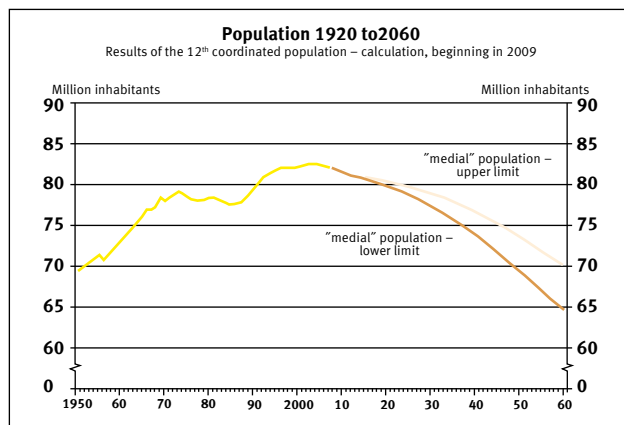


Photograph: Gemeinschaftskläwerk Bitterfeld-Wolfen GmbH

Demographic change

Whilst the global population is expected to grow by 50 % by the year 2100, the population in Germany is expected to fall from its current level of 82 million to an estimated 65 million by the year 2060. To date, there has been no decrease in population as a result of migration. However, the decrease in the birth rate, growing life expectancy and internal migration within Germany towards the urban centres is already leading to the partial desertion of peripheral, structurally weak, rural regions, coupled with rising ageing in such areas.

Figure 49: Development of population figures in Germany



Source: Federal Statistical Office (2009)

Outside of conurbation areas, fewer and fewer people now live in the same area of land, all of whom must be provided with local authority infrastructure components including water supply and wastewater disposal. In some cities and regions, by contrast, population figures will stagnate or even increase in the long term.

Declining population figures and falling population density are leading to changes in the wastewater disposal infrastructure. Wastewater sewers and treatment systems are over-dimensioned for the diminishing volumes of wastewater, and depositions in the sewer system are a growing problem. The consequences are: higher scouring frequencies, increased development of odours, and an increased operational input for wastewater discharge and treatment. As the incidence of wastewater is closely interrelated to drinking water consumption, the demographic impacts on the wastewater sector may be further exacerbated by additional water-saving measures. A falling incidence of wastewater and changes in wastewater composition mean that the existing plants no longer meet the requirements of ecologically and economically oriented wastewater disposal. The quantitative and qualitative changes necessitate new solutions for wastewater transportation and treatment. Hence it is up to the wastewater disposal agencies to adapt their infrastructures to the falling levels of water consumption.

There is a need for economically and ecologically expedient alternatives. By this, we mean technical, operational and conceptual solution strategies which safeguard the long-term performance capabilities and affordability of public wastewater disposal in the face of changing framework conditions, while at the same time satisfying the cross-media approach. The Federal Environment Agency commissioned a research project which assessed various innovative wastewater disposal techniques, plant management strategies, structural changes and organisational models vis-à-vis their relevance for adaptation of the wastewater infrastructure to demographic change, and formulated initial problem-solving approaches and recommended actions. Consideration was also given to climate change and water supply¹⁰⁴.

Rainwater management

See **Chapter 6.3**.

Wastewater hygiene

The “risks to humans” include, in particular, harmful microbial organisms whose emissions are to be avoided within the meaning of the IE Directive. With conventional wastewater treatment techniques, hygienically questionable wastewater pathogens (viruses, bacteria and parasites, including some pathogens with multiple resistance to antibiotics) are emitted in high

concentrations. In future, measures will be needed to make wastewater more hygienic, at least on those waterbodies which are used as bathing water. By using membrane filtration plants, for example, not only it is possible to comply with requirements for the more extensive purification of wastewater, but also to achieve a high standard of hygiene safety (with virtually complete elimination of pathogens) when discharging wastewater into surface waters.

Emissions into soils with the agricultural use of sewage sludge

Substances such as polycyclic aromatic hydrocarbons and heavy metals are bound to particles in high percentages in both waterbodies and wastewater. During wastewater treatment they become bound to the sewage sludge via adsorption, but are only inadequately biodegraded.

Sewage sludge used for agricultural purposes is subject to water legislation while at the wastewater treatment plant (as far as the plant gate), and then becomes subject to transport, waste and fertiliser legislation once it has left the plant. Limits for pollutants in sewage sludge are intended to prevent contaminated sewage sludge from being used as a soil improver. In order to “preventively avoid and reduce” management-related emissions from fertilisers into the soil and groundwater, most sewage sludge today is subjected to thermal recovery.

Recovery of raw materials from wastewater and sewage sludge

New techniques are also being developed, and in some cases tested in large-scale trials, to close substance cycles and recover the nutrients contained in wastewater. In particular, this concerns the recovery of phosphorus from wastewater, sewage sludge and sewage sludge ash. On the one hand, phosphorus is a vital element for all living organisms, yet on the other, significant environmental pollution may occur if phosphorus enters waters in excessive quantities and leads to eutrophication. Phosphorus is a non-substitutable raw material resource, supplies of which in adequate quality are limited because contamination of phosphate rock with uranium and cadmium is a growing problem. Each year, some 191 million tonnes of phosphate rock are mined, of which around 80 % is processed into fertilisers; global reserves are estimated at around 71 billion tonnes in total¹⁰⁵. Because Germany and the EU have almost no deposits of their own, they are currently almost entirely dependent on imports of mineral phosphate fertilisers, while at the same time, waste and wastewater rich in phosphates are being disposed of and thus distributed throughout the environment in a non-recoverable manner.

¹⁰⁴ Hillenbrand, T. et al. (2010): Demografischer Wandel als Herausforderung für die Sicherung und Entwicklung einer kosten- und ressourceneffizienten Abwasserinfrastruktur, Forschungsprojekt im Auftrag des Umweltbundesamts (FKZ 3708 16 305).

¹⁰⁵ US Geological Survey, Mineral Commodity Summaries, January 2012, minerals.usgs.gov/minerals/pubs/mcs/2012/mcs2012.pdf.

Following the successful completion in 2011 of the BMBF/BMUB funding initiative “Closed substance cycle for plant nutrients, particularly phosphorus” (offered to tender in 2005), and the initial trialling of recovery procedures, at least on a small scale, in 2012 the Federal Government adopted the Resource Efficiency Programme (ProgRes). The aim of ProgRes is to structure the abstraction and use of natural resources, particularly phosphorus, in a more sustainable way, to promote the closed substance cycle, and to reduce environmental pressures as far as possible. The recovery of phosphorus e.g. from sewage sludge which cannot be used in agriculture or horticulture due to its high level of pollutant contamination will therefore be further intensified.

The phosphorus levels contained in wastewater and sewage sludge equate to around half of Germany’s annual phosphorus mineral imports. At present, 40 % of the phosphorus input can already be recovered from wastewater and sewage sludge as magnesium ammonium phosphate (MAP) using a wet-chemical technique. MAP is ideally suited for use as a mineral fertiliser. An even higher recovery potential of around 90 % of the infeed is attainable with the recovery of phosphorus from sewage sludge mono-combustion ash. Although the mono-combustion of sewage sludge is more technically complex than wet-chemical techniques, it ensures the complete destruction of the organic pollutants in the sewage sludge, which have increasingly become the focus of attention in recent years.

Use of wastewater heat

The wastewater from households and commercial enterprises usually has a temperature of between 10 and 15 °C, even in the winter months. In well-insulated residential buildings, around 15 % of the heating energy used is therefore lost with the wastewater. From 1 m³ of wastewater, a thermal output of more than 1 KW can be derived from cooling by just 1 Kelvin. To date in Germany, only a few pilot projects have used wastewater in large sewers as a heat source for heating

apartment blocks, commercial buildings, a swimming pool and a sports hall. If the building technology were correctly adapted, up to 60 % of CO₂ emissions could be avoided by heating with wastewater heat compared with conventional heating technology.

Energy efficiency of public wastewater treatment plants

Wastewater treatment plants are major consumers of electricity. The 100,000 or so public wastewater treatment plants consume some 4,400 GWh of electricity each year, equivalent to the capacity of a typical modern hard coal-fired power plant. The volume of electricity currently used by public wastewater treatment plants therefore emits some 300 million tonnes of CO₂.

Specific electricity consumption depends to a large extent on the size of the plant. Size categories 4 and 5 only account for 37 percent of the 4,331 wastewater treatment plants that participated in the comparison, but they treat more than 92 percent of domestic wastewater and are responsible for around 91 percent of the total electricity consumption in this sector.

Many wastewater treatment plants have huge energy-saving potential. Energy savings can primarily be achieved with short- and medium-term measures with aeration and the treatment and recovery of sewage sludge, without impairing the purification performance or operational stability. More efficient aeration, improved control of the units and the use of maximum-efficiency motors and pumps alone is capable of achieving an average electricity saving of 20 % in Germany, corresponding to 900 GWh/annum or an annual emission reduction of around 600,000 t CO₂.

Electricity generation via the improved extraction and recovery of sewage gas is another aspect of the energy-efficiency operation of wastewater treatment plants. The entire process chain, from sludge dehydration to breakdown of the sewage sludge, the generation and recovery of sewage gas, and the recovery of fermentation residues, is relevant for the energy generation

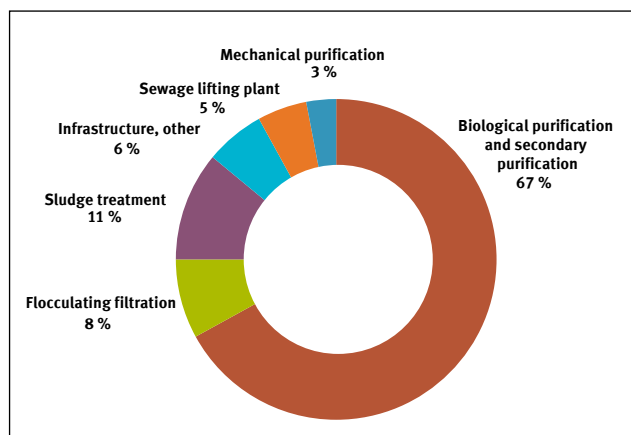
Table 13: Average specific electricity consumption of wastewater treatment plants

Size category	Population units	Average specific electricity consumption	Share of total electricity consumption by public wastewater treatment plants
GK 1	< 1,000 EW	54.1 kWh/EW × a	0.7 %
GK 2	> 1,000 – 5,000 EW	41.5 kWh/EW × a	4.0 %
GK 3	> 5,000 – 10,000 EW	38.1 kWh/EW × a	4.7 %
GK 4	>10,000 – 100,000 EW	34.1 kWh/EW × a	38.2 %
GK 5	> 100,000 EW	32.9 kWh/EW × a	52.4 %
total		34.0 kWh/EW × a	100 %

Source: DWA Leistungsvergleich kommunaler Kläranlagen 2011

potential. Optimised techniques could double electricity generation in public wastewater treatment plants (on average), and save almost 600,000 tonnes per year of CO₂; with co-fermentation the figure could even be quadrupled.

Figure 50: Typical shares of individual process stages among total energy demand



Source: Federal Environment Agency (UBA), after Haberkern et al., 2006

In small and medium-sized plants, solar drying and optimised organisational forms are expedient measures for boosting resource and energy efficiency.

As part of its Programme to support investments in demonstration projects to minimise environmental pressures (Environmental Innovation Programme), the Federal Environment Ministry, with expert support from the Federal Environment Agency, is supporting a total of 11 projects aimed at demonstrating that the energy content of wastewater could be far more extensively used and that an energy-autarchic wastewater treatment plant is achievable.

New sanitation concepts

New sanitation concepts aim to reuse water and recover the constituents of sewage. In the absence of a uniform terminology, a large number of synonyms have emerged for these new sanitation concepts. The basic concept behind them is the separate collection and selective treatment of substreams from facilities used for residential purposes or similar origins. Conventional wastewater treatment already provides tried-and-tested techniques which are also used in these new types of sanitation techniques.

In Germany, new sanitation concepts are mainly used in new developments and extensive renovation projects. These systems are particularly advantageous for plots in rural regions without connection to a public wastewater treatment plant, and for tourism and leisure facilities in exposed positions (such as allotments).

6.4.4.4 Micropollutants

Pharmaceuticals, hormones, diagnostic agents

When people think of pharmaceuticals, they tend to think primarily of the therapeutic benefits and possibly also of the potential risks to patients due to side-effects, rather than environmental problems.

Media reports in 2005 about vultures dying in India and Pakistan due to secondary poisoning with Diclofenac, a common analgesic, attracted a great deal of attention. The vultures were poisoned in large numbers because they had been eating the cadavers of cattle that had been treated with the pharmaceutical. In this way, scientist proved for the first time that a pharmaceutical can cause severe ecological damage to an entire region. The Indian Government responded in 2005 by banning the use of Diclofenac as a veterinary pharmaceutical.

In Germany, a few years ago, there were some rather random, unsystematic findings which indicated the presence of active ingredients from pharmaceuticals in the environment. Monitoring programmes by the Federal/Länder Working Party on Chemical Safety (BLAC) and LAWA have since shown that the active ingredients from pharmaceuticals are present in surface waters throughout Germany, and in isolated cases in the groundwater and drinking water as well. The concentrations of active pharmaceutical ingredients measured in the environment are generally significantly below the therapeutic doses of the medicines. However, this does not mean that they are safe for the environment. Effects on organisms in the environment which are not the intended target of pharmaceutical treatment associated with comparatively low but permanent exposure to pharmaceutical residues are largely unresearched. For example, long-term exposure could adversely affect the sensitive reproduction systems of aquatic and terrestrial organisms. One well-known example is 17 β ethinyl estradiol, the active hormone found in the contraceptive pill and some menopause drugs. Laboratory fish exposed to this active ingredient in environmentally relevant concentrations of just 4 ng/L were found to have significantly lower reproductive rates. Another example is fluoxetine, the active ingredient found in anti-depressants. In environmentally relevant concentrations of a few micrograms per litre, fluoxetine delays certain development stages from a fish egg to a mature specimen, and has an algo-toxic effect.

Elevated concentrations of > 0.1 μ g/L of numerous frequently prescribed human pharmaceuticals such as carbamazepine, ibuprofen, metoprolol, sulfamethoxazol and diclofenac have been measured in German waters. Germany's consumption of diclofenac in analgesics and rheumatism drugs totals some 85 tonnes per annum. Laboratory studies have indicated that diclofenac can cause serious damage to the kidneys of fish in the concentrations found in waterbodies.

Diagnostic agents (radiographic contrast media) are also regularly detected in the environment. Because medical use requires stability towards metabolic processes, they have a high level of persistency, and therefore accumulate continuously in the environment. Although these substances have a comparatively low active eco-toxicological potential, they should not occur in waterbodies due to their poor biodegradability.

The obligation anchored in EU law since 2001 to subject human pharmaceuticals¹⁰⁶ and animal pharmaceuticals¹⁰⁷ to environmental assessment within the context of licensing has proven expedient: In recent years, practical experience has shown that the use of various veterinary pharmaceuticals, in particular, causes environmental risks, and that therefore, authorisation should be tied to certain conditions in order to protect the environment (e.g. by restricting application areas), or that the option should be available to refuse licensing due to environmental risks. In 2005, the development of various international guidelines on the environmental assessment of veterinary pharmaceuticals was completed, and the requirements governing environmental risk assessments have since been internationally harmonised¹⁰⁸. In December 2006, a harmonised European guideline on the environmental risk assessment of human medicines also entered into force¹⁰⁹. With human medicines, however, an identified environmental risk is not a justification to refuse licensing. Further measures are needed here to reduce environmental discharge (e.g. safe disposal).

Environmental chemicals (fragrances, personal care products and detergents)

Around 1.3 million tonnes (t) of washing and cleaning agents are consumed by private households in Germany each year. On average, some 630,000 t of detergents, 220,000 t of fabric softener and 500,000 t of cleaning agents, including some 260,000 dishwashing detergents, enter our wastewater each year. Washing and cleaning agents contain a wide range of chemical substances. The level of environmental impairment depends on the degree of wastewater treatment and the nature of the constituents. Depending on the appli-

cation area, washing and cleaning agents will usually contain surfactants, complexing agents, builders, alkalis or acids, enzymes, optical brighteners, fragrances, preservatives, disinfectants and/or organic solvents.

Following the entry into force of the EU Detergents Regulation¹¹⁰ on 8 October 2005, only washing and cleaning agents containing surfactants for which proof of complete aerobic biodegradability has been submitted may be placed on the market. Surfactants that produce toxic by-products during degradation are no longer admissible. For all other constituents, biodegradability has not yet been regulated by law. As a result, individual constituents may pollute the environment.

Throughout Europe, the phosphorus contents in detergents have been limited since 30 June 2013 by the EU Detergents Regulation. Thanks to a voluntary commitment by industry, however, only phosphate-free laundry detergents have been used in private households in Germany since before that date. As a result, the phosphate levels in detergents have decreased sharply since the mid-1970s. In 1975, phosphate consumption totalled 276,000 t/a, primarily due to the use of phosphates in household laundry detergents; in 1993, thanks to the use of phosphate-free household laundry detergents, this figure had decreased to 4,000 t/a in the household sector and around 11,000 t/a in the commercial sector.

The use of phosphate-free laundry detergents has led to a halving of the water loads in wastewater treatment plants without P elimination and in discharges from mixed sewer overflows.

For a number of years, phosphate consumption in the household sector has been on the rise again, primarily due to the use of phosphates in household automatic dishwasher detergents. In 2008, the quantity used totalled 31,860 t¹¹¹. However, a limit on the phosphorus content in automatic dishwasher detergents is due to enter into force in January 2017 under the EU Detergents Regulation.

Fragrances are added to detergents, fabric softener and cleaning agents to give users a sense of cleanliness and freshness with a pleasant fragrance. In total, the manufacturing industry uses around 2,500 to 3,000 different fragrances, around 15 of which are produced in quantities in excess of 1,000 tonnes per annum. Selected fragrances may be comprised of a few to several hundred different fragrance substances.

To date, comparatively little is known about the effects of fragrances on health and the environment. We do know that some fragrances can cause contact allergies

106 Directive 2001/83/EC of the European Parliament and of the Council of 6 November 2001 on the Community code relating to human medicinal products, OJ No. L 311, p. 67 ff.

Directive 2004/27/EC of the European Parliament and of the Council of 31 March 2004 amending Directive 2001/83/EC on the Community code relating to human medicinal products, OJ No. L 136, p. 34 ff.

107 Directive 2001/82/EC of the European Parliament and of the Council of 6 November 2001 on the Community code relating to veterinary medicinal products, OJ No. L 311, p. 1 ff. Directive 2004/28/EC of the European Parliament and of the Council of 31 March 2004 amending Directive 2001/82/EC on the Community code for veterinary medicinal products, OJ No. L 136, p. 58 ff.

108 International Cooperation on the harmonisation of test requirements for veterinary medicines (VICH 2000), Topic GL 6: Environmental Impact Assessment for Veterinary Medicinal Products, Phase I. June 2000, Ref. No. CVMP/VICH/592/98
International Cooperation on the harmonisation of test requirements for veterinary medicines (VICH 2005), Topic GL 38: Environmental Impact Assessment for Veterinary Medicinal Products, Phase II. October 2005, Ref. No. CVMP/VICH/790/03
EMA (2008). Guideline on Environmental Impact Assessment for Veterinary Medicinal Products in Support of the VICH Guidelines GL6 (Phase I) and GL38 (Phase II). November 2008; Ref. No. EMA/CVMP/ERA/418282/2005-Rev.1.

109 EMA (2006). Guideline on the environmental risk assessment of medicinal products for human use. June 2006; Doc. Ref. EMA/CHMP/SWP/4447/00.

110 Regulation (EC) No. 648/2004 of the European Parliament and of the Council of 31 March 2004 on detergents, OJ L 104, p. 1, most recently amended on 25 June 2009, OJ L 164, p. 1643.

111 Source: Industrieverband Körperpflegeprodukte, Wasch- und Reinigungsmittel (IKW).

or other intolerances. Such fragrances may be either of natural origin or synthetically manufactured. Natural fragrances with allergenic potential include limonen, linalool and geraniol, some of which is obtained from the peel of citrus fruits. Certain fragrances, particularly certain musk compounds, also have very low degradability in the environment, and because of their good fat solubility, accumulate via the food chain primarily in the fatty tissues of animals. Since 1994, the industry has voluntarily replaced selected musk compounds with other substances. However, various polycyclic musk compounds such as HHCb and AHTN continue to be used and accumulate in fish. The accumulation potential of many other fragrances produced in smaller quantities has not been researched to date.

Biocides

Since 2003, biocide products have been subject to licensing throughout Europe. They undergo a two-stage assessment procedure, as regulated by the EU Biocide Regulation No. 528/2012¹¹². In Germany, the Biocide Regulation was transposed into national law by the Implementation Act, which was integrated into the Chemicals Act¹¹³. For products which were already on the market prior to 2003, certain transitional deadlines apply to active substance notified for the EU analysis procedure.

In the initial stage at EU level, all biocide constituents are analysed to determine their inclusion in the European Union list of approved active substances. In a second stage, a decision is then reached regarding the licensing of each individual biocide product at national level. As a general rule, only biocide products whose constituents have been approved within the framework of the EU procedure may be licensed in the EU Member States.

In both procedures (active substance analysis and product licensing), it is important to determine that, when used properly as per the intended purpose, the biocide product:

- ▶ is adequately effective
- ▶ does not cause any unacceptable impacts in the target organisms, such as the development of resistance or unnecessary pain and suffering, and
- ▶ according to the best available technology and current state of the art, is not thought to cause any unacceptable impacts on the environment or the health of humans and animals, where applicable via the use of adequate risk minimisation measures.

In view of their varied and very different application patterns, biocides are divided into 22 product types, including disinfectants, preservatives for various areas (such as wood, masonry, cooling fluids etc.), insecticides and other biocide products (such as anti-fouling products and embalming agents).

The wide variety of applications is also reflected in the number of potential emission routes into the environment, for example, into surface waters. Until now, emissions from biocide applications have been largely underestimated and not widely addressed. This has changed in recent years, partly due to a growing number of press reports on biocides detected in German surface waters, as well as publications verifying that emissions into waters of biocides from urban regions are often on a similar scale to pesticide emissions in rural areas.

The largest number of biocide products recorded in the Notification Register¹¹⁴ of the Federal Institute for Occupational Safety and Health (BAuA, Federal Agency for Chemicals, Licensing Agency for Biocides in Germany) are from the disinfectants group. Many of these constituents are not persistent, but they are used in large quantities and continuously discharged into the environment. Triclosan, for example, a disinfectant constituent with a broad application range (e.g. in bodycare products, clothing) is now regularly detected in German waters, as is the transformation product methyl triclosan, which is bioaccumulative and has been detected, for example, in bream in concentrations of up to 33 µg/kg wet weight (Environmental Sample Bank).

The rising levels of biocides detected in Germany's surface waters in recent years originate primarily from urban regions. These include masonry preservatives in product category 10 and coating preservatives for preventing the growth of algae and mould in category 7. These active ingredients include isoproturon, diuron and terbutryn which are transported to the surface when the facade becomes damp, where they prevent the growth of harmful organisms. During rain, however, this unavoidably leads to the constituents being leached out of the treated facades. They are either discharged directly into surface waters via rainwater sewers, or else into the wastewater treatment plant, where they cannot be eliminated completely due to their poor biodegradability. For example, terbutryn was detected in several surface waters in North Rhine-Westphalia in 2011 in concentrations of > 0.1 µg/l.

Because of their fungicide or algicide effects, many biocide constituents are also used in pesticides. For example, isoproturon is used both as a biocide in material preservatives and in pesticides. There are also some overlaps with the pharmaceutical sector. Many

112 Biocide Regulation No. 528/2012: <http://ec.europa.eu/environment/biocides/2012/overview.htm>

113 New version of the Chemicals Act of 23 August 2013, Federal Law Gazette (BGBl.) 2013 part I, no. 55 of 6 September 2013.

114 BAuA-Melderegister für Biozidprodukte in Deutschland (register for biocide products in Germany): <https://www.biozid-meldevorordnung.de/offen/>

biocidal constituents with a disinfectant or insecticide action are likewise found in human or animal pharmaceuticals.

As a result of the transitional regulations, biocide products which were already on the market prior to 2003 and whose notified constituents include biocide can still legally be used, even if they are already prohibited as pesticides. This is true, for example, of terbutryn and diuron, which may still be used as material preservatives but no longer as pesticides.

Nanomaterials

A proposal by the EU Commission dated 18 October 2011¹¹⁵ defines nanomaterials as materials occurring naturally, in processes and deliberately manufactured, including aggregates and agglomerates from them. At least 50% of the quantitative particle size distribution must be within the range 1–100 nanometres (nm). In derogation of this definition, some explicitly listed materials (fullerenes, graphene and single-walled carbon nanotubes – SWCNT) with dimensions of less than 1 nm are also classed as nanomaterials.

Nanotechnologies are used in downstream processes such as water treatment, wastewater treatment or groundwater purification. Nanotechnically optimised separation membranes and nanoparticles are used commercially for catalytic and adsorptive purification processes. Nanotechnology-based production processes can also significantly reduce wastewater pollution during the production process¹¹⁶. There are already a number of nanotechnology products used in drinking water processing, wastewater treatment and groundwater purification. For example, the separation of arsenic from drinking water and wastewater with nanoparticulate iron oxide (a FeOOH) is used in continuous fixed-bed reactors. Similar sorption techniques are under development for the separation of other toxic heavy metal compounds (antimony, lead, cadmium, chromium). Nanoparticulate iron has also been used in the remediation of groundwater damage, particularly in the event of contamination with chlorinated hydrocarbons. Under suitable conditions, remediation can be carried out quickly and highly effectively with nano-iron¹¹⁷.

Nanoscale titanium dioxide (TiO₂) can be a significant catalyst for water, air and soil. In the water, it can function as a photocatalyst and adsorbent, and therefore

be used for solar water treatment. In conjunction with water, oxygen, UV radiation and TiO₂, reactive free radicals are created, which can convert pollutants into potentially less harmful substances¹¹⁸. However, it is important to ensure that the degradation products and by-products do not indicate any toxic potential. The release of photocatalytically active TiO₂ into the environment must also be prevented as far as possible, because the oxidative stress potentially triggered by this material could prove harmful to aquatic organisms in particular.

As these synthetic nanomaterials become more widely used, growing quantities are likely to be discharged into the environmental compartment of water. However, studies of selected nanomaterials indicate that wastewater treatment plants are capable of retaining around 90%¹¹⁹. After releasing nanomaterials into waters, their transportation and persistence are influenced by the characteristics of the waterbody (such as pH, salt content, existence of organic components) and those of the nanomaterial itself (e.g. size, crystallinity, surface quality, chemical nature).¹²⁰ During aquatic transportation, nanomaterials may change their properties as a result of agglomeration, complexing, adsorption and absorption of substances and chemical reactions.¹²¹ Studies indicate that nanomaterials in the liquid compartment tend towards sedimentation.

Whereas a few years ago, only data on acute effects was available, studies are now available on the ecotoxicological long-term effects of nanomaterials.¹²² Further studies e.g. on the potential (eco-)toxicological effects of nanoparticles, such as the aforementioned TiO₂, are needed in order for the technical advancement and application of nanoparticles to be linked to the necessary scientific risk assessment.

6.4.5 Wastewater treatment prices

Like water supply, wastewater disposal is a public service task (Article 50, paragraph (1) of the Federal Water Act (WHG)) which is carried out by the local authorities within the context of their constitutionally guaranteed self-administration. This means that wastewater charges are set by the local authorities

115 Simultaneously published on the Internet and on 20 October 2011 in OJ L 275, p. 38–40 and <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:275:0038:0040:DE:PDF>

116 Luther, W., Bachmann, G., Grimm, V., Marscheider-Weidemann, F., Schug, H. and A. Zweck (2007): Zukunftsmarkt Nachhaltige Wasserwirtschaft und Nanotechnologie. Fallstudie im Auftrag des Umweltbundesamtes. Umwelt, Innovation, Beschäftigung 12/07.

117 UBA (2012): Einsatz von Nano-eisen bei der Sanierung von Grundwasser. Datenblatt Nanoprodukte 11.12.2012.

118 Martens, S., Eggers, B., Evertz, T. et al. (2010): Untersuchung des Einsatzes von Nanomaterialien im Umweltschutz. Umweltbundesamt TEXTE 34/2010.

119 Limbach, L.K.; Bereiter, R.; Müller, E.; Krebs, R.; Gälli, R.; Stark, W.J. (2008): Removal of Oxide Nanoparticles in a Model Wastewater Treatment Plant: Influence of Agglomeration and Surfactants on Cleaning Efficiency. *Environ Sci Technol* 42: 5828–5833.

120 Ottfuelling, S., Von der Kammer, F., Hofmann, T., (2011) "Commercial Titanium Dioxide Nanoparticles in both natural and synthetic water: Comprehensive multidimensional testing and prediction of aggregation behavior." *Environmental Science & Technology* (45), 10045–10052.

121 Levard, C., Hotze, E.M., Lowry, G.V., Brown, G.E. Jr., (2012) "Environmental Transformation of silver Nanoparticles: Impact on Stability and Toxicity" *Environmental Science & Technology* (46), 6900–6914.

122 Zhao, C.M. and Wang, W.-X. (2011): Comparison of acute and chronic toxicity of silver nanoparticles and silver nitrate to *Daphnia magna*. *Environmental Toxicology and Chemistry* 30 (4): 885–892.

and communities on the basis of the local authority fee legislation of the individual Länder with the corresponding local statutes. Under such legislation, charges are set on a polluter-pays basis, and are payable by all property owners and companies connected to the public sewers. In keeping with the cost recovery principle, therefore, the revenues of the local authorities must not exceed the actual operating and investment costs incurred in conjunction with the discharging and treatment of wastewater in the disposal area.

Given the wide variations in regional and local conditions, the cost of wastewater disposal at local level varies considerably. The diverse natural and infrastructure-related framework conditions (such as topography, geology and population density) within Germany determine the costs, as do the capacity of the wastewater treatment plants and the varying purification capacities, which depend on the nature of contamination in the wastewater being treated, as well as specific investments in the sewer network and treatment technologies.

In order to protect waterbodies from pressures and advance the use of technologies with an optimum purification effect, all companies in Germany that discharge wastewater into a waterbody (so-called direct dischargers), so also the local authority wastewater treatment plants, pay a wastewater fee. This applies nationwide. The level of the fee is based on the residual contamination remaining in the wastewater after treatment (cf. [chapter 4.2](#)). The wastewater fee is incorporated into the price paid by consumers for wastewater disposal.

Additionally, the local authorities may draw on various tariff models with different fee components when setting prices. The following factors are taken into account: a volume fee for wastewater in relation to the

volume of the consumed freshwater, a volume fee for precipitation water per square metre of sealed land, and a basic annual charge to cover fixed costs. The basic charge covers around 75–85 % of the costs of depreciation, interest, staffing, and plant maintenance incurred for wastewater disposal, irrespective of the quantity of water that is discharged and purified in the wastewater treatment plants.

A nationwide survey by the Federal Statistical Office in 2010 indicates the tariff systems used and the broad variation in fee levels.

If we calculate an average nationwide price for the individual fee components, this produces the following costs:

- ▶ Average wastewater fee: 2.36 € per m³ (according to freshwater consumption)
- ▶ Average precipitation fee: 0.49 € per m², per annum
- ▶ Average basic charge: 15.39 € per annum.

Taking as an example a standardised two-person household with a wastewater volume of 80 m³ who also pay a precipitation fee for 80 m² of sealed land and a basic charge, the level of expenditure on wastewater disposal can be calculated from these average figures. In 2010, this translates into an average wastewater disposal cost of € 243 for a two-person household.

The level of wastewater prices and the basic principles by which fees are calculated are a hotly debated topic among the general public. Recent court rulings on the admissibility of selected tariff models could lead to changes in the fee structure. To date, however, the level of fees has not been affected by this.

Table 14: Wastewater prices 2010

Local authorities with	Proportion of local authorities %	Price in €		
		Wastewater fee per m ³	Precipitation fee per m ²	Basic charge per annum
Only wastewater fee	29.8	2.44	----	---
Wastewater fee and basic charge	28.7	2.57	-----	73.45
Wastewater and precipitation fee	20.3	2.23	0.75	---
Wastewater and precipitation fee plus basic charge	12.7	2.45	1.03	53.54
Precipitation fee and basic charge	0.1	---	0.50	129.66
Only basic charge	0.6	---	---	178.03
Other fees	7.9	2.40	0.70	11.78

Source: Federal Statistical Office, 2013

6.5 Substances hazardous to water

6.5.1 Legal framework

Water resources management provisions relating to facilities and substances are outlined in Articles 62 and 63 of the Federal Water Act (WHG)¹²³. To date, the provisions governing facilities have been specified by the Land water legislation and 16 Land ordinances relating to facilities for the handling of substances dangerous to water. Seven Länder have additionally adopted ordinances outlining requirements for installations for the storage and filling of liquid manure, slurry and silage seepage. The General Administrative Provision on the Classification of Substances Constituting a Hazard to Water (VwVwS)¹²⁴ also contains provisions on the classification of such substances. It contains provisions on the assessment of water hazard potential, i.e. on the classification of substances into so-called water hazard classes and as non-hazardous to the aquatic environment.

The new provisions in the WHG following the federalism reform of 2006 offer an opportunity to formulate uniform nationwide provisions on the handling of substances constituting a hazard to water. In future, therefore, a Federal Ordinance on the handling of substances hazardous to water (AwSV) will replace both the 23 ordinances of the Länder and the VwVwS. Work on this ordinance is already well advanced, and it is expected to enter into force in 2014. The Länder are not able to deviate from a Federal Ordinance, since provisions relating to substances and installations are part of the core water legislation which cannot be deviated from, cf. Article 72, paragraph (3), no. 5 of the Basic Law¹²⁵. This therefore offers an opportunity to harmonise the provisions of the Länder, which in recent years have become increasingly disparate. This simplification of the law will not only benefit water protection but also planners, builders and operators of installations, experts, and licensing and monitoring authorities, by making the provisions more transparent in future.

The WHG stipulates that installations for the storage, filling, manufacturing and treatment of substances constituting a hazard to water must be of such a quality and constructed, maintained, operated and decommissioned in such a way that there is no reason to fear any disadvantageous changes in the properties of waterbodies (concern principle). The same applies both to installations for the use of substances hazardous to

water in the area of commercial industry and public installations, as well as to certain pipelines, with the exception of long-distance pipelines.

Facilities for the loading and unloading of substances hazardous to water and installations for the storage and filling of liquid manure, slurry and silage seepage and of comparable substances arising in agriculture must be of such a quality and must be constructed, maintained, operated and decommissioned in such a way as to ensure the best possible protection of water resources from disadvantageous changes to their properties. As such, different requirements apply to such facilities, but in practice, they likewise offer a level of protection that prevents water pollution. As a minimum requirement, however, the installations of both these groups must meet the generally accepted technical standards. Articles 62 and 63 of the WHG require the operators of installations for the handling of substances hazardous to water to observe certain technical and organisational requirements. These requirements will be defined in more detail in the new Ordinance, which will essentially be based on the sample installations ordinance drafted by LAWA and the existing ordinances of the Länder.

As the provisions of the WHG were already designed with a view to the forthcoming Federal Ordinance, regulatory gaps must be avoided until it enters into force. A transitional ordinance will apply during this period¹²⁶.

6.5.2 Installation-related waterbody protection

In individual cases, concerns about waterbody contamination from an installation, depends on the substance used, the technical and organisational safety measures, and the site-specific conditions. For this reason, the requirements governing installations are graduated according to their hazard potential¹²⁷. An installation's hazard potential depends on the volume of substances hazardous to water and their water hazard categories.

Installation operators are required to ensure that the relevant technical and organisational requirements are met. Generally speaking, requirements cover the following four areas:

- ▶ General safety, e.g. stability, suitability of the installation's parts for handling the substances concerned, resistance to anticipated mechanical, thermal and chemical influences, prevention of the escape of substances hazardous to water
- ▶ Multiple safety, particularly redundant structural and/or technical safety precautions such as collecting chambers and overflow safeguards

¹²³ Federal Water Act (WHG) of 31 July 2009, Federal Law Gazette (BGBl.) I, no. 51, p. 2585; most recently amended on 21 January 2013 (Federal Law Gazette (BGBl.) I p. 95).

¹²⁴ General Administrative Provision to the Federal Water Act on the Classification of Substances Constituting a Hazard to Water into Water Hazard Classes (VwVwS) of 17 May 1999, BAnz. p. 8491 and supplement, amended on 27 July 2005, BAnz. no. 142a (supplement).

¹²⁵ Basic Law for the Federal Republic of Germany of 23 May 1949, Federal Law Gazette (BGBl.) p. 1, most recently amended by Article 93 of the Act of 11 July 2012, Federal Law Gazette (BGBl.) I, page 1478.

¹²⁶ Ordinance on Installations for the Handling of Substances Hazardous to Water of 31 March 2010, Federal Law Gazette (BGBl.) I, page 377).

¹²⁷ Berlin and North Rhine-Westphalia have deviated from this system.

- ▶ Operator obligations and expert inspections
- ▶ Systems for detecting if a substance hazardous to water has escaped, and the preparation of measures to be implemented during and after any such incidents.
- ▶ All facilities in certain areas such as water protection areas or flood plains are subject to additional requirements.

Administrative Regulation on substances dangerous to water – VwVwS

Substances dangerous to the aquatic environment are assessed as either non-hazardous or else assigned to one of three water hazard classes (WGK 1 to 3) according to their hazard level. The procedure for classifying substances is set out in the “General administrative provision to the Federal Water Act on the classification of substances constituting a hazard to water into water hazard classes” (VwVwS) of 17 May 1999 and the “General administrative provision amending the VwVwS” of 27 July 2005. The provisions on the classification procedure will be transferred into the new Federal Ordinance AwSV.

The VwVwS currently lists some 1,850 substances in water hazard classes 1, 2 or 3. A further 79 substances are listed as not constituting a hazard to water. The amendment to the VwVwS of 17 May 1999 served to harmonise the classification systems. Since then, WGK classification has been performed and documented by the operators of facilities for the handling of substances hazardous to water themselves, and can be derived directly from the R-phrase classification under hazardous substance law.

To date, the WGKs of some 8,000 substances and substance groups have been documented under the self-classification procedure, and submitted to and published by the Federal Environment Agency (UBA). Following the publication of WGKs on the Internet (<http://www.umweltbundesamt.de/wgs/index.htm> or <http://webigoletto.uba.de/rigoletto/public/welcome.do>), interested parties can also access the relevant safety data sheets (SDS). The decisive difference from the R-phrase classification under hazardous substances legislation lies in the consideration of the precautionary principle that is anchored in water legislation, which states that substances for which no adequate analyses of toxicity and environmental danger are available should be classified in the highest water hazard class as a precaution. By contrast, a lack of analyses does not lead to R-phrase classification under the GefStoffV, making it impossible to determine whether a substance not labelled as environmentally harmful is actually harmless to the environment, or whether there are simply no relevant eco-toxicological investigations available.

The WGK classification system designed for process safety is therefore an expedient addition to hazardous substances law to prevent damage to waters, particularly when handling untested substances. At the same time, classification creates a permanent incentive to substitute particularly hazardous or poorly documented substances with others that are less hazardous to water and have been well-tested.

In addition to the aforementioned laws and ordinances, installations constituting an operational area or part of an operational area as per the definition in Article 3, paragraph (5a) of the Federal Immission Control Act (BImSchG) are subject to the 12th Ordinance to the Federal Immission Control Act (Hazardous Incident Ordinance)¹²⁸ which stipulates that construction and operation must observe the best available safety technology. An operational area of this kind applies, for example, to certain plants containing 100,000 kg or more of environmentally harmful substances with the risk phrase R 50 (very toxic to aquatic organisms) or R 50/53 (very toxic for aquatic organisms, may have long-term harmful effects in waterbodies), or 200,000 kg or more of environmentally harmful substances with the risk phrase R 51/53 (toxic to aquatic organisms, may have long-term harmful effects in waterbodies). The Hazardous Incident Ordinance implements the Directive on the control of major-accident hazards involving dangerous substances (Seveso II Directive) and the corresponding amendment Directive¹²⁹.

Accidents in installations with substances dangerous to water

Despite the safety requirements in place, accidents associated with the operation of installations containing substances constituting a hazard to water do still occur. If a substance hazardous to water escapes, this must be notified immediately to the competent authority or the nearest police station, even if there is the slightest suspicion that substances may have penetrated a body of surface water, a wastewater treatment plant or the soil. Each year, the Federal Statistical Office evaluates these notifications on the basis of the Environmental Statistics Act and publishes the results¹³⁰.

The latest figures refer to the year 2012. These indicate that there were 818 accidents involving the handling of substances hazardous to water in commercial operations and private households. Some 14 million litres of contaminants were released, almost three times as much as in the previous year (5 million litres). The significant increase in overall volume compared to 2011

128 Hazardous Incidents Ordinance of 8 June 2005, Federal Law Gazette (BGBl.) I, p. 1598.

129 Directive 2003/105/EC of the European Parliament and of the Council of 16 December 2003 amending Directive 96/82/EC, OJ No. L 345, p. 97 and Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances, OJ 1997, no. L 10, p. 13.

130 Unfälle mit wassergefährdenden Stoffen (2008), Fachserie 19 Reihe 2.3, Statistisches Bundesamt (Federal Statistical Office).

was attributable in part to some 1 million litres of kerosene that escaped from a defective pipeline, and in particular, some 10.5 million litres of liquid manure, slurry and silage seepage and fermentation substrates released in 157 incidents. Although liquid manure, slurry and silage seepage are classed as hazardous to water, they are not classified into water hazard classes. However, once released in large quantities, they pose a considerable threat to the environment.

Incidents involving liquid manure, slurry and silage account for 6.8 % of all accidents (2,292 accidents in the transportation and handling of substances hazardous to water). The volumes released in such accidents account for the bulk of all contaminants released, at 72 %.

Of the quantities of substances hazardous to water released, almost 8.3 million litres (around 57 %) were recovered, *inter alia* via pumping or reloading into different containers.

Most accidents with substances hazardous to water were caused by human error. Failure of protective equipment and material defects were also a common cause of accidents.

6.5.3 Transport of substances hazardous to water by road, rail and water

Freight traffic has increased greatly in Germany in recent years. The main causes of this are:

- ▶ Structural changes in the economy (more valuable goods are being transported in smaller quantities)
- ▶ Spatial/temporal changes in industrial production (European-centric production)
- ▶ Liberalisation of transport markets and opening of Eastern Europe.

The transport of dangerous goods has increased in proportion to freight traffic. The modal shift from rail

and ship in favour of transportation by road is also continuing. Unless the framework conditions change with regard to economic and transport policy, we must expect the transportation of dangerous goods by road to increase further.

In addition to global and local environmental pollution caused by ever-increasing transport densities, with the transportation and handling of dangerous goods there is an increased potential threat to the environment associated with the release of substances due to accidents. Statistics on transport accidents have been kept since 1975.

In 2012, a total of 1,474 accidents involving substances hazardous to water were notified in connection with transport. They involved the release of 396 m³ of substances dangerous to water, of which 269 m³ (68 %) was recovered. 1,378 (93 %) of these were road traffic accidents. In 75 % (1,108) of all transport-related accidents, substances dangerous to water were released from fuel tanks, accounting for 60% of the total volume released. More figures on transport accidents in 2012 are shown in **Table 15**.

The environmental protection task here is to reduce, as far as possible, or prevent the release of substances during accidents. As regards the transport of dangerous goods, there are three possible ways of achieving this:

- ▶ Traffic prevention
- ▶ Traffic relocation
- ▶ Improving the legislation governing the transport of dangerous goods and the technical and organisational requirements to be met.

Traffic prevention

Traffic prevention is an interdisciplinary long-term structural policy task. In order to succeed, it must at least partially sever the link between traffic development and economic development. To this end, conditions must be created which will enable traffic preven-

Table 15: Accidents during the transport of substances dangerous to water

	Volume released [m ³]	Volume recovered [m ³]	Recovery rate
1378 accidents (93,5 %) during transport by road	343.7	239.1	69.6 %
30 accidents (2,0 %) during transport by rail	3.4	1.9	55.9 %
56 accidents during transport by water (3,8 %)	40.9	20.7	50.6 %
0 accidents during transport by long-distance pipelines	–	–	–
10 accidents (0,7 %) involving other modes of transport	7.5	7.4	98.7 %

Source: Federal Statistical Office, 2012

tion to be incorporated into entrepreneurial decisions, competition policy and consumer behaviour.

Examples include:

- ▶ Substantially increasing transport costs with the internalisation of external costs
- ▶ Preventing infrastructural measures that increase capacity, especially for road traffic, and
- ▶ Regionalisation of industrial cycles.

The unavoidable transport of dangerous goods must be rendered safe. In addition to measures aimed at technical optimisation, e.g. safety and control systems, organisational measures are also gaining in importance.

Improved links between the planning and licensing of production plants, transport routes and transport licenses are needed.

Traffic relocation

Relocating freight traffic to only one mode of transport cannot solve the impending problems of the projected growth in traffic. The key is to encourage expedient links between modes of transport to unburden the roads and encourage the use of transportation by rail and ship, using the respective system-based benefits and resources to ensure the optimum utilisation of all modes of transport. The most ecologically expedient transport system must be selected, taking into account the potential environmental risk.

Apart from their quantity and environmentally hazardous properties, other factors determining the potential risk associated with the transport of such goods are the distribution pattern following release, and the speed and effectiveness of technical measures to prevent or eliminate accident-related releases. The extent of damage also depends on the regional sensitivity of the area affected.

Road freight has the lowest quantities per transport operation, followed by shipments by rail and inland waterways (depending on capacity utilisation). The quantities potentially released per transport operation are therefore correspondingly low in transportation by road. In the case of rail transport, it can be assumed that only individual wagons will be affected in the event of an accident, and not the entire train. Releases from accidents during the transport of dangerous goods by road or rail will predominantly lead to soil contamination, sometimes indirectly via the air.

Contamination of surface waters may occur as a result of traffic accidents on inland waterways; the risk from road and rail is much lower by comparison, although it cannot be ruled out completely. The extent to which soil contamination caused by an accident involving dangerous goods might affect groundwater differs

greatly from region to region and depends primarily on the retention capacity of the soil. Groundwater contamination is essentially long-term damage, the remediation of which requires very high technical and financial input. It is often impossible to restore it to its original condition.

Improving the legislation governing the transport of hazardous goods and associated technical and organisational requirements

Until now, the dangerous goods classification scheme has only considered the “traditional” hazard characteristics of substances such as flammable, toxic, corrosive, etc. Since 2009, however, the criterion “environmentally hazardous (aquatic environment)” must additionally be considered for all dangerous goods. If the dangerous goods are already classified in one or more of the classes 1–9, the property “environmentally hazardous (aquatic environment)” must be marked as an additional risk. The description of the dangerous goods remains unchanged. Since 2009, the criteria for the classification of dangerous goods as “environmentally hazardous (aquatic environment)” have been harmonised with hazardous substance legislation.

6.5.4 Transport of substances hazardous to water in long-distance pipelines

Germany currently has a network of long-distance pipelines with a total length of around 3,000 km for transporting substances dangerous to water, primarily crude oil and petroleum products. There is also a widespread network of military pipelines for petroleum products. Although in normal operation, pipelines are relatively environmentally friendly compared to other transport carriers in terms of pollutant emissions, noise and energy input, they may nevertheless pose a substantial threat to soil and water in the event of an accident.

The construction and significant modification of certain long-distance pipelines, including those used to transport substances constituting a hazard to water, requires planning permission and/or plan approval under Part 2 of the Environmental Impact Assessment (EIA) Act.

Permission and approval may only be issued provided there is no danger to humans, fauna and flora, soil, water, air, climate and landscape, cultural assets and other assets, and provided precautionary measures are taken to prevent any impairment of these protected commodities, particularly as a result of structural, operational or organisational measures, in accordance with the best available technology. The project must not conflict with environmental provisions and other public law regulations, the objectives of regional planning must be observed, and work safety requirements

must be respected. For long-distance pipelines used to transport certain substances hazardous to water, these requirements are set out in the Long-Distance Pipeline Ordinance¹³¹ and the “Technical Rules on Long-Distance Pipeline Installations”.

The relocation of the licensing obligation from the WHG into the EIA Act adopted by the amended version of the EIA Act in 2001 accepts that long-distance pipelines may not only impact and pose a hazard to waterbodies, and recognises that encroachments into nature and soil e.g. as a result of construction measures or keeping the overground route clear should be given equal weighting within the context of plan approval or planning permission.

Under Article 9 of the Long-Distance Pipeline Ordinance, the Committee for Long-Distance Pipelines (AFR) was set up to address technical issues associated with the transport of hazardous substances in pipelines. It is tasked with advising the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and proposing suitable technical rules in line with the best available technology. The AFR has 13 members from Land and Federal Government authorities and ministries, long-distance pipeline companies, manufacturer and other organisations, and expert organisations. The latest results from their work into pipeline safety issues may be found at <http://www.bam.de/de/microsites/afr/afr-arbeitsergebnisse.htm>.

Long-distance pipelines are often transboundary installations, and the safety of sections of the pipeline in one country may be dependent on sections of the installation in another country. No European directive currently exists in this respect. International recommendations governing the safety of the pipelines are, however, contained in the UNECE “Industrial Accidents” and “Water” Conventions. These “Safety Guidelines/Best Practices for Pipelines” define the minimum safety protection standards for transboundary pipelines (see: <http://www.unece.org/env/teia/pubs/pipelines.html>).

6.6 Agriculture

6.6.1 Legal framework

A range of important legislation for environmentally-friendly agriculture has already been adopted, including the Federal Water Act, the Fertilisers Act, the Plant Protection Act, the Federal Soil Conservation Act, the Closed Substance Cycle Waste Management

Act, the Plant Protection Products Regulation^{132 133}, the Directive¹³⁴ on the sustainable use of pesticides, the Nitrates Directive, the Sewage Sludge Directive and the IE Directive¹³⁵. The length of this list also shows that the requirements for farmers to protect waters and the environment are not only varied, but also spread over a number of different legal spheres.

A debate over environmental protection in agriculture must also consider the subsidies granted under the Common Agricultural Policy (CAP). From 2005 onwards, Germany largely severed the link between direct payments and actual production. From 2010 onwards, in a four-phase process, Germany switched completely to the so-called regional model, so that as of 2013, each Land now has a regional, uniform land premium for arable land and grassland. Other key aspects of the 2007 agenda (applicable to the period 2007–2013) were:

- ▶ Cross compliance, i.e. linking direct payments to environmental protection, animal protection and food safety standards. The environmental standards under sectoral legislation will also include selected requirements from the Nitrates Directive and directives concerning groundwater.
- ▶ Compulsory modulation, i.e. cutting direct payments by 3 % (2005), 4 % (2006) and 5 % from 2007 to 2012, so that these funds may be channelled into the development of rural areas (including the agro-environmental programmes).

After almost two-and-a-half years of negotiations, in late June the EU Commission, the EU Agriculture Council and the European Parliament agreed on a reform of the Common Agricultural Policy (CAP) for the period 2014–2020. The CAP is supposed to become “fairer, greener and more efficient”. Over the next few months, on the basis of the agreement reached, it will be a matter of finalising the draft regulations already published in autumn 2011 with legally binding validity, translating these into all the official languages of the EU, and formally adopting them. The European Parliament’s consent is considered a given. Nevertheless, there will be transitional regulations for 2014, and parts of the reform will not enter into force until 1 January 2015.

The new EU budget (medium-term financial framework) will include the following guidelines for the reformed CAP: a reduction in the agricultural budget overall, a moderate redistribution in favour of those Member States with below-average agricultural subsidies (external convergence), a gradual standard-

131 Federal Law Gazette (BGBl.) I 2013, page 3231.

132 Ordinance on the licensing and approval procedures for pesticides (Pesticides Ordinance) of 15 January 2013, Federal Law Gazette (BGBl.) I, p. 74.

133 Regulation (EC) No. 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC, OJ L 309, p. 1 ff.

134 Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides, OJ L 309, p. 71 ff.

135 Directive on industrial emissions of 24 November 2010, OJ L 334, p. 17.

isation of the different acreage premiums currently still existing in different Länder in Germany (internal convergence), more selective support for the “active farmer”, the linking of direct payments to compulsory environmental protection measures over the entire acreage (“greening” – see below for further details), concentration of support for disadvantaged areas in biophysically unfavourable locations, and changes to rural development (“second pillar”). The focus on the support of “active farmers” is intended to encourage land management, rather than land ownership. However, the reform contains numerous exemptions. For example, the enormous discrepancies between EU Member States in the level of direct payments to farms will only be partially reduced (“external convergence”). Within Member States, too, imbalances will be ameliorated but not abolished (“internal convergence”; with in Germany, however, guidelines issued by the Federal Constitutional Court in 2008 must be implemented. Under these guidelines, acreage premiums will become uniform nationwide by 2020).

For national implementation of the CAP Reform, a special Conference of Agricultural Ministers on 4 November 2013 resolved to give more support to smaller farms by granting an additional € 50/ha for each farm’s first 30 hectares. The next 16 hectares (up to the national average of 46 ha) will receive an additional € 30/ha. The required funding for this purpose will be raised by reducing support from the 47th hectare below the ceiling in a cost-neutral manner. This type of regulation (“redistribution variant”) allows the Länder to avoid other approaches such as “degression” and “capping”, which had caused great controversy ahead of the reform because they would disproportionately affect large farms in the new Länder.

Furthermore, it was agreed that 4.5 % of the funds earmarked for direct payments (acreage premiums) would be redistributed in favour of rural development (“flexibility between the pillars”), thereby benefiting organic farming and other agro-environmental measures. Additionally, the Länder have asked the Federal Government to increase its share of the “Joint Task for the Improvement of Agricultural Structures and Coastal Protection” (GAK) by a further € 200 million, which would have a similar effect (note: following the coalition agreement for the 18th legislative period, the GAK is to be reformed and developed into a “Joint Task for Rural Development”).

In this way, at least in part, direct payments to farmers will be underpinned by a new, green justification, in accordance with the principle of “public money for public assets”. This heralds a long-overdue paradigm shift in agricultural policy, meaning that subsidised farmers will be subject to more requirements on how they manage their land, in the interests of societal concerns. Above and beyond compliance with existing legal standards (cross compliance; this will be retained),

under the newly introduced “greening”¹³⁶, farms must cultivate at least three different fruits which protect grassland (the requirements are less stringent for small and medium sized farms) and initially manage 5 % (later increasing to 7 %) of their subsidy-eligible acreage as so-called ecological priority areas. The emphasis here should be on environmental protection aspects. Organic farms and farms with predominantly grassland or forest remain exempt from the greening requirements. Such farms are already considered sufficiently green by definition”.

The WFD still falls outside of the EU Directives to be met by farmers within the context of cross-compliance. However, the rural development programmes planned for the period 2014 – 2020 should explicitly support the attainment of the WFD’s targets.

In addition to the general duty of care outlined in Article 5, the Federal Water Act (WHG)¹³⁷ also contains various aspects affecting agricultural activities.

- ▶ The discharge of substances into groundwater and the storage and deposition of substances which could contaminate the groundwater are prohibited (Article 48 of the WHG).
- ▶ As well as the discharge of substances into groundwater and the abstraction of groundwater (Article 9, paragraph (1), nos. 4, 5 of the WHG), so-called “spurious uses” as defined in Article 9, paragraph (2), no. 2 of the WHG also require a licence. This concerns measures that are deemed likely to cause permanent or significant harmful changes to water. The licence obligation therefore applies to agricultural measures which may pose a significant threat to water. However, good agricultural practice is not subject to a licensing obligation under water legislation.
- ▶ The provision governing riverbank buffer zones in Article 38 of the WHG is designed to protect the ecological functions of such buffer zones. Paragraph (4) is the heart of this provision, and in addition to the general requirement to conserve riverbanks, also lists a catalogue of prohibited activities. For example, the ban on converting grassland into arable land cited in no. 1 is intended, firstly, to prevent erosion and elutriation, and secondly, to prevent the discharge of nitrate and phosphates into groundwater and surface waters. Furthermore, in accordance with Article 38, paragraph (4), no. 3 of the WHG, the application of pesticides and fertilisers in riverbank buffer zones may be prohibited under Land law.
- ▶ When designating drinking water protection areas, restrictions may be formulated for agriculture. Where applicable, the affected farmers may be

¹³⁶ Also known as “ecologisation component”.

¹³⁷ Federal Water Act (WHG) of 31 July 2009, Federal Law Gazette (BGBl.) I, p. 2585, last amended on 21 January 2013, Federal Law Gazette (BGBl.) I page 95.

entitled to financial compensation for the losses suffered as a result of the change in management.

- ▶ The WHG also contains regulations on flood alleviation affecting agriculture. For example, the conversion of grassland into arable land and the conversion of riparian forest into other uses is prohibited in flood plains, and the emission of substances constituting a hazard to water is likewise prohibited, unless such substances are permitted for use within the context of good agricultural practice.
- ▶ It is hoped that the management plans and programmes of measures prepared by the end of 2009 under the WFD will ensure the achievement of a good status for all waterbodies by 2015. Within the context of these planning mechanisms, decisions must also be made regarding the reduction of discharges from diffuse sources, including agriculture.

The Ordinance on Fertilization¹³⁸, which transposes the EU Nitrates Directive into German law, requires the preparation of fertiliser audits and fertiliser quantities commensurate with plant requirements. For organic fertilisers of animal origin, the upper limits have been set at 170 kg N per hectare, per annum, with an exception for grassland under certain conditions of 230 kg N/ha, per annum. It is hoped that gradually reducing the upper limits for tolerable nitrogen balance surpluses will lead to a reduction in environmental pollution with nitrogen compounds. The Ordinance on Fertilization is currently being updated.

The Plant Protection Act (PflSchG¹³⁹) outlines principles for the authorisation and application of pesticides. Article 3, para. (1), first sentence states that pesticides may only be used in accordance with “good agricultural practice”.

For instance, pesticides may not be used if the user can expect their use, in individual cases, to adversely affect human or animal health, or the groundwater, or to have other significant adverse impacts, particularly on the natural balance (Article 3, para. (1), third sentence PflSchG). When licensing pesticides, the Federal Environment Agency will investigate, *inter alia*, whether an active ingredient in the pesticide and its principal metabolites are likely to seep into the ground on a relevant scale.

In order to keep the risk of damage within ecologically justifiable limits, where necessary, application provisions will be specified when licensing a product. In order to minimise emissions via spray drift, for

example, minimum distances may be specified or a drift-minimising technology stipulated.

In order to protect against unjustifiable/undesirable discharges into the groundwater and surface water as a result of surface run-off, the use of selected pesticides is only permissible subject to the presence of a river-bank buffer zone of a defined minimum width that is sealed by plant growth, or application using a mulching technique, for example. Corresponding application provisions regulate the use of such substances. The guide to “Good expert practice in plant protection”¹⁴⁰ (1998) published in the Federal Gazette contains a series of recommendations but is not binding for users.

In addition to the provisions of the Federal Soil Conservation Act (BBodSchG)¹⁴¹, the observance of “good agricultural practice” also ensures precautionary requirements. The principles of “Good agricultural soil use”¹⁴² (1999) were concretised and published within the context of a joint Federal/Länder working party of the BMELV (2001)¹⁴³. However, Articles 3 and 17 of the BBodSchG state that official directives may not be imposed on agricultural activity for precautionary purposes, only to avert specific threats (e.g. to avert the risk of harmful soil changes as a result of soil erosion by water).

6.6.2 Water pollution from agriculture

Discharges of phosphorus and nitrogen compounds, as well as pesticides, have posed a problem for groundwater, streams, rivers and lakes, as well as for coastal waters and seas, in Germany and Europe for many decades. Although reduction measures have already been adopted, including the ban on atrazine (1991), the amendments to the Plant Protection Act (1996) and the Fertilisers Ordinance (1996, tightened in 2007), to date all of these measures have been only partially effective.

Around 80 % of all nitrogen emissions and more than 60 % of all phosphorus emissions from agriculture in the period 2006 to 2008 originated from nutrient emissions into Germany’s surface waters. Neither the dramatic reduction in cattle stocks in the new Länder following reunification nor efficiency improvements in fertilisation practices in agriculture have managed to significantly reduce the surplus to date.

¹³⁸ Ordinance on Fertilization (DüV) in the version promulgated on 27 February 2007, Federal Law Gazette (BGBl.) I, p. 221, most recently amended on 24 February 2012 by Article 5 (36) of the Act Reorganizing the Closed Substance Cycle and Waste Management Act, Federal Law Gazette (BGBl.) I, p. 212.

¹³⁹ Plant Protection Act of 6 February 2012, Federal Law Gazette (BGBl.) I p. 148, recast p. 1281.

¹⁴⁰ Principles for the enforcement of good expert practice in plant protection (BANz. No. 220a of 2 November 1998).

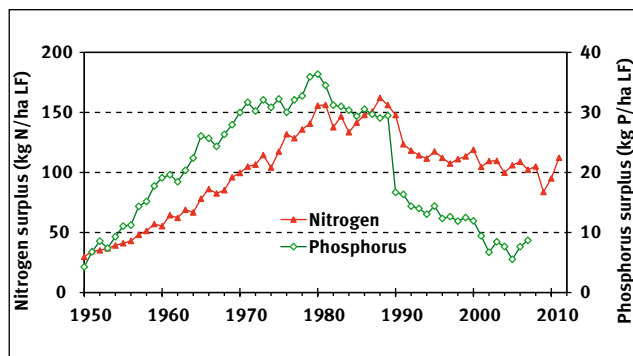
¹⁴¹ Act for protection against harmful soil changes and for remediation of contaminated sites (Federal Soil Protection Act – BBodSchG) of 17 March 1998, Federal Law Gazette (BGBl.) I, p. 502, last amended on 24 February 2012, Federal Law Gazette (BGBl.) I, p. 212, 261.

¹⁴² Principles and recommended actions for good agricultural soil use (BANz. No. 73 of 20 April 1999).

¹⁴³ BMELV (2001): Federal Ministry of Food, Agriculture and Consumer Protection (editors): Gute fachliche Praxis zur Vorsorge gegen Bodenschadverdichtungen und Erosion. Bonn.

For this reason, since 2007 the Fertilisers Ordinance has imposed upper limits for tolerable nitrogen surpluses, which are gradually being tightened up. However, there are no consequences for persons who exceed the upper limits. Furthermore, farmers are only required to calculate the nitrogen balance of their arable land. Ammonia losses in the barn and during application, which can also damage forests and waterbodies, are disregarded. **Figure 51** shows the development of the overall balance (also known as the “farm gate balance”), which also includes such losses.

Figure 51: Nutrient surpluses from agriculture, 1950 to 2011



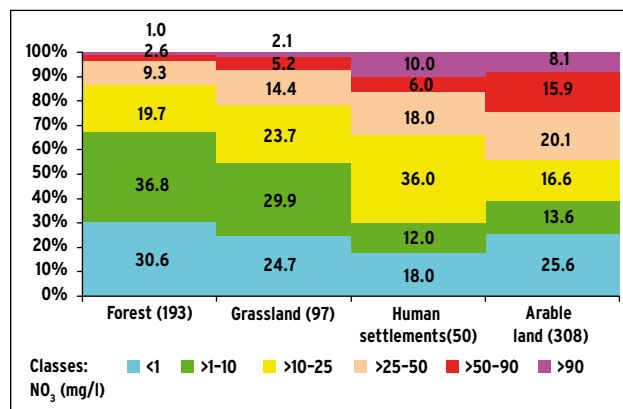
Source: M. Bach, H.-G. Frede, Institut für Ressourcenmanagement, Univ. Gießen and F. Godlinski, M. Hofmeier, J. Greef, Julius Kühn-Institut, Braunschweig
2011: provisional figures

Pollutants in groundwater

Groundwater in Germany is often contaminated with nitrate.¹⁴⁴ Recent representative measurements from 2010 indicate that the nitrate limit under the Groundwater Ordinance¹⁴⁵ of 50 mg/l NO₃ was exceeded at 14 % of all monitoring sites. 35 % of the monitoring sites indicated significantly to greatly elevated nitrate levels. Nitrate levels of less than 10 mg/l, corresponding to a natural or only slightly modified state, were only found in around 51 % of all monitoring sites.

An analysis of land use provides clear indications of the sources of nitrate. Comparing monitoring sites whose catchment area is characterised primarily by forest with those in the catchment area of arable land indicates significantly higher groundwater nitrate loads in the latter (cf. **Figure 52**). Monitoring sites in grassland likewise have higher nitrate levels than those in forest. Contamination levels are even higher in human settlements, although most are attributable to leaking sewers.

Figure 52: Nitrate pollution in forest, grassland, human settlements and arable land



Source: Federal Environment Agency (UBA)

Pollution in rivers and lakes

Since the mid-1980s, the principal discharge sources for nitrogen and phosphorus have changed significantly. In the 1980s, most nitrogen originated from point sources, primarily wastewater treatment plants. Since the mid-1990s, inflows from agriculture via the groundwater have been the principal source of nitrogen emissions into surface waters such as rivers and lakes. Today, nitrogen emissions from agriculture are more than twice as high as those from point sources (**Figure 53**).

Waterbodies have a long memory. Although there has been a noticeable reduction in nitrogen surpluses in German rivers, the river basins have a more delayed response to changes in pollution. In the case of the Rhine, experts estimate that a load reduction will become apparent within two to ten years, but in the case of the Elbe, not for another 20 to 30 years.

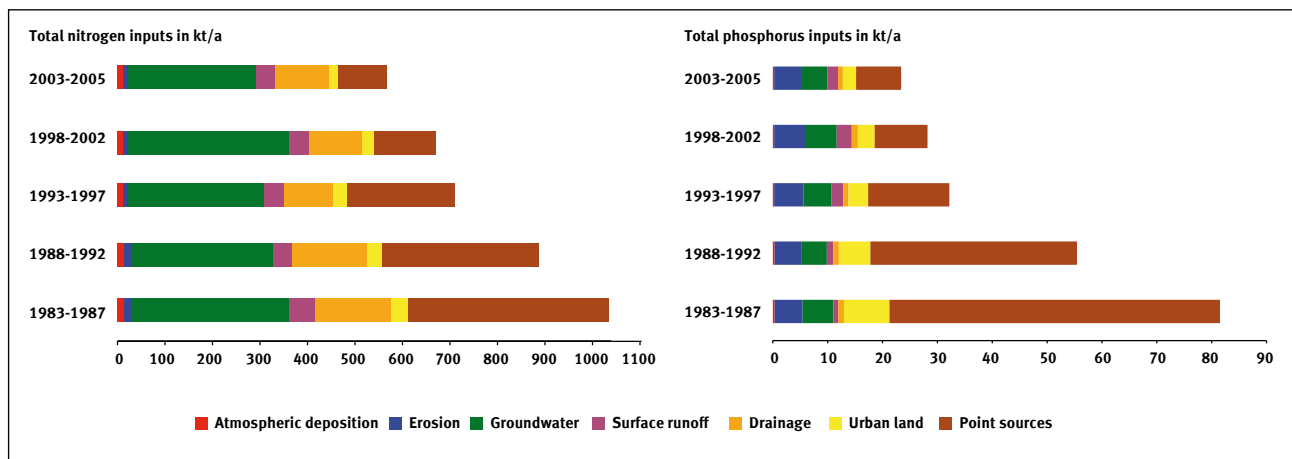
Phosphorus shows a similar picture: The phosphorus content of soils, and hence discharges, continues to rise because average surpluses of 8 kg/ha are still entering our soils each year (see **Figure 53**). In the case of acidic, oxygen-free or extremely sandy soils, phosphorus, while initially insoluble, is discharged into the groundwater. Groundwater is therefore responsible for approximately 20 % of the phosphorus contamination in rivers and lakes. The proportion of soil erosion and surface runoff is even higher, at 30 %.

Overall, it is true to say that the water quality situation in Germany remains unsatisfactory, despite some partial improvements. Only 15 % of 257 representative monitoring sites in rivers met the requirements of quality class II and above for nitrate nitrogen in 2011 (**Figure 54**), while 33 % of 257 monitoring sites met the requirements of quality class II and above for phosphorus. Since 1998, however, there has been a general increase in the proportions of the higher quality classes – the proportion of class III is decreasing, while class II–III is increasing.

¹⁴⁴ Cf. chapter 5.2.1.2 on groundwater quality, section on nitrate in groundwater.

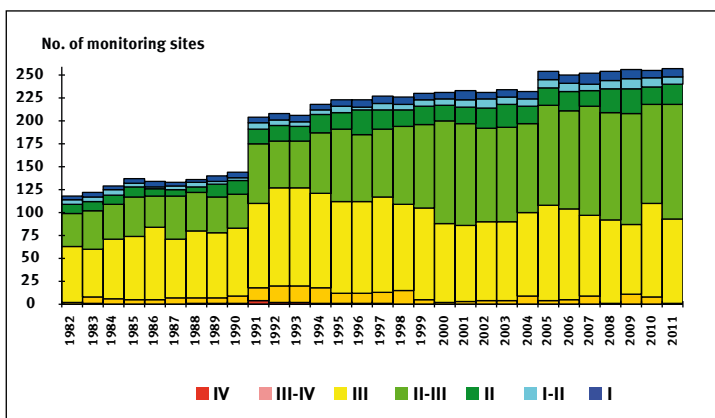
¹⁴⁵ See chapter 4.2 on the Groundwater Ordinance.

Figure 53: Nitrogen and phosphorus discharges from point and diffuse sources into German surface waters – More than 90 % of emissions via erosion, surface runoff, drainage and groundwater and 50 % of atmospheric depositions of nitrogen originate from agriculture



Source: Federal Environment Agency (UBA), 2009

Figure 54: Quality classification of nitrate nitrogen (LAWA monitoring network)



Source: Federal Environment Agency (UBA)

It is not just nutrients that are harming our waters, but also heavy metals and pesticides. Around 20 to 40 % of heavy metal discharges into surface waters originate from erosion or surface and drainage runoff from agricultural land. In the case of chromium, the figure is as high as 60 %. Once again, it is important to stress that other sources of pollutants, particularly from industry, have been substantially reduced, and the proportion of the overall load attributable to agriculture has therefore increased.

Most pesticide pollution originates from agriculture, from application on the field, but equally from cleaning sprayers and other equipment. In the monitoring period 2006 to 2008, of 38 pesticides considered relevant to water management, only 21 satisfied the quality requirements for the protected commodities “aquatic communities” and “drinking water” at all the monitoring sites analysed. A few substances that are

banned or no longer licensed (e.g. atrazine) indicated decreased pollution levels during the 1990s.

Pollution of coastal waters

The assessment of the ecological status of coastal and marine waters carried out in 2008 concluded that of the 27 waterbodies along the German North and Baltic Sea Coasts, 26 fell short of a good status. This is mainly due to the excessive nutrient emissions and their adverse impacts on microalgae and large algae, on flowering plants (such as seagrass) and on bottom-dwelling invertebrates. On the other hand, a good chemical status was achieved in most coastal and transitional waters, although this is primarily attributable to the fact that many pollutants have not yet been assessed on the basis of the environmental quality standards (EQS) of the EQS Directive. A reassessment of chemical status is likely to produce inferior results.

A long way to go before achieving a “good status” of waters

Back in 1991, the realisation that agriculture was responsible for nitrogen contamination in many waterbodies prompted the European Parliament to adopt the Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources.

Since the adoption of the WFD in the year 2000, strategies and protection concepts have been geared towards achieving a “good status” of waterbodies by 2015 (cf. chapter 2).

The management plans for all ten German river basins indicate that agriculture is responsible for a large proportion of nutrient and pollutant discharges. It is part of the reason why around 38 % of groundwater aquifers, 89 % of streams and rivers, 57 % of lakes and almost all coastal waters in Germany will fail to achieve

a “good status” unless effective reduction measures are introduced by 2015. For contaminants in groundwater, in 27 of the aforementioned 38 %, nitrate pollution from agriculture is to blame, and in 5 %, pesticide pollution from agriculture is responsible. For lakes and coastal waters, eutrophication as a result of nutrient discharges is by far the greatest problem. In the case of streams and rivers, structural damage is the main factor. In the past, watercourses have been straightened and deepened for agricultural use, as well as for hydropower and shipping; their beds are often trapezoid, reinforced and uniform, and natural structures are prevented and eliminated¹⁴⁶.

6.6.3 Sustainable agriculture

The principles of good agricultural practice apply to land management. For example, fertilizers and pesticides should be used in a demand-based, efficient and low-loss manner. In order to attain a “good status” of waters, these compulsory measures must be supplemented and tried-and-tested practices established which facilitate optimum waterbody protection without adversely affecting agricultural yields.

6.6.3.1 Ways of minimising water pollution

Fertiliser management and nutrient balances

The Ordinance on Fertilization (Düngeverordnung) provides the statutory basis for the use of fertilisers. The aim of good, water-conserving practice is to reduce nutrient surpluses and minimise the accumulation, leaching and run-off of fertilisers into the groundwater and surface waters. This necessitates a comprehensive fertiliser application plan for the entire farm, covering the nutrients nitrogen, phosphorus and potassium. Planning must include organic fertilisers arising on the farm, together with any fermentation residues that may arise. Planning must be based on an up-to-date calculation of nutrient requirements, together with the results of soil and plant analyses.

Crop rotation and site-adjusted land use, riverbank buffer zones

Optimum crop rotation and site-adapted land use will have a positive effect on water quality, because they increase the content of organic substance in the soil, and improve the soil’s fertility, structure and water-retaining capacity. In this way, they help to minimise nitrate leaching, and reduce erosion and surface nutrient runoff.

Buffer zones along waterbodies or protection strips in areas at risk of erosion can help to prevent direct nutrient emissions into surface waters. Their effectiveness depends on the adjacent use, the width of the strip,

and the angle of the slope. The strips must be cohesive, otherwise water will “flow around” them. However, the principle applies that erosion protection must take place in the land.

The ploughing of permanent grassland leads to extreme nitrate leaching, because humus that has accumulated over a period of years or even decades is decomposed in just a few months. For this reason, it is important to avoid ploughing of grassland particularly in areas at risk of erosion or flooding, in water meadows and in drinking water extraction areas, and this is often stipulated by law or in ordinances, and within the context of cross-compliance (environmental protection requirements as a prerequisite for obtaining direct payments).

Plant protection

Good agricultural practice also includes the principles of integrated plant protection, which must be observed as a minimum requirement from a water protection viewpoint. Additionally, any measures that reduce the volume of pesticides used are advisable.

- ▶ Prevention, including mechanical maintenance, biological, biotechnical, plant breeding and cultivation techniques (such as multi-crop rotation) are ideal for minimising chemical plant protection. Where the use of spraying is nevertheless deemed necessary, it is important to check whether it is economically viable (damage threshold principle).
- ▶ In order to prevent leaching and spray drift, distance regulations and application requirements must be observed, at least 5 m from the upper edge of the riverbank.
- ▶ Spraying equipment should be cleaned on the field, and where applicable, upgraded for this purpose. Residual quantities and cleaning fluids should be disposed of properly. Rinse residues should be disposed of on the field or as hazardous waste. Discharging into farmyard drains or sewers is prohibited.

Ecologically oriented waterbody maintenance

Germany has many diverse natural types of small watercourses, but these have become more unified as a result of development, maintenance and use. Streams and ditches have been made narrower, straightened, shortened, and their beds constricted and deepened. Agricultural use often extends as far as the upper edge of the riverbank. Under Article 39 of the WHG, waterbody maintenance comprises the care and development of waterbodies including the banks. Improving the ecological conditions based on the natural type and meeting the requirements of users, e.g. with regard to outflow, are ranked with equal importance. Impairments to the water balance of land ecosystems and wetlands should be avoided as far as possible.

¹⁴⁶ Further details may be found in a brochure published by the Federal Environment Agency (UBA), “Gewässer pflegen und entwickeln – Neue Wege bei der Gewässerunterhaltung” of 2009.

Ideally, if land is available along the watercourse, this should be left to develop its own natural dynamics. Semi-natural elements such as gravel banks may be left as they are. Side shifts may be prompted by dead-wood or bank erosion. If streams need to remain significantly below the upper edge of the land for drainage purposes, a secondary meadow may be facilitated.

Even if there is no space available and stream beds are to remain in their current locations, waterbody maintenance can still be carried out carefully to ensure the diversity of waterbody structures, habitats and organisms. Hard bank and bottom structures may often be removed. Mowing, weeding, profile and wood maintenance can be carried out less frequently and more carefully. Shading from the tree line prevents the growth of weeds, and semi-natural structural elements can be left without hindering outflow, even within the current stream profiles. Finally, not all flood damage needs to be repaired, because this marks the beginning of structural diversity^{147 148}.

6.6.3.2 Ways of improving the (environmental) policy framework conditions

European and national specifications and the requirements of agricultural and water protection law provide the framework for measures by individual farms. In order to reduce contamination of waters by the agricultural sector, there is a need to coordinate and improve statutory and political mechanisms.

For effective political control, combining European requirements with valid European-wide minimum standards and supplementary, regionally adapted measures agreed between the water industry and agriculture, based on the recommendations of the preceding chapter, is advisable. Effective monitoring and consultation, coupled with education and training courses, are indispensable elements.

Minimum ecological standards for good agricultural practice

Minimum standards of soil and water protection in “good agricultural practice” should be consistently anchored as binding legal requirements and as a vital element of environmentally friendly agriculture, with nationwide implementation throughout all EU Member States. Limiting implementation to vulnerable zones or sensitive areas is inadequate.

Demanding and promoting environmental achievements

In order to incentivise farmers to use environmentally friendly, water-conserving production and management practices, it is necessary to strengthen the so-called “second pillar” of the EU’s Common Agricultural

Policy (CAP). As part of agricultural funding under the CAP, by 2013 the financial framework of the second pillar was gradually increased to 10 % by way of “modulation” (cutting the direct payments previously paid depending on the size of the farm). Under the currently ongoing CAP reform, for the period from 2014 onwards, the available options of flexibility between the pillars will be maximised, i.e. strengthening of the second pillar in order to tackle the “new challenges” such as renewable energies, climate change, biodiversity and water management. This must not be allowed to occur at the expense of existing activities to promote rural development.

The EAFRD Regulation¹⁴⁹ provides the statutory basis for funding rural development, and also provides the framework for the agricultural and environmental programmes of the Länder. In Germany, agri-environment programmes are used to integrate agricultural measures going beyond legal standards into the WFD management plans. In addition to the voluntary measures offered within the context of agri-environment programmes, the EAFRD Regulation also provides for compulsory measures implementing the WFD and compensating for the associated restrictions of use and increase in expenditure. The relevant conditions in this respect are still being worked out by the EU. With regard to water protection, it is essential that the Länder use this opportunity to impose compulsory measures in areas with high levels of pollution.

Making use of agri-environment programmes

The agri-environment programmes of the Federal Länder are designed to reward more environmentally friendly forms of management and production. In the current support period (up until 2013), they have tended to focus more on sites at risk of erosion and leaching. The majority of Länder supports measures to reduce nutrient discharges, protect against erosion and promote environmentally friendly land use, such as the cultivation of intercrops or undersowing, the cultivation of flowering strips, flowering areas and riparian buffer strips over several years, the use of mulching or direct sowing, and the use of low-emission techniques for the application of slurry. Furthermore, some Länder subsidise the semi-natural development of waterbodies, the improvement of waterbody ecology, and the sustainable development of wetlands in conjunction with agricultural activity.

Communication and training

Incorporating environmental and water protection aspects into the education and training of farmers helps to support their understanding of water protection, and improves their technical knowledge of environmentally friendly production techniques. Targeted information and advice can encourage voluntary measures and their implementation at farm

¹⁴⁷ Federal Environment Agency (UBA): *Kleine Fließgewässer pflegen und entwickeln – Neue Wege der Gewässerunterhaltung*, 2009.

¹⁴⁸ Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (German Association for Water Resources Management, Wastewater and Waste, DWA): *Neue Wege der Gewässerunterhaltung – Pflege und Entwicklung von Fließgewässern*. Merkblatt DWA-M 610. 2010. p. 422.

¹⁴⁹ European Agricultural Fund for Rural Development.

level, so that in the long term, eco-friendly practices become integrated into everyday agricultural life. Cooperative water protection agreements both within and outside of water protection areas at Land and river basin level also encourage water-friendly agricultural practices.

Strengthening organic farming

Organic farming is considered a particularly sustainable method of production, even though it too generates emissions. By refraining from the use of mineral nitrogen fertilisers, its N balance surpluses are lower, and the risk of nitrate elutriation is lower than in conventional farming. It also uses no chemico-synthetic pesticides, and in this way relieves pressure on the environment.

Some local authorities selectively use organic farming as a way of ensuring a good groundwater quality and thereby ensuring the basis of water supply to large towns and cities. This is achieved on a cooperative (contractual) basis with compensatory payments. Examples include the Mangfall region (water supply to the city of Munich) or the Canitz reservoir near Leipzig (water supply to the city of Leipzig). The compensatory payments made to farmers who have switched to organic farming are low compared with the cost of treating water if nitrogen emissions are not reduced.

In its sustainability strategy, the German Government is aiming to increase the share of organically farmed land to 20 % of the agriculturally used area. At the moment, however, it accounts for just 6 % (2011). Consumer demand for organic produce significantly exceeds domestic production, leading to rising imports. Our aim should therefore be to encourage and subsidise farmers to switch to organic farming and make it so attractive that demand in Germany can be largely met from domestic production.

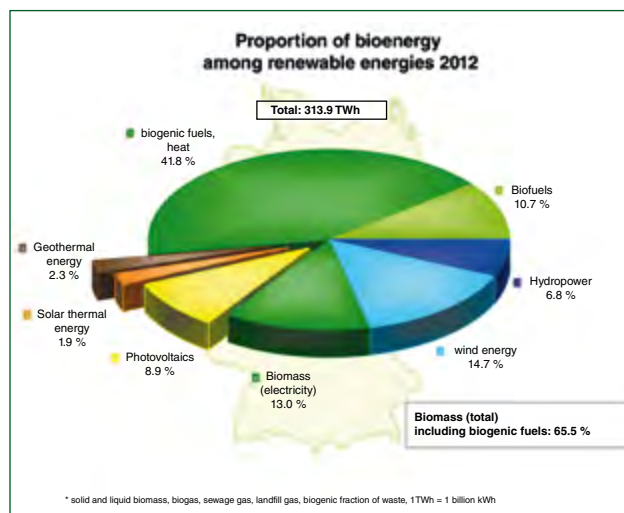
6.6.4 Use of bio-energy

Bio-energy currently plays a major role in energy supply. As illustrated in **Figure 55**, energy extraction from biomass accounts for the largest portion of renewable energies.

Although in future, large quantities of energy will be generated from windpower and solar power, a further expansion in bio-energy is also anticipated, despite the limited potential.

There are various technical ways of utilising the energy potential of whole plants, sections of plant, and organic residues and wastes to generate electricity, heat or biofuels. Established techniques include the extraction of biodiesel from rapeseed and the fermentation of plant material or organic residues such as slurry and biowaste into biogas.

Figure 55: Structure of final energy supply from renewable energy sources in Germany, 2012



Source: BMU 2013 Entwicklung der erneuerbaren Energien in Deutschland im Jahr 2012 unter Verwendung aktueller Daten der Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE Stat), February 2013

Biogas is an important energy carrier, because it can be used for electricity and heat, as well as in the transport sector as biomethane. At present, it is primarily used to generate electricity. Biogas currently accounts for more than 50 % of electricity generation from biomass. In total, in 2012, some 41 terawatt hours (TWh) of electricity were generated from biogenic sources, covering 7 % of Germany's gross electricity consumption.

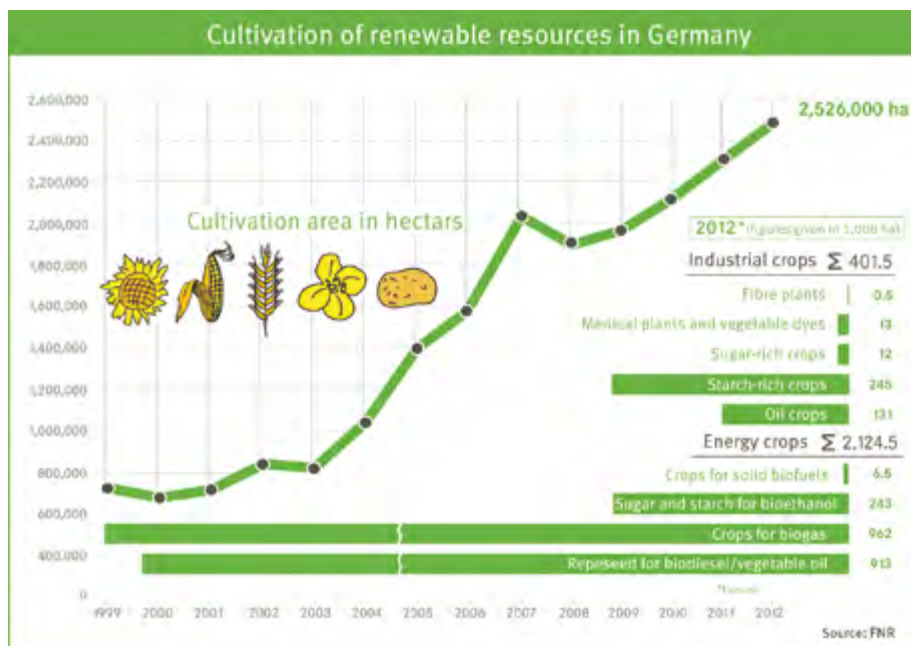
Since 2002, the number of biogas plants has increased from just over 1,600 to around 7,600. This rapid growth was prompted by the Renewable Energy Sources Act¹⁵⁰ (EEG), which since 2004 has also supported the use of renewable feedstock in biogas plants. Today, almost 80% of the biogas generated in Germany originates from energy crops deliberately cultivated for this purpose. In other words, more and more arable land is being used for energy production and is therefore no longer available for the production of food and feedstuffs. At present, energy crops are cultivated on more than 17 % of Germany's arable land. In particular, the amount of land dedicated to the two dominant crops, rapeseed (as a feedstock for biofuels) and maize (as a substrate for biogas generation) has been extended significantly.

This development also impacts soils and waters, both via land use and via the generation of energy itself:

- The growing cultivation of energy crops adversely impacts groundwater and surface water, because a growing number of sites are being used for intensive biomass production. Rapeseed and maize

¹⁵⁰ Act on granting priority to renewable energy sources (Renewable Energy Sources Act – EEG) of 25 October 2008, Federal Law Gazette (BGBl.) I, p. 2074, most recently amended by Article 5 of the Act of 20 December 2012, Federal Law Gazette (BGBl.) I, p. 2730.

Figure 56: Cultivation area used for energy crops, 2012



Source: FNR, 2013

are problematic crops from a water protection viewpoint, because they require comparatively large quantities of fertiliser and pesticide. Rapeseed leaves behind large quantities of nitrogen in the soil which can be converted, *inter alia*, into nitrate. Unless crops requiring a high level of nitrogen are cultivated, nitrate may be elutriated into the groundwater. Maize encourages erosion, because its slow growth means that arable land is left exposed for long periods before it is protected from wind and rain by the leaves of the plants. It is also a so-called humus depleter. If cultivated for several years in succession on the same plot, humus losses will occur in the soil, adversely impacting the soil's structural stability, which in turn makes it more susceptible to wind and water erosion. Yield-oriented production, close cropping with high proportions of rapeseed or maize and expanding cultivation areas, coupled with regional concentration, all combine to exacerbate these problems. As a result, there is a risk that the pollution of waterbodies by agriculture, already at a high level, could increase further.

- ▶ Because producing additional feedstock for energy purposes is so financially attractive, measures for the water-friendly management of agricultural land, such as agro-environmental programmes, and extensive production techniques, are increasingly being neglected as they are unable to compete financially.
- ▶ Biogas production is likewise linked to various water-related problems. The fermentation residues produced are reused as fertilisers thanks to their high nutrient content, whereby the nu-

trients and constituent ingredients are largely determined by the substrates fed into the system. Ahead of maize, liquid manure is the most important initial substrate for biogas extraction in Germany. The fermentation residues arising from this mixture can be difficult to define and control, which increases the risk of plant- and site-inappropriate use. There is also a risk of an oversupply of nitrogen to agricultural land surrounding the farm.

- ▶ Deficiencies in the construction and operation of biogas plants, coupled with failure to comply with the Ordinance on the handling of substances constituting a hazard to water, could lead to contamination of the groundwater and surface waters in the area surrounding such plants, e.g. if seepage contaminated with pollutants escapes due to leakages or if there is accidental damage to fermentation tanks.

In order to minimise these adverse environmental effects, a rethink of the subsidy provisions under the EEG is required. For the construction of new facilities, for example, financial subsidies should only be granted for using residues and waste, such as liquid manure, cuttings and landscape management materials, and not for energy crops cultivated specifically for that purpose.

However, as long as renewable feedstock for biogas extraction continues to be cultivated, the impairments to waters should be reduced by means of eco-friendly cultivation techniques. Minimum requirements must also be observed regarding the return of fermentation

residues to agricultural land, as set out in the Fertilisers Ordinance.

Recommendations for water-friendly bioenergy

For the first time, the sustainability ordinances adopted in 2009 for liquid biomass in the electricity and biofuels sector link the cultivation of energy crops to certain environmental and management standards. From a water protection viewpoint, however, these criteria are not sufficient, especially as the requirements are limited to good agricultural practice and the cross-compliance regulations. Instead, it is necessary to adopt site-adapted, water-friendly management principles for energy crop cultivation (cf. [chapter 6.6.3](#)).

Farmers should also exploit the full range of crop rotation opportunities to counteract one-sided cultivation structures and minimise the risks of waterbody pollution. The use of plants for energy makes it possible to broaden the spectrum of species in the fields, for example by introducing new cultivars such as millet, *silphium perfoliatum* and topinambur.

Mixed cultures and duoculture systems also offer opportunities for water-friendly energy crop production. Both techniques promise to reduce diffuse nutrient discharges by minimising the use of fertilisers and pesticides, although they have not yet been widely used in practice.

The ploughing of grassland areas is to be avoided, particularly in sites at particular risk of erosion and leakage, since ploughing mineralises and releases large quantities of nitrogen, and furthermore, large quantities of the carbon stored into the soil are released into the atmosphere.

The use of fermentation residues plays a central role in the operation of biogas plants. The relevant provisions governing the application and storage of organic fertilisers are inadequate. If fermentation residues are applied as fertilisers, they must be fully included in the farm's calculated application limit of 170 kg N/ha. The entire volume of nitrogen must be included in the calculation, not just the proportion of animal origin. Fermentation residues contain various initial substrates, and as a result, their nutrient contents vary considerably. In order to ensure eco-friendly agricultural use, therefore, farm- and plant-specific analyses are needed in order to ensure targeted application.

The targeted, precisely timed application of fermentation residues pre-supposes adequate storage capacities, possibly beyond the six-month deadline. Application after harvesting and in the autumn should be reduced to a minimum or avoided altogether in order to prevent the relocation and elutriation of soluble nitrogen portions. Particularly in regions where the vegetation period is too short for an intermediate winter

crop, this means that the application of fermentation residues to the growing cultivar is only appropriate in spring. In such cases, the storage capacity for fermentation residues should be 12 months.

6.7 Other uses and pressures

6.7.1 Flood risk management

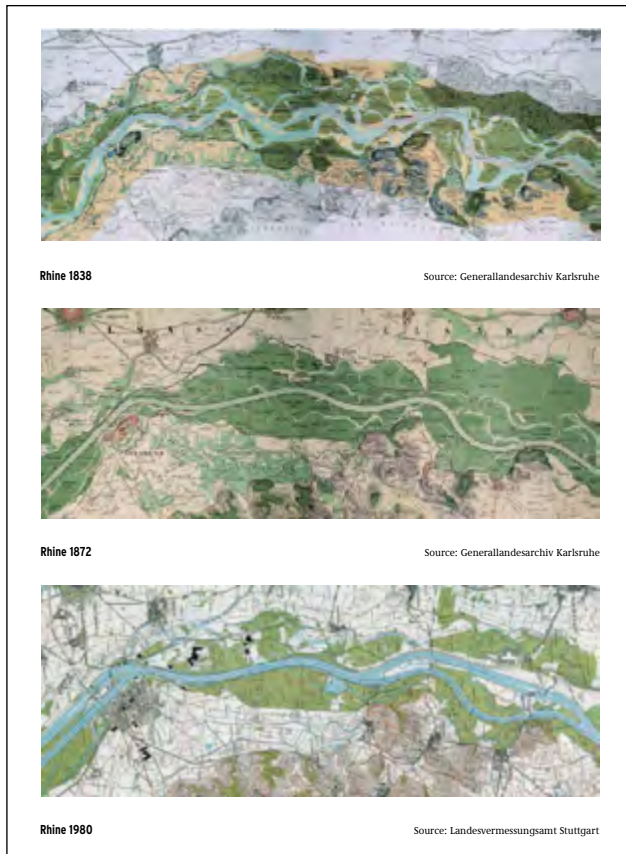
Floods, as a consequence of meteorological events, are natural and a regular factor in the natural cycle. The biotic communities in rivers and flood plains have adapted to the changing water levels. However, a large number of serious anthropogenic interventions over many years have led to the loss of natural flood plains and wetlands, causing fundamental changes to the flow characteristics of waterbodies which were adapted to the landscape and seasonal rhythms. The course of many rivers and streams were changed in order to create land for industry and housing, make waterbodies navigable, intensify agriculture, utilise hydropower, and protect against flooding. Due to the straightening and shortening of river courses, flood waves now travel faster and transport larger volumes of water per unit of time. For example, since the last large-scale straightening of the Rhine in the mid-19th century by hydro-construction master Johann Gottfried Tulla, the number of flood plains on the Upper Rhine between Basle and Karlsruhe has decreased by 87 %.

All in all, the flood plain of the Upper Rhine was reduced by 60 % or 130 km². River straightening measures led to a shortening of the run – on the Upper Rhine by approximately 82 km, and on the Lower Rhine by approximately 23 km – which in turn led to an acceleration of runoff. For example, the flow rate of the flood wave in the Rhine section between Basle and Maxau has been reduced from 64 to 23 hours.

From a nationwide perspective only around 1/3 of the former flood plains are currently available to retain the water in the event of major flooding. In large river basins such as the Rhine, Elbe, Danube and Oder are in some sections only 10–20 % of the former flood plains now remain¹⁵¹. Besides changes to the rivers and flood plains, climatic factors also influence the scale, frequency and timing of flood events. Based on current predictions of climate change apart from temperature increases, we can also expect a significant intra-year shift in the precipitation regime as well as increasing variability in the area of heavy rains in future. This will lead to an increase in extreme weather events, which can be caused both periods of flooding and drought (cf. [chapter 2.3](#)).

151 Federal Agency for Nature Conservation (BfN) "Auenzustandsbericht – Flussauen in Deutschland" Bonn, 2009.

Figure 57: Changes to the Rhine as a result of development and straightening



Source: Generallandesarchiv Karlsruhe und Landesvermessungsamt Stuttgart

Parallel to the above mentioned structural changes, humans accumulate tangible assets in flood risk areas, which the potential for damage. It is only the interaction of these two independent mechanisms that causes the high levels of damage observed in cases of flooding.

In order to limit flood damage in future, viable long-term strategies at river catchment area level are being drafted both nationally and internationally. Thereby the flood risk is going more and more in the focus of considerations. Water management administrations no longer merely assess the hazard of flooding, but also relate the likelihood of this event to the anticipated damage, so that measures can be developed more target oriented.

In Europe, the EU Directive on the assessment and management of flood risks (EU Floods Directive) has been in force since November 2007. The Floods Directive pursues a three-stage approach:

- ▶ Stage one in the Floods Directive was accomplished by March 2012, with a preliminary assessment of flood risks at river basin district level. For the purposes of this assessment, the Member States drew on information about past flooding, as well as available knowledge regarding the im-

pacts of climate change on flooding probability. The results of preliminary flood risk assessment are represented in **Figure 58**. The different colours indicate which Federal states based their results on pre-existing assessments of the flood risk (Article 13 of the Floods Directive).

- ▶ In stage two, the Member States are drawing up flood hazard maps and flood risk maps. These make a significant contribution towards improving flooding awareness by indicating the risk of extreme events too. These maps have been provided by March 2014.
- ▶ This will be followed by the development of flood risk management plans by 2015. These plans contain the handling of flooding in a river basin district from analysis of the last flood and follow-up measures, to the development of flood protection and prevention measures, through to the possible need for disaster management with any future flood. These plans should focus primarily on prevention, protection and preparedness.

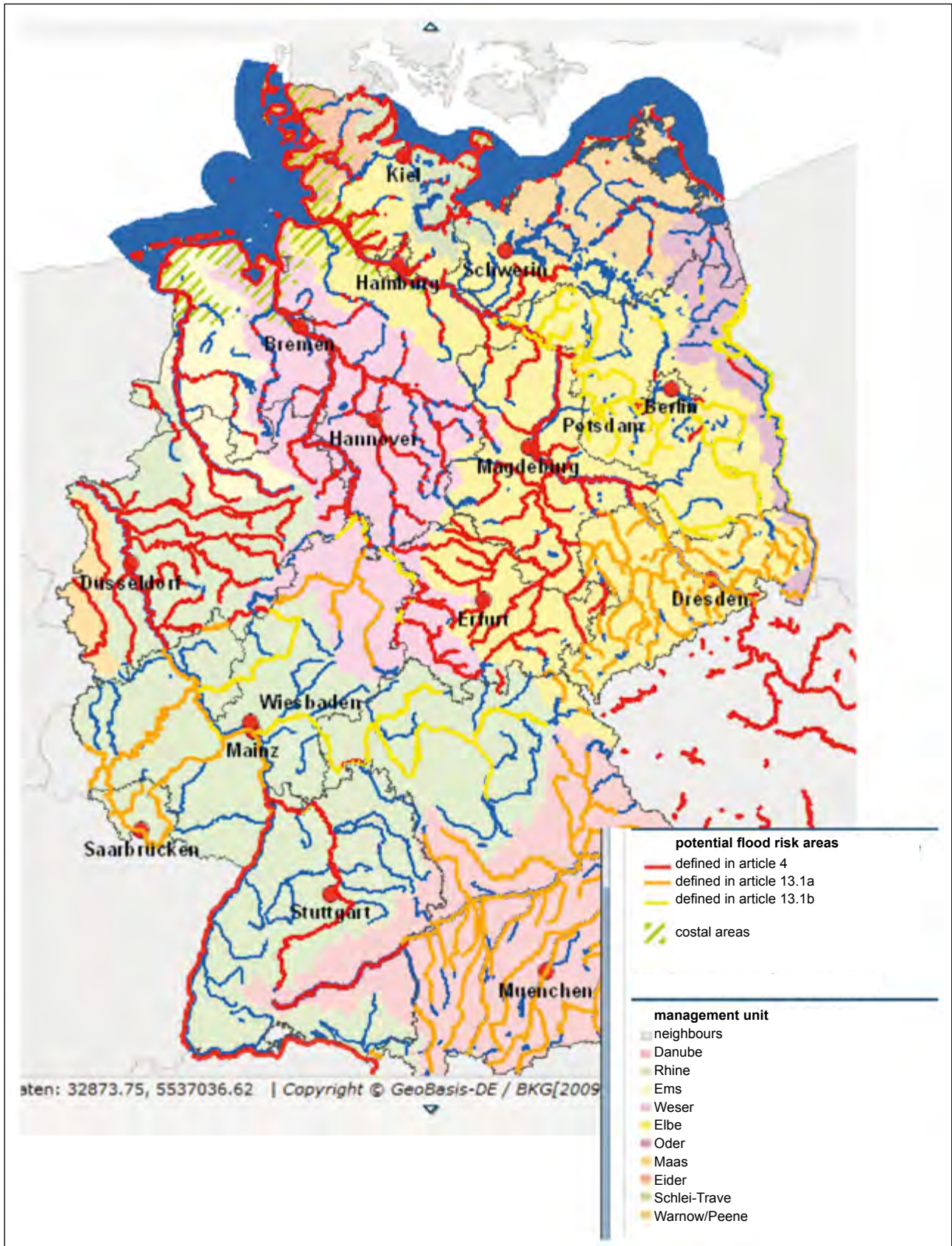
The steps outlined in the Floods Directive are to be reviewed every six years, so that new findings from climate change research and associated changes to the likelihood of flooding may be duly incorporated.

In Germany, there are a wide range of measures available in various different sectors for addressing flood risk management:

- ▶ Precautionary land use planning, e.g. restricting construction in flood plains, flood-adapted usage/ planning in the areas, designation of flood plains in regional plans
- ▶ Natural water retention, e.g. decentralised rain-water infiltration, reduction of land sealing, preservation and restoration of wetlands sites, recovery of flood plains
- ▶ Technical flood protection, e.g. dykes, dams, retention basins, physical protection of buildings, protection of oil tanks
- ▶ Precautionary construction measures, e.g. flood-adapted modes of construction
- ▶ Private risk precaution, e.g. accumulation of reserves, insurance policies
- ▶ Supply of information, e.g. flood warning
- ▶ Precautionary behaviour, e.g. public education and preparation for flooding with specific recommended actions for the general public
- ▶ Preparation for hazard prevention and civil protection, e.g. alarm- and operation plans, drills and training for emergency and rescue services.

When discussing and selecting measures for dealing with flooding, however, it is worth remembering that

Figure 58: Results of the preliminary flood risk assessment – Sections of waterbodies with a potential risk of flooding



technical measures are only effective up to a certain water level. If the flood level on which they are based is exceeded, the supposedly protected areas behind the dykes become high-risk areas.

For successful flood risk management, cooperation must transcend administrative boundaries, in order to ensure a balanced combination of measures on the river itself, in the catchment area, and in the flood risk areas. The Floods Directive pre-supposes the involvement of the general public and coordination in the catchment area.

At Federal level, important regulatory instruments for improving flood risk management already exist in the form of the Federal Water Act (WHG), the Construction Code (BauGB), the Regional Planning Act (ROG) and the Federal Soil Protection Act (BBodschG). Following the floods in the Elbe and Danube river basins in August 2002, which caused 21 fatalities and more than 10 billion Euros' worth of damage in Germany alone, it became clear that there was a need to define national regulations in greater detail.

Figure 59: Large-scale flooding of the Elbe and Mulde in August 2002



Photograph: M. Zebisch, 2002

This occurred with the Act to Improve Preventive Flood-Control, which entered into force on 10 May 2005. This Act supplements the WHG, the BauGB, the ROG, the Federal Waterways Act and the Act for the German Weather Service by adding essential provisions to improve preventive flood mitigation. The WHG was revised in 2009, and its amended version entered into force on 1 March 2010. Within the course of revising the Environmental Appeals Act, the legal definition of the term “flood” was revised and adapted in line with European regulations. According to the new definition, flooding not only includes inundations from surface waters and seas, but also from rising ground-

water and inundations caused by heavy precipitation. However, flooding associated with groundwater and heavy precipitation play no role in the designation of flood plains.

Apart from the provisions of the EU Floods Directive, the principal provisions on flood risk management in the WHG regarding the preliminary assessment of the flood risk, flood hazard maps and risk maps, and flood risk management plans, are as follows:

- ▶ The designation of flood plains by the Länder by 22 December 2013. This concerns areas which have statistically been affected by flooding at least once in 100 years (flood level HQ100) or for which flood relief and retention are required.
- ▶ Farther-reaching provisions apply to designated flood plains which support an improvement in the ecological structures of waters, prevent erosion-encouraging measures, ensure the conservation and recovery of flood retention areas, and regulate flood discharge as well as helping to minimise damage. Examples include:
 - Prohibiting the zoning of areas for new development; exceptions are only possible subject to compliance with strict prerequisites (e.g. there is no other option for housing development, there is no anticipated threat to human life or considerable damages to health or property, the flood discharge and water level will not be adversely influenced, the project is being carried out under the aspects of precautionary construction measures, etc.).
 - Regulations governing the handling of substances hazardous to water such as the banning of oil heaters and flood-proof upgrading of existing oil heating installations.
 - Measures to retain or improve the ecological structures of waterbodies and their flood plains.
 - Requirements governing a site's proper agricultural and forestry use in order to reduce erosion and minimise pollutant discharge into waterbodies.

The international River Basin Commissions play a vital role in coordinating river basin districts -related flood risk management measures at international level. Coordination occurs in all international river basins in which Germany is involved, including the International Commissions for the Protection of the Rhine, Danube and Elbe. At national level, river basin districts (RBD) coordinate the respective Länder, such as the RBD Elbe or the RBD Weser. Apart from developing joint flood risk and flood hazard maps, current tasks here (also at river basin district level) include defining the objectives of flood risk management and developing flood risk management plans, in some case incorporating existing flood action plans.

The Convention on the Protection and Use of Transboundary Watercourses and International Lakes was adopted by the United Nations Economic Commission for Europe (UNECE) on 17 March 1992 and entered into force on 6 October 1996. In order to strengthen preventive flood control as an important area of sustainable water protection at national and international level, the UNECE submitted guidelines for preventive flood control which were adopted by the Member States at the 2nd Conference of the Parties in March 2000. It is hoped that implementation of the guidelines will achieve approximation to the targets and strategies for flood prevention and flood control by means of joint activities in the riparian states of transboundary watercourses, with due regard for differing local, national and transboundary aspects. The guidelines are not binding, but constitute an important basis for the formulation of strategic plans of measures for each river basin. The UNECE guidelines for sustainable flood prevention were revised at an international conference in 2004 following the August 2002 floods in the catchment areas of the Elbe and Danube, and their validity was confirmed. Other recommendations include the drafting of farther-reaching policy guidelines for the areas of flash floods, the links between flooding and water pollution, the linking of flood management and dealing with drought situations, rainwater management, and consideration of the impacts of climate change. UNECE's work on the topic of flood risk management concentrates on knowledge sharing and the exchange of experience. An international workshop in April 2009 addressed the need for transboundary data exchange to improve flood forecasting, intergovernmental cooperation in river basins on the drafting of flood risk management plans, and the establishment of a statutory agreement on transboundary cooperation.¹⁵²

6.7.2 Shipping

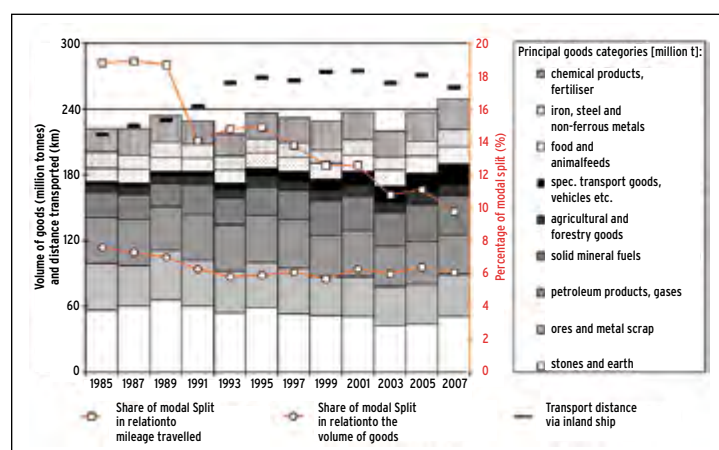
6.7.2.1 Inland shipping

The large European rivers are used as waterways, and form part of the transport network alongside road and rail. Germany has a high density of waterways, as do the Netherlands and parts of Belgium and France. In 2010, European inland shipping transported some 485 million tonnes (t) of goods, corresponding to a 6.1 % market share in 2010 of the transport capacity (measured as the product of volume of goods multiplied by the distance transported shown as transported tonne kilometres). By comparison with the rest of Europe, Germany has the most extensive and best-developed network of inland waterways with the highest volume.

For the purposes of shipping legislation, Germany's Federal waterways are divided into inland Shipping lanes and marine shipping lanes. Around 90 % of inland waterways are used for shipping and form a wide-meshed, coherent network which around 7,306 km long. Of this, around 35 % is free-flowing sections of river, 41 % impounded sections of river, and 24 % canals. They connect the major ports with economic centres in Germany and abroad ("hinterland traffic"), as well as interconnecting key industrial zones. The vast majority of Germany's major cities have a direct waterway connection with their own inland port. Inland shipping lanes are also becoming increasingly significant for sports and leisure use. However, their predominant function is as a transportation route for goods. The total volume of goods transported by inland shipping in Germany was around 230 million tonnes in 2010, corresponding to an average 6 % of the total transport volume of the various different transport carriers, measured in terms of tonnage.

In recent years, German freight traffic has seen a sharp increase in transport capacity. The largest rise has been in road traffic, which now accounts for more than 70 %. As a result of this development, since 1985 inland shipping has lost around 9 % of its market share, despite an increase in absolute transport capacity resulting from an increased distance transported. It currently accounts for less than 10 % of total freight transport capacity in Germany, where the average distance transported is 270 km.

Figure 60: Development of freight traffic on Germany's inland shipping lanes according to principal goods category, distances travelled, and development of inland shipping as a share of the modal split among German freight traffic, 1985 to 2010 (pre-1990 figures refer to the former territory of the Federal Republic of Germany)



Source: Verkehr in Zahlen 1998, 2012/2013

The main focus of German and indeed Central European inland shipping is in the Rhine corridor. On the Rhine, and its shipping tributaries the Moselle, Main

152 UN-ECE "Transboundary Flood Risk Management – Experience from the UN-ECE Region", Geneva 2009.

and Neckar, as well as on the West German canal network, large-engine freight ships (110 x 11.45 x 2.80 m; 2,350 t), push tows with 2 tugs (185 x 11.45 x 2.8 m; 3,600 t) and two-layer container transporters may be used. Around 88 % of the transport capacity of inland freight shipping occurs in this area. Other inland waterways such as the Oder, Ems, Danube, Elbe and Weser are not as developed and offer less favourable natural conditions than the Rhine. From an environmental viewpoint, it is preferable to maximise the existing potential rather than to further expand the Federal waterways. To this end, there is a need for improvements at a nautical level, such as modern transport management, fleet modernisation (for instance, the ERP environmental and energy efficiency programme with a focus on supporting inland shipping), and the logistical linking of transport carriers via the creation of intermodal interfaces at port locations. This would also help to ease the pressure on the environment caused by pollutants which are currently still emitted in excessive quantities by ships with outmoded engines.

The consequences of climate change can affect Germany's waterways in various ways. If the altered peripheral conditions – such as the decrease in precipitation during the summer months – reduce the number of navigable days and reduce transport capacity, this should be factored into the decision-making processes regarding additional infrastructure measures. Decisive importance is attached to the threshold levels at which the cost of maintaining waterbody use exceeds the benefits to society, and the same is true of cost/benefit calculations for hydraulic engineering projects.

In addition to their use for shipping purposes, Federal waterways are subject to many different impairments which, taken collectively, lead to a lack of key habitats for indigenous organisms and inadequate living conditions. The intensive use and redesign of the major rivers into Federal shipping lanes has meant that 80 % of Germany's waterways are now characterised as heavily modified. A good ecological potential is the aspired environmental objective. To date, the target achievement level is less than 1 %. Even in the remaining 20 % of Federal waterways that are still classified as natural and in which a good ecological status is achievable, the situation is little better (<1% target achievement).

However, it is possible to minimise the hydro-ecological impacts of river engineering measures. This necessitates integrated waterbody development concepts for Federal shipping lanes at a supra-regional level, combining aspects of shipping, flood protection, nature conservation, hydropower (where applicable) and water resources management. At present, a comprehensive concept of this kind is being developed for

the Elbe by the Federal Government and the Länder in collaboration with the relevant associations. Many effective improvements in waterbody morphology are already possible at the level of water body maintenance.

Competencies for the Federal waterways are shared. The Federal Government's Directorate-General of Waterways and Shipping is responsible for creating river continuity as a sovereign task, and within the framework of ownership responsibility, for the maintenance of water resources. The Länder are responsible for pollution control in waterbodies, flood protection, water resources management and ecologically-driven development measures on Federal waterways. The Federal Ministry for Transport and Digital Infrastructure is currently collaborating with the Länder to implement a concept to create river continuity on the weirs of Federal waterways. Other direct impacts of shipping on waterbody status, e.g. as a result of cargo residues or wastewater, are regulated by specific conventions (such as the Convention on the Collection, Deposit and Reception of Waste Produced during Navigation on the Rhine and Inland Waterways (CDNI)).

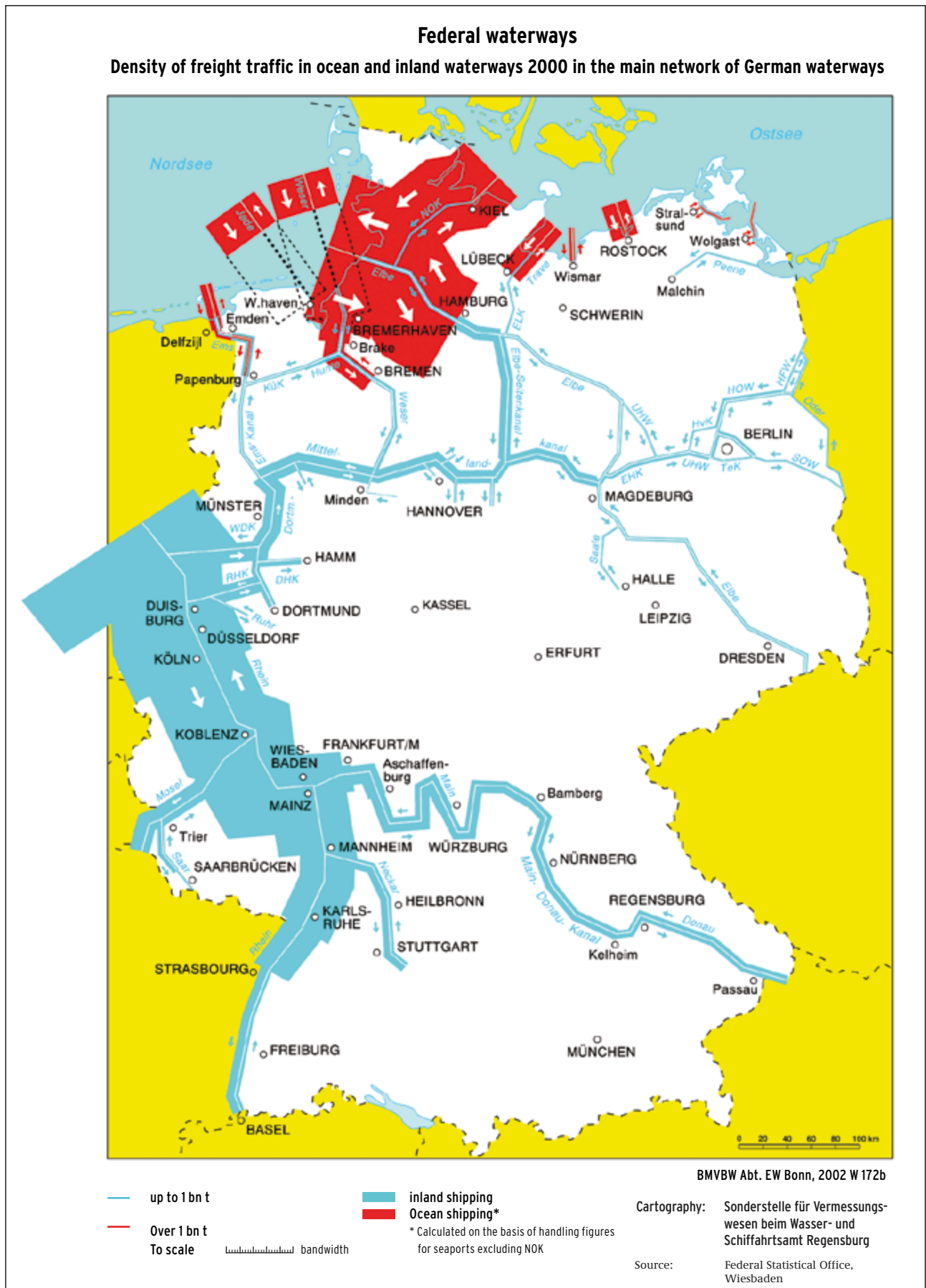
6.7.2.2 Maritime shipping

90 % of the EU external trade and more than 40 % of the EU internal trade happens via maritime shipping. On a global level, around one-third of all vessel movements are destined for or originated in the EU. The North and Baltic Seas are among the most frequently and densely travelled seas of the world. Each year, more than 30,000 vessels traverse the Kiel Canal; at any given time, there are around 2,000 vessels in the Baltic Sea. Germany's "Exclusive Economic Zone" (EEZ) and the coastal waters of the North and Baltic Seas are characterised by waterways and sea transport corridors (known as traffic separation zones / schemes).

Three of Europe's most significant harbours are in Germany – the North Sea harbours of Hamburg, Wilhelmshaven and Bremen/Bremerhaven, while in the Baltic Sea, Lübeck, Kiel and Rostock are among the top ferry ports, and an increasingly popular point of call for cruise liners. In 2008, some 2.8 million passengers visited the Baltic Sea on board cruise liners. Through traffic to the Russian oil ports also account for a significant proportion of traffic in the Baltic Sea.

In recent decades, global ocean shipping has risen continuously at a rate of more than 4 % per annum. Forecasters expect this growth to continue in future, following a downturn prompted by the 2009 economic crisis. An annual increase of 2–3 % is anticipated up until 2020.

Figure 61: Density of freight traffic in Germany's Federal shipping lanes in million tons (tkm/length of waterway in km)



Source: Federal Statistical Office

Figure 62: Container ship



Photograph: Bernd Sterzl/Pixelio.de

Ships contribute to the direct pollution of the seas, coastal waters and rivers via the emission of air pollutants, discharges of liquid and solid materials, and underwater noise pollution. Air pollutants and the CO₂ emissions from sea-going ships also have a supra-regional or global impact. In 2007, international shipping – some 100,000 vessels (container ships, passenger ships, oil tankers, tugs etc.) – accounted for around 3 % of anthropogenic greenhouse gas emissions, roughly the same as the figure for Germany as a whole¹⁵³.

Air pollutants (e.g. nitrogen oxides NO_x, sulphur oxides SO_x, particle emissions PM) adversely impact human health, and in some cases affect the environment. In particular, soot emissions impact cloud formation, and if deposited on white snow and ice surfaces, for example in the Arctic, reduce the amount of sunlight reflected, which in turn leads to the warming and melting of such areas.

Coastal waters, the coasts themselves and port cities are particularly affected by the environmental pollution caused by shipping, since the ships spend most of their time travelling close to the shore. This is addressed below (see pages 150 ff.). Around 70 % of shipping movements occur within the 200 nautical mile zone, 36 % within a 25 mile zone.

The impacts of shipping on the marine environment are also subjects of the EU Marine Strategy Framework Directive (MSFD). Descriptor 10 in Annex I, for example, addresses the input of waste into the seas (see **chapter 6.7.8**), and descriptor 11 is concerned with the input of energy including underwater noise (see **chapter 6.7.9**).

Vulnerable marine regions may be designated by the IMO as “Particularly Sensitive Sea Areas” (PSSA) if they merit particular protection due to a recognised ecological, socio-economic or scientific significance and are under threat from international shipping. The Wadden Sea in the North Sea, the coastal sea from Spain to Ireland (“Western European Waters”) and the entire Baltic Sea, with the exception of Russian waters, are included in this category. Under these regulations, certain conditions may be imposed on shipping, such as the creation of route guidance systems (traffic separation scheme) or special routes for the transportation of hazardous goods. However, sea transport in general cannot be prohibited. The designation of further marine regions as PSSAs, for example in the Arctic, would be desirable.

Oil contamination

Most sea-going ships are powered by so-called heavy fuel oils (HFO). These are produced from refinery residues and are of inferior quality compared with the petrol and diesel used in road traffic. They also have a high contaminant content. Heavy oils must be processed on-board in an energy-intensive operation, creating oily residues – called sludge. Some ships still illegally dispose sludge directly into the sea. In recent years, there has been a decrease in illegal oil contamination of the Baltic Sea, despite the fact that shipping movements and the number of monitoring surveillance flights has increased. The trend is therefore positive.

In addition to the environmental damage caused by illegal discharges of oil or oily wastewater, there is also the risk of shipping accidents leading to the loss of a ship’s fuel and/or load to the sea, which may contain crude oil, petroleum products or other toxic substances such as chemicals or fertilisers. Following a number of major oil disasters in recent decades (the “Erika” off the Brittany coast in 1999, the “Prestige” off the Spanish coast in 2002), the international regulations have been tightened up considerably. For example, a double hull is now compulsory for tankers; oil reception facilities in ports must accept the residues.

Oil contamination poses a major problem for marine ecosystems. The initial oil film on the water’s surface is distributed by wind, waves and currents; some parts evaporate, while other parts settle on the seabed or are washed to the shore. Animals ingest the oil. In addition, the feathers of seabirds become oily and are no longer water repellent; this impairs their ability to swim. Seabirds which catch their food by diving, such as guillemots, eider ducks and red-throated divers, are particularly at risk.

Contamination of the sea and the coast from shipping waste

Marine litter is a serious problem (see **chapter 6.7.8**). Shipping is responsible for a significant proportion of this, although it is generally difficult to clearly pinpoint the origins of litter. For the German North Sea Coast,

153 IMO: Second GHG-Study, 2009 (<http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Greenhouse-Gas-Study-2009.aspx>).

Table 16: Provisions governing the disposal of waste on board ships pursuant to MARPOL 73/78, Annex V; regulations 3 and 5

Overview of the restrictions regarding the discharge of all types of garbage into the sea pursuant to the regulations 4, 5 and 6 of MARPOL Annex V

(Note: This table is intended as a summary. The provisions of MARPOL Annex V prevail, not this table)

Garbage type ¹	All ships except platforms ⁴		Offshore platforms located more than 12 nm from nearest land and ships when alongside or within 500 metres of such platforms ⁴ Regulation 5
	Outside special areas Regulation 4 (Distances are from the nearest land)	Within special areas Regulation 6 (Distances are from nearest land or nearest ice-shelf)	
Food waste comminuted or ground ²	≥ 3 nm, en route and as far as practicable	≥ 12 nm, en route and as far as practicable ³	Discharge permitted
Food waste not comminuted or ground	≥ 12 nm, en route and as far as practicable	Discharge prohibited	Discharge prohibited
Cargo residues ^{5,6} not contained in washwater	≥ 12 nm, en route and as far as practicable	Discharge prohibited	Discharge prohibited
Cargo residues ^{5,6} contained in washwater		≥ 12 nm, en route and as far as practicable (subject to conditions in regulation 6.1.2)	
Cleaning agents and additives ⁶ contained in cargo hold washwater	Discharge permitted	≥ 12 nm, en route and as far as practicable (subject to conditions in regulation 6.1.2)	Discharge prohibited
Cleaning agents and additives ⁶ in deck and external surfaces washwater		Discharge permitted	
Animal carcasses (should be split or otherwise treated to ensure the carcasses will sink immediately)	Must be en route and as far from the nearest land as possible. Should be > 100 nm and maximum water depth	Discharge prohibited	Discharge prohibited
All other garbage including plastics, synthetic ropes, fishing gear, plastic garbage bags, incinerator ashes, clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery and similar refuse	Discharge prohibited	Discharge prohibited	Discharge prohibited

- 1 When garbage is mixed with or contaminated by other harmful substances prohibited from discharge or having different discharge requirements, the more stringent requirements shall apply.
- 2 Comminuted or ground food wastes must be able to pass through a screen with mesh no larger than 25 mm
- 3 The discharge of introduced avian products in the Antarctic area is not permitted unless incinerated, auto-claved or otherwise treated to be made sterile
- 4 Offshore platforms located 12 nm from nearest land and associated ships include all fixed or floating platforms engaged in exploration or exploitation or associated processing of seabed mineral resources, and all ships alongside or within 500 m of such platforms
- 5 Cargo residues means only those cargo residues that cannot be recovered using commonly available methods for unloading
- 6 These substances must not be harmful to the marine environment

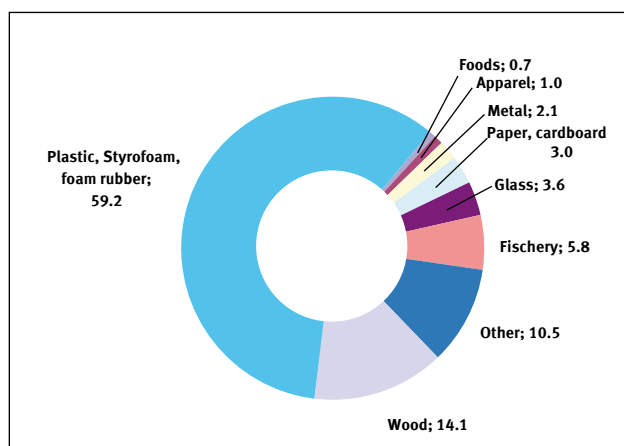
Source: 2012 Guidelines for the implementation of MARPOL Annex V

maritime activities, with a significant contribution from shipping, in conjunction with land-based leisure and tourism activities are assumed to be responsible for the bulk of inputs. Substantial quantities of waste are generated on board ships: approximately 3–3.5 kg per person, per day. In other words, a 7-day cruise with 3,000 passengers on board will generate up to 74 tonnes of waste.

Waste discharges from shipping are regulated by the International Maritime Organisation (IMO). The revision to Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL) prohibits the discharge of waste from ships into the sea, apart from defined exceptions. Tighter regulations have been in force since January 2013. The general ban on the dumping of plastics, plastic ropes, fishing nets, plastic bags and packaging materials has been extended (inter alia) to include incinerated waste (ash), glass, oil, paper, rags and bottles. If illegally or accidentally jettisoned overboard, all these materials will lead to pollution of the driftline¹⁵⁴. Coastal communities must allocate significant funds to the removal of shipping waste from their beaches. As a general rule, the MARPOL Annex V provisions only apply to ships with a gross registered tonnage of more than 400. The majority of fishing vessels operating around the globe are smaller than this, and therefore not covered by the provisions. Left nets, lines and packaging materials, in particular, are floating traps for marine creatures, as they may become entangled in and strangled by them.

The Baltic and North Seas have been designated as special areas under MARPOL Annex V in 1998 and 1991 respectively. Additionally, in 2000 an EU Directive was adopted which is intended to improve the facilities for the shipping of waste and cargo residues in European ports. However, studies into pollution of the German North Sea coast with litter which have been ongoing since 1992 have so far failed to measure any substantial decrease in the litter washed to shore. In the Baltic Sea, the “Baltic Strategy on Port Reception Facilities for Ship-generated Wastes” with the introduction of the “no special fee” system has helped to scale down litter from shipping. Analogous to the Baltic Sea, the on-going process to revise the EU Directive on port reception facilities will be used to ensure the uniform and uncomplicated acceptance of waste in European harbours where disposal fees are already included in the port fees.

Figure 63: Composition of litter found on the beaches of the North Sea coast



Source: Federal Environment Agency (UBA), 2003

Discharge of wastewater from ships

Both black water and grey water is created by ships. Black water originates from toilets, sanitation areas, or rooms where animals are held. Grey water refers to effluents and wastes from kitchens, bathrooms and showers. In particular passenger ships, i.e. ferries and cruise ships, create large quantities of wastewater. On a cruise ship, approximately 32 litres of black water and 250 litres of grey water are produced per passenger, per day; for a vessel with 3,000 passengers (including crew), this translates into a weekly volume of 627 m³ of black water and 5,250 m³ of grey water.

Under MARPOL Annex IV, the discharge of untreated black water into the sea is prohibited. It must either be collected in tanks or treated in wastewater treatment plants. The effluent is usually disinfected with chlorine prior to being discharged into the sea. The discharge of grey water is not regulated under MARPOL Annex IV.

Anti-fouling paints for ships

The outer hull of vessels is coated with a special anti-fouling paint to prevent the growth of mussels, barnacles, gastropods and algae, and thereby prevent any increase in the flow resistance of the hull. In the past, paints containing tributyltin (TBT) as a biocide were widely used. This paint gradually washed off and the TBT entered the marine environment and sediment, where it caused damage. Pathogenic changes were observed in fish, mussels and crabs. The Antifouling Convention of the International Maritime Organization (IMO) now prohibits the use of TBT in ship's paints worldwide (since 2003 for all new vessels and since 2008 for vessels that had previously been treated with a paint containing TBT). Efforts to design more energy-efficient ships are currently leading to the development of new coating concepts, including the use of nanoparticles and silicone. A comprehensive investigation into the potential eco-toxicological effects of such materials is still needed.

¹⁵⁴ The driftline is defined as the shore region where material is deposited.

Figure 64: Shipworm (top left), comb jellyfish (top right), mitten crab (bottom)



Photographs:

Top left: Wikipedia – <http://de.wikipedia.org/w/index.php?title=Datei:Shipworm.jpg&filetimestamp=20051024144045>, top right: http://de.wikipedia.org/w/index.php?title=Datei:LightRefractsOf_comb-rows_of_ctenophore_Mertensia_ovum.jpg&filetimestamp=20050619020853, bottom: Wikipedia – <http://upload.wikimedia.org/wikipedia/commons/7/70/EriocheirSinensis1.jpg>

Impairment of the indigenous ecosystem and biodiversity from ballast water

Ships need ballast to stabilise their position in the water and balance out different loads. To this end, seawater is pumped into special ballast water tanks – which in large vessels may hold up to 100,000 tonnes – and in this way, is transported from one port to the next, where part or all of it is then discharged when new cargo is loaded. Worldwide, some 10 billion tonnes of ballast water are transported each year. In this water organisms “travel” around the world, and can become established in new ecosystems. The diversity of species detected in the ballast water of ships ranges from microscopic algae to mussels, molluscs and crabs, and even fish up to 15 cm in length. These introduced, potentially invasive species can displace indigenous species, disturb the ecosystem and biodiversity, and cause economic damage. In the North Sea alone, scientists have detected more than 200 non-native species introduced on ships’ hulls or in ballast water.

In the North and Baltic Seas, shipworm, comb jellyfish and mitten crab are among the best-known invasive species.

The Ballast Water Convention was adopted in February 2004. This states that in future, ships must be equipped with facilities for the treatment of ballast water. The systems may use filters, UV light as well as chemicals to kill organisms. However, the Convention will not enter into force until 12 months after it has been ratified by 30 countries whose commercial fleets make up at least 35 percent of the gross tonnage of the world’s commercial fleet. By March 2014, 38 countries had signed the Convention, but only accounted for 30.38 % of the gross worldwide tonnage, so the Convention is not yet in force¹⁵⁵. Germany ratified the Convention in spring 2013 and transposed it into German law. The Ballast Water Act of 5 February 2013 was

¹⁵⁵ As at: 6 March 2013.

published in the Federal Law Gazette on 13 February 2013 (Part II 2013, p. 42).

Emission of air pollution pollutants from ships

The limits values for the emission of pollution pollutants from ships are far less ambitious than in other transport sectors. This is why ship emissions accounted for by far the largest proportion of local pollutant emissions in the heavily frequented ferry ports of the North and Baltic Seas. Emissions per transported unit and kilometre travelled also exceed those of road traffic.

Emissions of sulphur oxides (SO_x), nitrogen oxides (NO_x) and particulate matter (PM) are particularly relevant. Studies indicate that unless further action is taken, by 2020, NO_x and SO_x from ships will exceed total land-based emissions in Europe. Emissions impact the terrestrial ecosystems, the ocean and human health.

SO_x emissions contribute to the acidification of soil and water; they irritate the respiratory tract and increase the risk of heart and lung disease. NO_x emissions lead to the eutrophication of ecosystems and contribute to the formation of ground-level ozone. Studies suggest that maritime traffic contributes around 24% to the atmospheric input of nitrogen into the Baltic Sea. NO_x emissions can trigger asthmatic reactions, and also have a cell-modifying and carcinogenic effect.

PM emissions lead to heart and lung disease; soot ("black carbon") was classified as a carcinogenic by the WHO in 2012.

Air pollutants do not recognise national boundaries; international shipping traverses the world's oceans, and international regulations are therefore particularly important here. With this in mind, the International Maritime Organisation has defined limit values to reduce pollutant emissions, as set out in Annex VI to MARPOL.

SO_x emissions are regulated via the sulphur content in fuel. This is being gradually reduced from its previous limit of 4.5 %, to 3.5 % at present, to 0.5 % by 2020. Additionally, the MARPOL Convention has created the option of designating Emission Control Areas (ECAs). The Baltic Sea was declared a SECA (Sulphur Emission Control Area) in 2006, and the North Sea in 2007. More stringent limit values apply to sulphur emissions in these areas (currently: 1.0 %; from 2015: 0.1 %). Alternatively, the sulphur emission limits may be met via exhaust gas treatment systems known as scrubbers. There are a number of different systems on the market. The Federal Environment Agency (UBA) suggests that in future, only systems which do not entail a relocation of emissions from the air into the water should be used. To date, only the dry scrubber system offers this option; in so-called wet scrubbers, the wash water is emitted into the sea.

As a general principle for UBA, the problem of high sulphur emissions should not be addressed by exhaust gas treatment systems on board ship, but should instead begin on land, by providing clean, low-sulphur fuels for sea-going vessels. These enable the use of additional exhaust gas treatment systems, such as particle filters to reduce soot emissions.

In European ports, a sulphur emission limit of 0.1 % has been in force since the beginning of 2010. This is intended in particular to improve air quality in port towns, where ships' emissions account for a significant proportion of SO₂ emissions (in Lübeck-Travemünde, for example, the figure is more than 90 % of SO₂ emissions).

Because ships use their auxiliary engines and boilers to maintain on-board operation in ports, a few port towns have begun offering land-based electricity connections (so called "cold ironing"), enabling ships to switch off their auxiliary engine.

Nitrogen oxide emissions (NO_x) are likewise regulated by MARPOL Annex VI. However, the emission limits for existing vessels are less ambitious. An emission reduction of around 80 % is required from Tier III onwards, but this only applies to new vessels built in 2016 or later, and only if such vessels are operating in a NO_x Emission Control Area (NECA). To date, only the North American coast of the USA and Canada has been designated as NECA. For the North and Baltic Seas, corresponding applications are currently being drafted. Consequently, this international regulation will only help to reduce emissions in the very long term.

Shipping noise

Over the past century, the volume of shipping, in terms of the number and size of vessels, has grown continuously (cf. [chapter 6.7.9](#)). This has led to a significant increase in the ambient noise level caused by ships. The underwater sound spectrum in the seas of the northern hemisphere is dominated by noise from commercial shipping. High noise levels are generated within a broad frequency range over a comparatively large area surrounding the vessels. Depending on the vessel's type and size, the intensity and frequency of noise emissions vary between 158–190 dB re 1 µPa at 7–430 Hz¹⁵⁶. In the frequency range of 10–300 Hertz, the natural noise level is increased by 20–30 decibels due to ship traffic. In the past 30 years alone, the average continuous ambient noise level has risen by around 10 decibels.

This underwater noise may damage the hearing and sense of direction of marine mammals, trigger behavioural changes and even drive them permanently away from their feeding and breeding grounds. Large

156 Simmonds et al. 2003.

whales primarily use the same frequency range as shipping noise to communicate, and calls from dolphins and porpoises have also been recorded at low frequencies. However, cargo ships are not the only perpetrators of noise; small vessels such as those used for whale watching are also among the culprits. They can cause evasive responses up to a distance of four kilometres. There are indications of a negative correlation between shipping routes and the presence of porpoises, the only native species of whale in German waters.

The ship's hull is a good transmitter of mechanical waves, which may re-emerge at certain points as noise. At high speeds, vibrations are caused primarily by motor, gearbox and propeller noise. At lower speeds, the back-up engines tend to predominate.

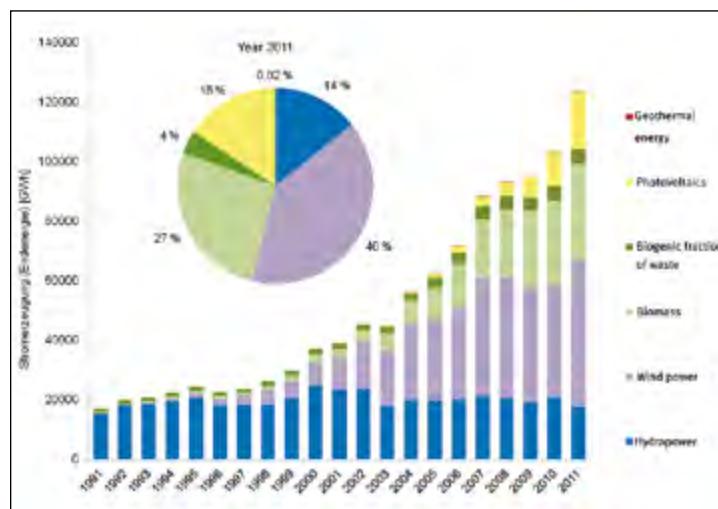
Chronic ambient noise is a major stress factor in the marine environment. In implementing the MSFD, it would be expedient to follow international reduction targets, such as those identified by the IMO and the International Whaling Commission (IWC). The scientific committee of the IWC is calling for a three decibel reduction in shipping noise in the 10–300 Hertz range within 10 years, and 10 decibels within 30 years, compared with current levels.

The IMO has also drawn up recommendations to reduce noise from ships. The revised basis for the award of the “Blue Angel” eco-label for environmentally friendly ship design (RAL-UZ 141) now includes criteria governing underwater noise.

6.7.3 Hydropower

The German Federal Government has prioritised the expansion of renewable energies with a view to effective climate protection and the development of a sustainable energy supply. By the year 2020, it wants to increase the contribution of renewable energies to electricity supply to at least 35 %, and to heat supply to 14 %, followed by further continuous increases thereafter. Renewables are to account for at least 80 % of electricity supply by 2050 at the latest. In order to attain these targets, we need to maximise the potential of the various regenerative energy forms in an environmentally compatible fashion. Renewable energy from hydropower is obtained from storage, outfall and streamflow power plants. The use of hydropower depends on both the natural gradient and the outflow level. By European comparison, Norway and Iceland have particularly favourable conditions in this respect, and are able to cover their electricity requirements almost entirely from hydropower. In Luxembourg, Austria, Italy, Switzerland and Sweden over 50 % of the electricity generated originates from this regenerative energy source.

Figure 65: Structure of electricity supply (final energy) from renewable energy sources in Germany, 1990 to 2011



Source: BMU 2012

By contrast, in Germany the natural conditions for the use of hydropower are less favourable. Germany currently has around 7,700 hydropower plants with a total electrical output of around 4,400 MW¹. 406 of these, with a total electrical output of around 3,400 MW, are classed as large hydropower plants with more than 1 MW capacity. These produce more than 84 % of Germany's electricity from hydropower, at a standard operating capacity of 20.9 TWh in total, and are therefore pivotal to hydropower's contribution to the expansion target for renewable energies. Depending on the hydrological conditions, the proportion of total electricity generated in Germany from hydropower ranges between around 3 and 5 %. Over 80 % of this is generated in the Central German Uplands in Bavaria and Baden-Wuerttemberg, areas with high levels of precipitation. In 2012¹⁵⁷, some 21,200 GWh of electricity was provided from hydropower, corresponding to 3.6 % of gross electricity consumption in Germany. Whilst hydropower still played a significant role in renewable electricity generation in 2000, its significance has diminished in recent years. In 2011, hydropower ranked below wind power (8.1 %) and biomass, which produced 6.1 % of gross electricity consumption including the biogenic portion of domestic waste, and slightly ahead of photovoltaics, which accounted for 3.2 % of gross electricity consumption¹⁵⁸. The importance of hydropower in electricity generation will continue to decrease, because its potential is almost exhausted and there is no significant scope for the construction of new capacity in Germany.

¹⁵⁷ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, BMU) (editors), (2013): Schaubilder “Entwicklung der erneuerbaren Energien in Deutschland im Jahr 2012” Internet: www.bmu.de / www.erneuerbare-energien.de

¹⁵⁸ Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety) and Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology) (2012): Erster Monitoring-Bericht “Energie der Zukunft”. Taufkirchen, p. 64.

In Germany, the usable potential of water as an energy carrier¹⁵⁹, with due regard for technical, ecological, infrastructure and other requirements, is around 26 TWh, around 80 % of which has already been developed. Output could be increased primarily by optimising and modernising or reactivating hydropower plants at existing impoundments in large waterbodies (4 TWh). In smaller and medium-sized waterbodies, there is a far smaller potential for the construction of new capacity (1 TWh).

Apart from the advantage of largely emission-free energy production compared with fossil energy carriers, however, developing watercourses for hydropower use also brings with it significant adverse consequences for the water ecosystem.

The principal impairment to the structure and function of water-dependent ecosystems associated with hydropower use is that it interrupts the passability of watercourses, and causes direct damage to and kills organisms as a result of turbine operation and at power plant grills affecting downstream migration. Where several plants exist in sequence, this damage has a cumulative effect, placing fish populations at risk. The weirs used for hydropower or shipping cause atypically low flow speeds, leading to sludge accumulation, a lack of oxygen, and the transformation of typical watercourse biocoenoses into degraded lake biocoenoses. Dyke construction and uniformly high or unnaturally fluctuating water levels leads to a loss of contact with watermeadows, and the water balance is disturbed. Sedimentation in the weir leads to the reabsorption of bed material below the weir, and deepening of the river bed, together with the lowering of groundwater in the watermeadows.

A good ecological status as called for by the WFD cannot be attained in most affected river sections (cf. **chapter 5.1.1.2**) due to the consequences for water ecology. As a result, some of these river sections have been classified as “heavily modified”. The environmental goal for waterbodies is to achieve a “good ecological potential” by means of improvement measures, without significantly impairing usage. Such measures entail, for example, structural changes (installation of fish ladders, smaller grill sizes) and modifications to operation (opening the weirs during fish migration periods), which will entail a loss of profits. The long concession periods of several decades required to safeguard investment necessitate the voluntary participation of operators as well as incentives. The Renewable Energy Sources Act¹⁶⁰ provides for financial support, and this is being utilised.

Given that only 21 % of waterbody sections in Germany have a waterbody structure that is classified as unaltered to moderately altered, partly as a consequence of hydropower use, and there is negligible potential for building new capacity in order to meet the expansion targets for renewable energies, particularly in the case of smaller plants, the construction of new hydropower plants in the few remaining undeveloped, passable sections of waterbody would be inappropriate. When modernising or reactivating hydropower plants, it is important to optimise the plant’s design and operating mode to improve the ecological balance in the water as well as in connected terrestrial ecosystems and wetlands. This can be achieved primarily via the creation of biological and morphodynamic waterbody passability, and by ensuring adequate minimum water outflows in discharge sections.

159 Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, BMU) (editors), (2010): Potenzialermittlung für den Ausbau der Wasserkraftnutzung in Deutschland als Grundlage für die Entwicklung einer geeigneten Ausbaustrategie.

160 cf. Act to Amend the Act on Granting Priority to Renewable Energy Sources and Amending Associated Regulations of 25 October 2008, Federal Law Gazette (BGBl.) 2008, part 1, no 49, p. 2074.

Figure 66: Barrage weir for hydropower generation in Bremen-Hemelingen



Photographs: Federal Environment Agency (UBA)

6.7.4 Underground uses

6.7.4.1 Geothermia

Geothermal energy refers to the energy stored in the form of heat beneath the earth's crust (VDI Guideline 4640). It is also known as ground heat or geothermia¹⁶¹.

Geothermal energy potential is assessed according to the heat content stored in the subsoil. Up to a depth of around 10 to 20 m below the earth's surface, the temperature is influenced by sunlight and climatic temperature fluctuations. At the limit of this range of influence, the temperature in our latitude is around 10 °C on average, and increases by 3 °C per 100 m. However, temperature distribution in the subsoil is not uniform, and depends on the structure and composition of the earth's crust. In Germany, there are certain areas where the temperature gradient – in this case, the increase in temperature as the depth increases – is significantly above average. In some areas of the Upper Rhine Rift (Oberrheingraben), in the vicinity of Bad Urach at the foot of the Swabian Alb, near Landshut in Bavaria and in selected areas of the North German Basin, the temperature increases by 5 °C, and in some cases even 10 °C, per 100 m. These areas exhibit so-called positive temperature anomalies. The benefit for geothermal energy use is that a usable temperature can be achieved at a low depth, which means lower drilling costs and lower investment costs. Geothermal systems may be classified according to various aspects; one common classification is to divide them into deep and shallow geothermia.

Deep geothermia

Alongside the booming but supply-dependent energy forms of wind power and photovoltaics, and the limited availability of hydropower and biomass, deep geothermia is another option for base load power generation from renewables, and is becoming increasingly important in the energy debate. Deep geothermia refers to all systems where geothermal energy is tapped via deep drillings, allowing its energy to be utilised directly. At present in Germany, this primarily refers to hydrothermal systems with a low heat content and direct use of the groundwater available in the subsoil, e.g. to feed into local and long-distance heating networks or for heating greenhouses. It can be converted into electricity from a temperature of around 100 °C. With the technology currently available, certain strata of the South German Molasse Basin, the Upper Rhine Rift and the North German Basin are potential sources of geothermal electricity generation (Figure 67).

Shallow geothermia

Around 60 % of total energy consumption in Germany is used for the heating and cooling of buildings. The

use of shallow geothermal energy offers considerable potential for meeting a large proportion of this energy consumption. Energy from the subsoil is supplied indirectly via geothermal heat probes up to a depth of 400 m, whereby the majority of geothermal heat probes currently in operation reach depths of between 70 and 200 m. There are already some 290,000 geothermal heating (and cooling) plants in operation in Germany. In heating mode, thermal energy is taken from the subsoil and raised to the required temperature via a heat pump. Conversely, thermal energy from the room's air, for example, can be routed into the subsoil for cooling. This also supports the regeneration of the thermal reservoir outside of the heating period, and improves the efficiency of the plant. Demand for the extraction of thermal energy is continuously rising, and geothermal heat probes are expected to become far more widely used.

Risks to groundwater

As a general principle, the construction, operation and decommissioning of facilities for the use of geothermal heat must not be allowed to pose a threat to groundwater. However, as the number of encroachments into the subsoil rises, so does the threat to the groundwater ecosystem and the use of groundwater for drinking water purposes. The drilling itself poses the greatest threat. Damage often occurs due to a lack of knowledge about the subsoil conditions and the use of non-adapted technology, drilling technology in particular. Some typical types of damage include:

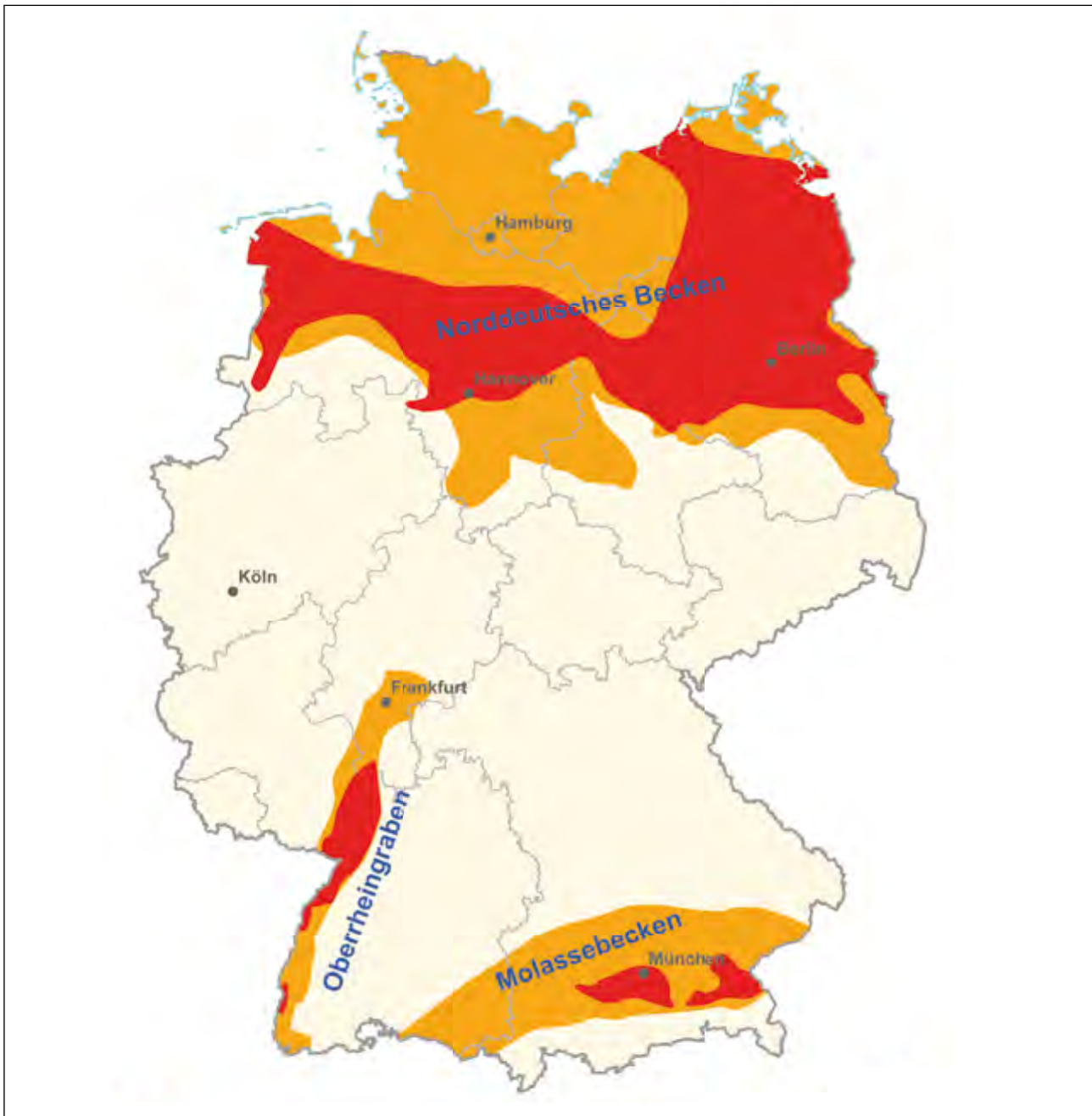
- ▶ Short-circuits of aquifers and the resultant possible entrainment of pollutants from shallow layers to deeper ones
- ▶ Settlement or lifting damage to adjacent infrastructure
- ▶ More highly mineralised groundwater may rise towards the surface.

Until now, damage has primarily affected the area close to the surface. The same high standards apply to deep geothermia in Germany as to deep drillings for oil and gas extraction, with particular emphasis on good insulation from groundwater aquifers. The few projects on deep geothermia that have been carried out in Germany to date have failed to establish any signs of damage.

Particularly in open geothermal systems close to the surface, the temperature and pressure changes in the groundwater reserves can be severe. Gas releases changes in the redox potential, changes in the pH value and shifts in solution equilibria, coupled with iron hydroxide and carbonate precipitation, are all possible. The licensing of groundwater use limits the maximum temperature difference between abstraction and return. Directive VDI 4640 on the thermal use of the subsoil recommends a maximum difference of 6 kelvin.

161 Stober I. et al., (2011): Tiefe Geothermie – Nutzungsmöglichkeiten in Deutschland, Bundesministerium für Umwelt, Naturschutz und Strahlensicherheit (BMU).

Figure 67: Overview of areas that may be suitable for deep geothermal use: Regions with groundwater aquifers whose temperature exceeds 100 °C (red) or 60 °C (yellow); 100 °C is required for the generation of electricity, and 60 °C for direct heat use



Source: Geothermisches Informationssystem Deutschland (GeotIS)

If the geothermal heat probe tubes are filled with a heat exchanger fluid other than water, only certain liquids in hazard category 1 (WGK 1) (ethylene or propylene glycol) are admissible. While underground installations must usually be twin-walled, geothermal heat probes may be of a single-walled construction, provided they are suitably protected so that the installation is deactivated and an alarm emitted in the event of a leak. The probe tube must be back-filled with a material intended for this application by the manufacturer and whose

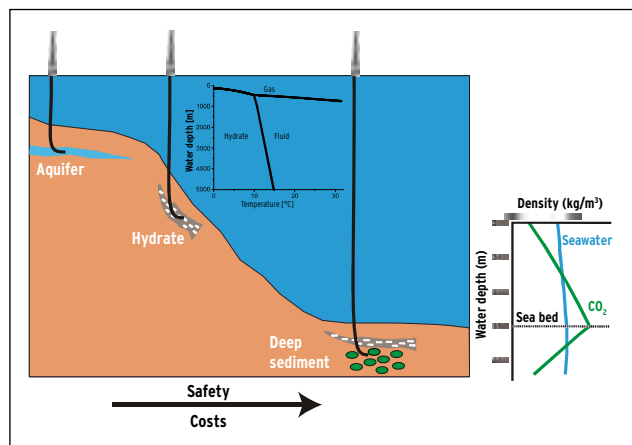
groundwater safety is proven. Prior to commissioning, the probe should be subjected to functional testing, particularly with regard to its leak-tightness.

6.7.4.2 CCS – Storage of CO₂ in the subsoil or ocean floor

Future projects for the storage of CO₂ in the subsoil may occur on land or in the sub-seabed. The technology used is known as Carbon Capture and Storage (CCS), designed to help reduce the amount of CO₂ emit-

ted into the atmosphere. The CO₂ may originate from power supply plants, industrial processes or biomass plants. Experts anticipate that the technology will be available on a commercial scale within 10 to 15 years. Potentially suitable storage sites include depleted gas and oil fields. Experts are also debating the possibility of storage in saline aquifers. The storage of CO₂ poses various risks to the environment: Acidification of the groundwater may be caused. Among other things, heavy metals may be released and transported into the groundwater. It is also important to note that the stored CO₂ is not a pure gas, but a mixture of substances, some of which might be toxic, originating from the production process or from capture, transportation or the storage process. Both acidification of the groundwater and the associated release of contaminants, as well as the emission of pollutants with the CO₂ itself, may adversely affect groundwater quality. When CO₂ is discharged into saline aquifers, the saline water contained in the pore spaces of these groundwater aquifers is displaced. The salification of freshwater aquifers would be particularly critical. The salt water could also infiltrate other ecosystems, if for example it were to rise to the earth's surface, and cause damage to surface waters (rivers, lakes) or terrestrial ecosystems. The application of CCS technology is also problematic because it necessitates the use of significant additional quantities of energy.

Figure 68: CO₂ storage in the subsoil



Source: UBA-Forschungsvorhaben, CO₂-Abscheidung und Speicherung im Meeresuntergrund, Forschungskennzahl (FKZ) 206 25 200

When sequestering CO₂ streams into the sub-seabed, the main concern is the risk of it and other toxic substances escaping from the storage formations, leading to acidification of the local marine environment and other contamination.

To date, no technically verified upper limit has been established for the emission limit value of CO₂ from stores close to the surface into marine waters which would guarantee the protection of marine organisms.

As a pragmatic solution, experts propose that the CCS stores should not exceed the rate at which CO₂ is naturally formed on the ocean floor as a result of the degradation of organic substance by more than 10 %. This requirement is significantly more severe than the leakage rate of 0.01 % per annum considered adequate for climate-effective sequestration.

6.7.4.3 Fracking

Hydraulic fracturing (fracking) is a technique used to extract natural gas from previously inaccessible, so-called unconventional deposits. However, this technique is highly controversial due to the possible impacts on man and the environment.

There are significant unconventional natural gas deposits in Germany, located in shale formations, coal seams and dense sandstone. According to the Federal Institute for Geosciences and Natural Resources (BGR), there are some 1.3 trillion cubic metres of technically extractable shale gas resources. This could cover Germany's gas requirements for more than a decade. However, in a statement dated May 2013 the German Advisory Council on the Environment (SRU) estimated that the extraction of shale gas in Germany is not a relevant energy policy option. Shale gas, it concluded, would not reduce energy prices, nor would it make a significant contribution to the reliability of supply. Hence, from Germany's viewpoint, there is no political interest in extracting this gas¹⁶².

In fracking, water plus a so-called proppant (such as quartz sand) and chemical additives are briefly pumped into the well at high pressure, this creates fractures in the rock. The quartz sand is intended to prevent the fractures from closing again once the hydraulic pressure is withdrawn, and to ensure that natural gas can flow through to the drilled well. The other substances added to the water are intended to ensure, for example, that the quartz sand mixes with the water and that bacteria is unable to reach the deposit.

Once fracking is complete, the natural gas can be extracted. A large portion of the fracking fluid used is pumped back together with the gas flow and the deposit water (flowback), but part of it remains behind in the deposit.

Particular concerns include the possible contamination of groundwater with the chemicals used, the possibility of natural gas rising through natural or artificial routes, and the problem of wastewater disposal (flowback).

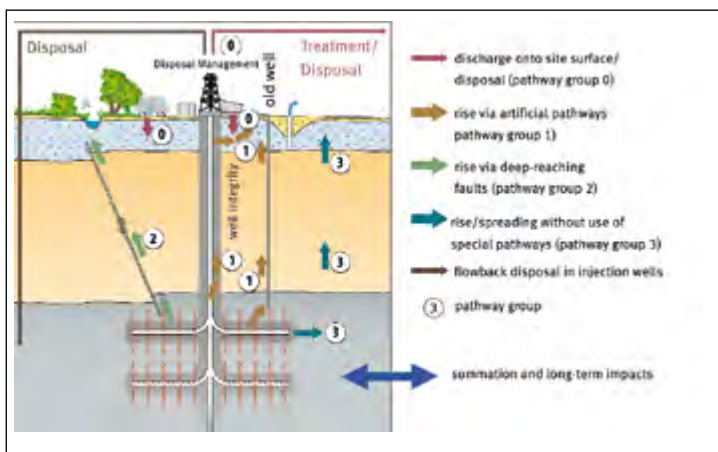
¹⁶² Fracking for Shale Gas Production – A contribution to its appraisal in the context of energy and environment policy http://www.umweltrat.de/SharedDocs/Downloads/EN/04_Statements/2012_2016/2013_09_Statement_18_Fracking_for_Shale_Gas_Production.pdf?__blob=publicationFile

Figure 69: Mining rights in Germany (yellow, as at: 31 December 2011) to explore unconventional hydrocarbon resources (background: regions with fundamental geological conditions for the formation of shale gas are shown in ochre)



Source: BGR (2012), Abschätzung des Erdgaspotenzials aus dichten Tongesteinen (Schiefergas) in Deutschland, Ladage, S. und Berner, U. (Koord.), Andruleit, H. et al. (Autoren), Bundesanstalt für Geowissenschaften und Rohstoffe (Hrsg.), Hannover, (http://www.bgr.bund.de/DE/Themen/Energie/Downloads/BGR_Schiefergaspotenzial_in_Deutschland_2012.html)

Figure 70: Diagrammatic representation of potential pathways



Source: UBA 2012

In 2011, the Federal Environment Agency published its first assessment of possible shale gas extraction in Germany¹⁶³, examining various environmental risks associated with fracking technology, and citing minimum requirements for reducing these risks, such as the exclusion of fracking operations in water protection areas and compulsory environmental impact assessments. A scientific assessment of the risks to groundwater occurred within the context of an expert report subsidised by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety¹⁶⁴. In it, the experts advised against the large-scale use of fracking to tap into unconventional natural gas resources in Germany for the time being. Given the lack of sufficient data on deposits, the impacts of drilling and the chemicals used and flowback, instead, the experts recommend proceeding on a step-by-step basis with individual projects closely monitored by authorities and scientists in order to obtain findings and analyse the risks. The expert report also proposes multiple amendments to mining and administrative law, partly with the aim of strengthening the participatory rights of affected individuals and the general public.

Alongside the risks to groundwater, a comprehensive assessment of fracking technology should also include other aspects, such as methane emissions, induced earthquakes, the overground land and infrastructure requirements, and aspects of nature conservation. A follow-up report published by the UBA in 2014 on the environmental impacts of fracking stresses that greater consideration should be given to the cumulative aspects if fracking were to be used to explore hydrocarbon reserves in a densely populated country like Germany.¹⁶⁵

In view of the many unanswered questions, many experts recommend it would be irresponsible to use fracking for the commercial exploration of natural gas from unconventional deposits. Current findings indicate that the priority must be to protect groundwater and drinking water, and to carefully analyse the impacts on the entire environment with the involvement of the general public and in close collaboration with the environmental authorities. Furthermore, fracking licences should not be granted in particularly sensitive areas such as drinking water protection areas. Tightening up the law in this respect is a top priority for environmental policy, and appropriate measures are in the pipeline.

¹⁶³ Einschätzung der Schiefergasförderung in Deutschland, http://www.umweltbundesamt.de/wasser-und-gewaesserschutz/publikationen/stellungnahme_fracking.pdf

¹⁶⁴ Umweltauswirkungen von Fracking bei der Aufsuchung und Gewinnung von Erdgas aus unkonventionellen Lagerstätten, <http://www.umweltbundesamt.de/uba-info-medien/4346.html>

¹⁶⁵ Umweltauswirkungen von Fracking bei der Aufsuchung und Gewinnung von Erdgas aus unkonventionellen Lagerstätten – Teil 2.

6.7.5 Energy generation at sea

Offshore windpower

The German Government's energy concept envisages building offshore wind farms with a total capacity of 15,000 MW by 2030. In Germany, as at 31 December 2013, there were 113 offshore wind turbines in operation with a total output of 508 MW. These are the Alpha Ventus offshore wind farm and the wind turbines in the BARD Offshore 1 field in the North Sea and the Baltic 1 wind farm in the Baltic Sea. There are currently eight offshore wind farms under construction, together comprising of some 637 turbines with a capacity of around 2,709 MW. Theoretically, this capacity would be sufficient to generate electricity for more than 1.5 million households. To date, some 30 wind farms have been approved in the German Exclusive Economic Zone (EEZ) of the North Sea, as well as three in the German EEZ of the Baltic Sea. Four wind farms have been approved to date in the territorial seas of the North and Baltic Seas. When connecting the offshore wind farms to onshore power grids, ensuring the best possible environmental protection is crucial. This includes bundling of cables, routing them parallel to existing transmission routes, selecting the shortest possible path, and laying outside of protected NATURA 2000 areas as far as possible.

Transformer stations are constructed at sea for converting three-phase current into direct current with low losses. High-voltage direct current (HVDC) cables transmit it to the sea floor and then by land to the closest infeed point. Offshore wind farms must be built and operated in the most environmentally friendly way, in harmony with the MSFD's objective of achieving a "good environmental status" of the seas by 2020.

Offshore wind farms are licensed in accordance with the Marine Facilities Ordinance (SeeAnlV) together with the provisions of the Federal Nature Conservation Act, the Habitats Directive and the Birds Directive.

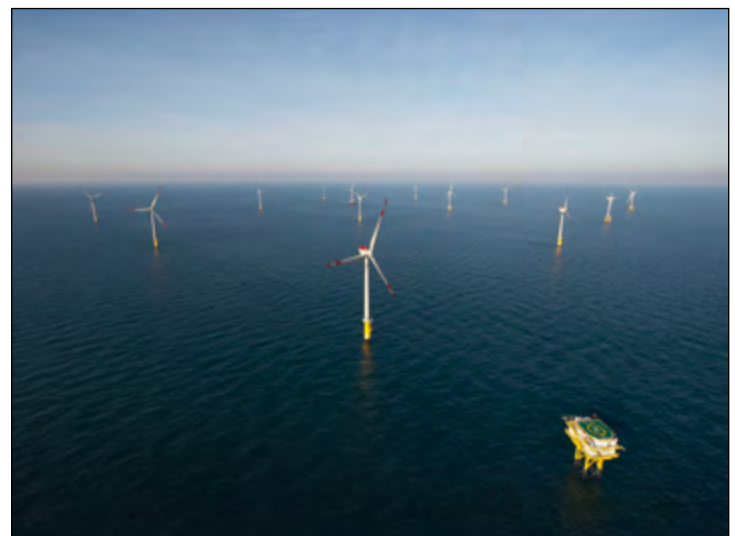
Decision-making is based on a broad-based study programme into the ecological impacts of wind farm construction and operation. The following impacts are particularly relevant:

- ▶ Risk of collision with birds and barrier effect of turbines, together with loss of resting and feeding grounds for birds
- ▶ Damage to hearing, behavioural changes and temporarily driving away marine mammals such as porpoises in large numbers due to the noise caused by pile-driving
- ▶ Changes in bottom-dwelling biotic communities near the turbine foundations.

In order to protect migrating birds, the Federal Environment Agency recommends need-based lighting of offshore wind farms. In order to minimise bird losses due to collisions, following the assessment the licensing authorities reserve the right to require that wind farms are fitted with deterrents or temporarily switched off during nights with extensive bird migrations that coincide with poor weather and visibility conditions. In order to prevent damage to porpoises – a key species – associated with the noise from pile-driving for offshore wind farms, the UBA recommends dual noise protection limits of 160 decibels sound exposure level and 190 decibels peak sound level at a distance of 750 metres from the source of the sound. The Federal Maritime & Hydrographic Agency (BSH) has adopted this recommendation and incorporated it into its licensing permits. The dual criterion was subsequently integrated into the noise protection concept applicable to the construction of offshore wind farms in the EEZ of the German North Sea, published by the BMUB on 1 December 2013. Technical noise reduction measures must now be developed or improved in order to meet these limits. Some noise reduction techniques used during pile-driving, such as air bubble curtains, hydro sound dampers and drainable "cofferdams", have already proven effective. Alternative foundation techniques, e.g. by drilling instead of pile-driving, are likewise at the development or trial stage.

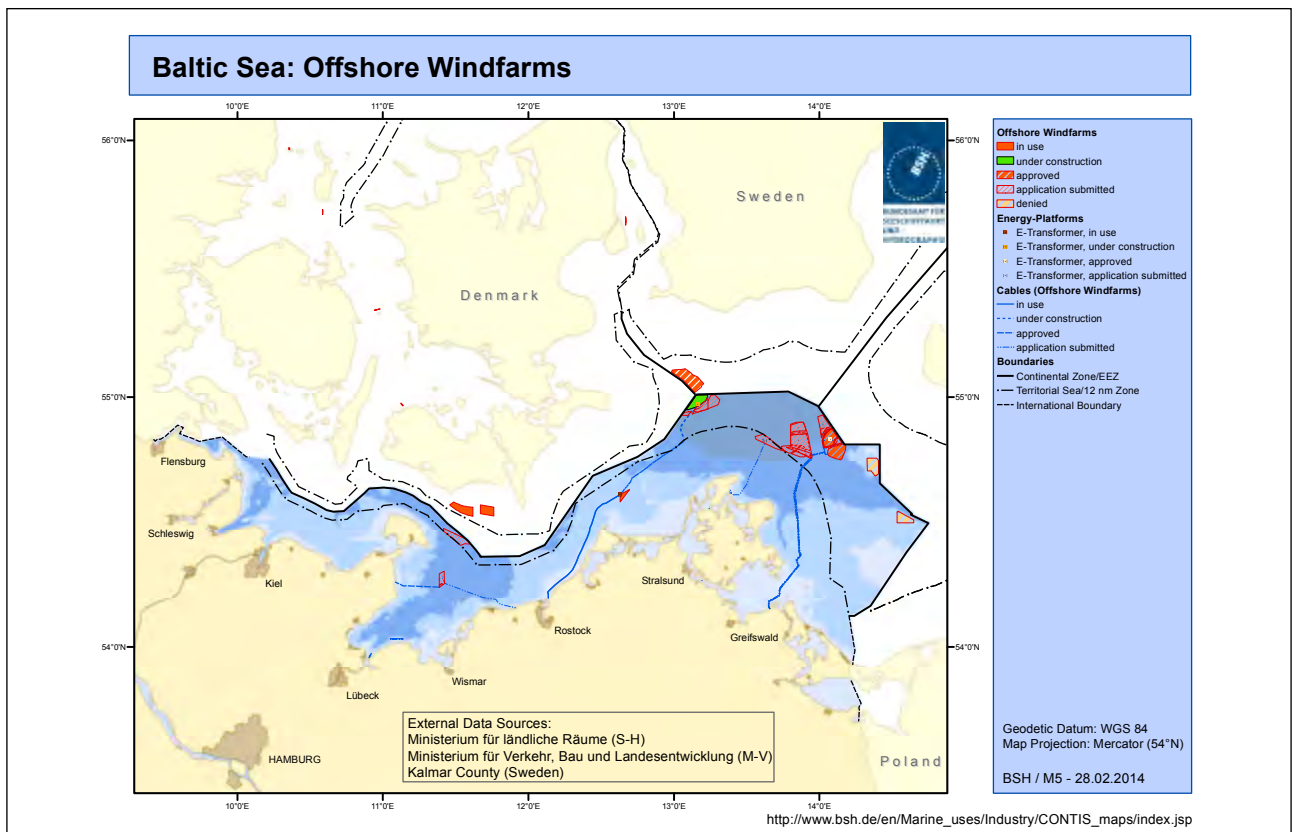
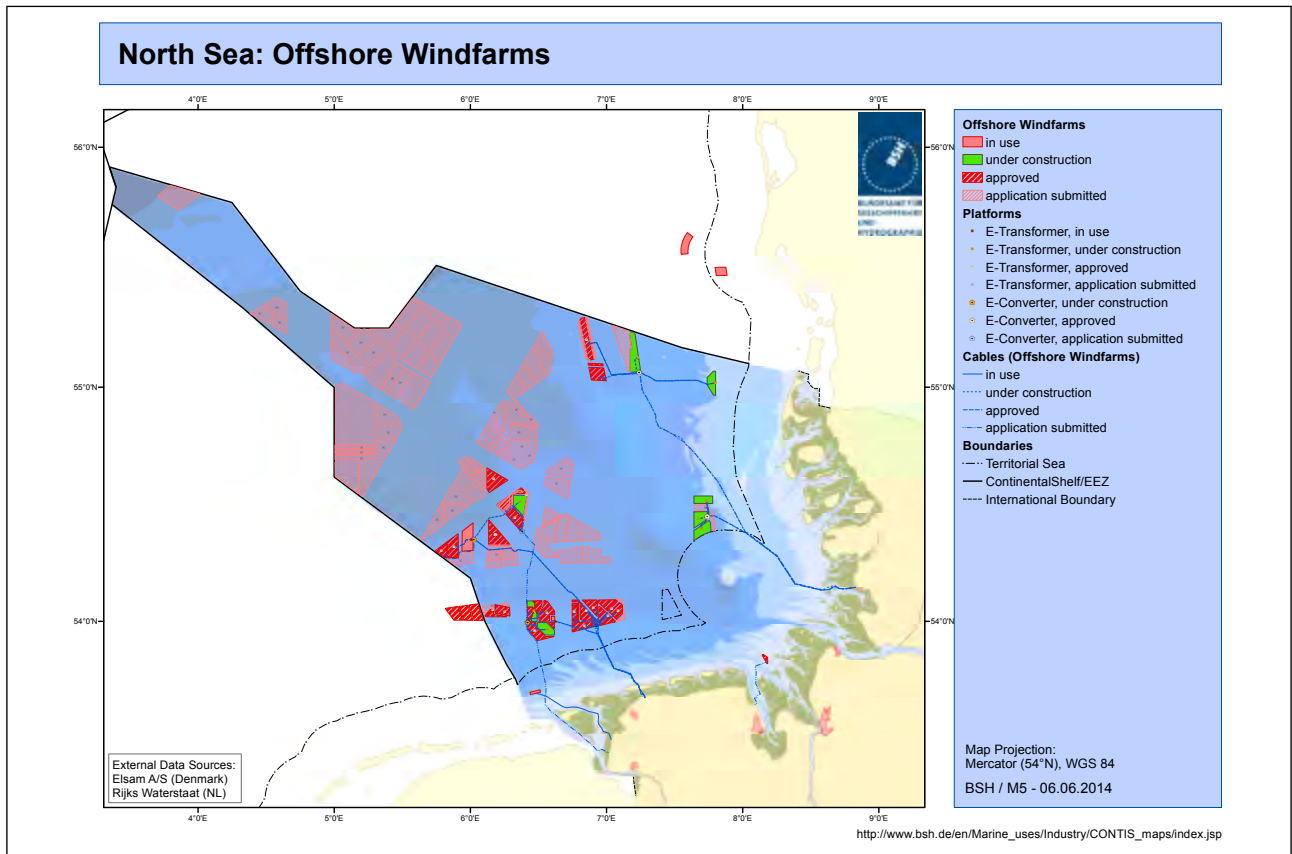
As well as generating electricity from renewable sources, the construction of offshore wind farms might also achieve positive environmental protection effects. For example, these areas could become retreat zones for fish, as dragnet fishing is unlikely to be practised here. The bottom fauna impaired by bottom-trawling, especially long-lived species, would likewise benefit from the elimination of this form of fishing.

Figure 71:



Photograph: AREVA Wind/Jan Oelkerr

Figure 72: Offshore wind farms in the North and Baltic Seas



Source: BSH

Oil and gas extraction

The discovery of oil and natural gas in the North Sea in the 1960s and 1970s led to one of the largest investment projects in industrial history. Today, the North Sea is one of the world's largest production areas for the offshore industry.

Whereas the extraction of oil occurs primarily in British and Norwegian waters, natural gas is also extracted from the shallow waters off the Dutch and Danish coast. In the North-East Atlantic, there are currently some 700 installations for oil and gas extraction, including 420 oil and gas platforms, approximately 200 undersea installations, and around 80 drilling installations¹⁶⁶.

There are three oil platforms in the Russian part of the EEZ of the Baltic Sea. **Figure 74** provides an overview of the uses and protected areas of the North Sea (and parts of the Baltic Sea)¹⁶⁷.

Oil and gas are likewise extracted in Germany's Exclusive Economic Zone (EEZ) and territorial seas, and exploration rights also exist over large areas. There are currently two offshore plants in operation in the German North Sea: The Mittelplate oil platform (Schleswig-Holstein Wadden Sea National Park) and the gas platform A6-A in the EEZ. There are currently no offshore oil or gas operations in the German Baltic Sea.

The United Nations Convention on the Law of the Sea and the OSPAR Convention provide the legal framework for the oil and gas industry.

Following the events in the Gulf of Mexico, the EU Commission undertook a comprehensive review of all safety concerns in the offshore oil and gas industry for the OSPAR Convention area (and other European seas). Following on from this review, on 12 June 2013 the EU Commission published Directive 2013/30/EU¹⁶⁸ of the European Parliament and of the Council on safety of offshore oil and gas operations.

The Federal Mining Act (Bundesberggesetz, BBergG) regulates the detection, extraction and processing of mineral resources with the aim of protecting raw material supplies. The laying of pipelines in order to transport the raw materials likewise falls within the regulatory scope of the BBergG.

The exploration, extraction and transportation of oil from the North Sea invariably have consequences for the sea. Exploration and production as well as the routing of pipelines conflict in particular with nature conservation, environmental protection, fishing, and

future transmission networks for electricity from offshore wind farms, as well as with the wind farms themselves. Ecologically relevant factors include the increased threat to the environment from accidents and the pressures associated with the installation and operation of platforms and pipelines due to the discharge of pollutants into the sea.

Seismic testing is used to explore raw material reserves in the subsoil of these areas. The use of airguns and other acoustic measurement techniques represents an anthropogenic sound discharge into the marine environment. There is a risk that communication between marine mammals and their acoustic perception of their marine environment could be impaired by the acoustic, temporal and spatial characteristics of these technologies. Furthermore, the aforementioned methods may cause behavioural-biological or physical impairments, ranging to injury and even death. Marine mammals perceive the frequencies generated by airguns above 500 Hz even at a distance of more than 10 kilometres.

Figure 73: Oil platform in the North Sea



Photograph: Storman – Fotolia.de

¹⁶⁶ SPAR Daten 2008.

¹⁶⁷ www.bsh.de/de/Meeresnutzung/Wirtschaft/CONTIS-Informationssystem/ContisKarten/Gesamte_Nordsee%2c_saemtliche_Nutzungen_und_Schutzgebiete.pdf

¹⁶⁸ Directive 2013/30/EC of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC.

In the production process, oil can enter the sea via four routes:

- ▶ As a result of accidents
- ▶ Via the operational discharge of production water¹⁶⁹
- ▶ Via cuttings¹⁷⁰ and
- ▶ As a result of flaring gas during test drillings (drilling to test the productivity of a potential deposit).

The aforementioned Directives and provisions are intended to reduce or prevent potential oil discharges from offshore installations (see **chapter 5.2.3.1**).

Other uses

The use of marine energy is still at the development and research stage worldwide. In recent years, however, a number of technical innovations have been presented, and initial foreign experience has been collated. Pilot projects such as the 300 kW prototype

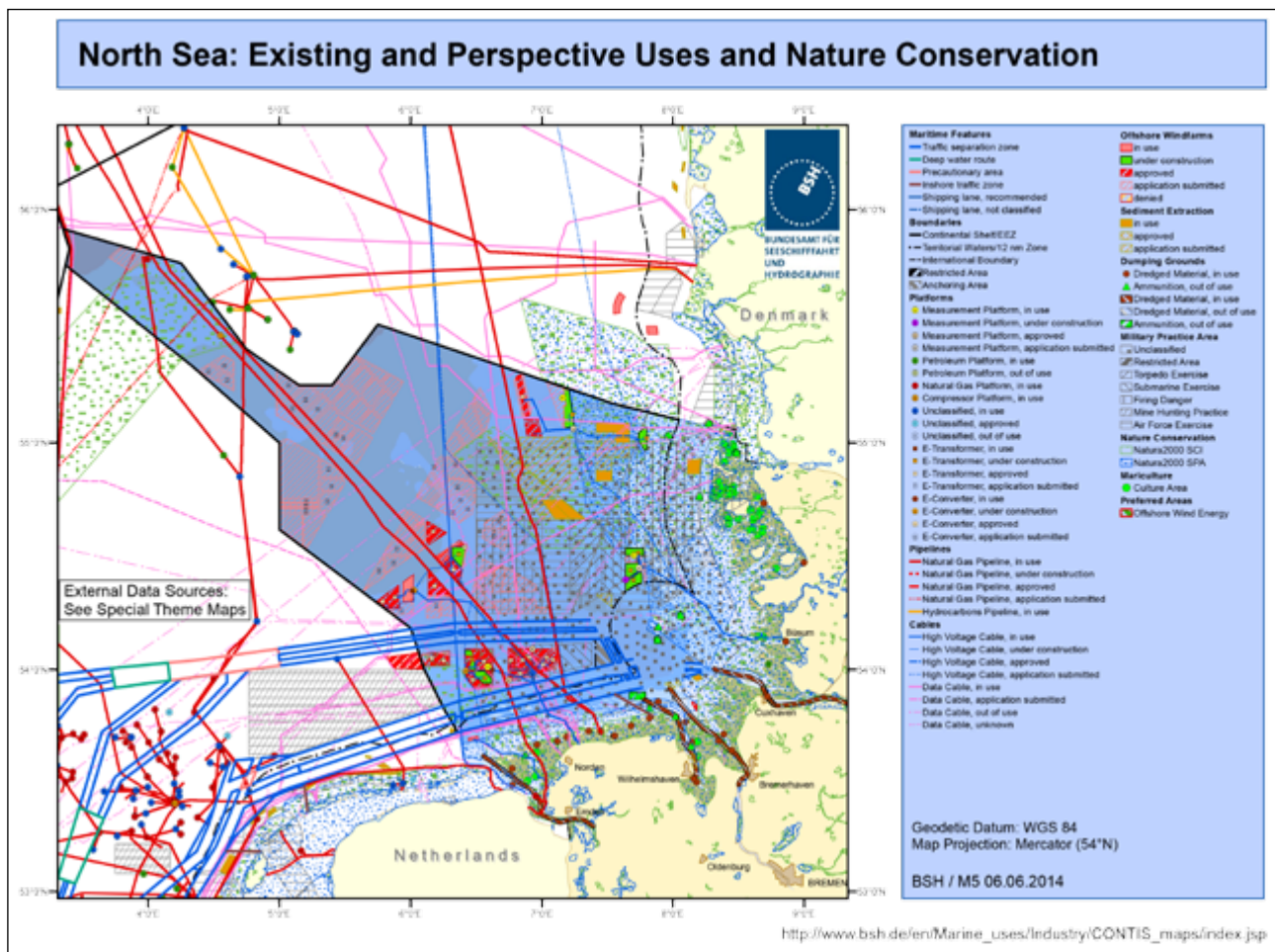
of the Seaflow-1 marine current turbine installed off the English coast, the SeaGen marine current turbine in Northern Ireland, and the world's first prototype of an osmosis power plant which began operation as a miniature power plant in November 2009 in Tofte, Oslofjord (Norway), are indicative of the technical progress in this field. Marine energy refers to energy forms such as tidal range, waves, current, salt gradient (osmosis) and temperature gradient.

Current estimates suggest that the usable potential of marine current energy, wave energy and other forms of marine energy use in Germany is minimal. Globally, however, the potential for the use of marine energy is thought to be very large.

6.7.6 Extraction of raw materials at sea – deep-sea mining

The importance of mineral raw materials from deep-sea deposits is growing, prompted by a strong demand and rising metal prices. The principal raw material

Figure 74: North Sea: Uses¹⁷¹ and protected areas



169 Deposit water separated on the platform (separation of oil components).

170 Cuttings refer to the spoils left by drilling (fragments of stone), extracted via the drilling lubricant used.

171 Note: The chart does not contain any figures on fishing and protected areas outside of Natura 2000.

types are manganese nodules (polymetallic nodules), cobalt-rich iron and manganese crusts, together with massive sulphides and ore sludge. The manganese nodules are commercially attractive primarily because of their high contents of copper, nickel and cobalt. Among massive sulphides, alongside non-ferrous metals (copper, zinc and lead), the precious metals gold and silver are particularly important, together with trace metals such as indium, tellurium, germanium, bismuth, cobalt and selenium.

Deep-sea mining has a major impact on pelagic habitats and communities.

- ▶ Environmental damage on and in the sea floor as a result of the use of mining equipment: Overall pelagic communities are removed from their habitats together with the nodules. Recolonisation is not possible because the nodules are lacking as substrate.
- ▶ Formation of plumes by sediment stirred up during the use of mining equipment, which drift and disperse close to the sea floor, and then are deposited again as sediment in the direction of the current. This can bury bottom-dwelling organisms, such as sponges, due to sudden sedimentation.
- ▶ Creation of additional plumes on the surface or at medium water depths when the fine-grained transportation water (tailings) lifted together with the manganese nodules is returned. The contaminants therein contained are scattered in the sea and may accumulate in the food web, depending on their substance properties. Impairment of the phytoplankton may occur as a result of turbidity.

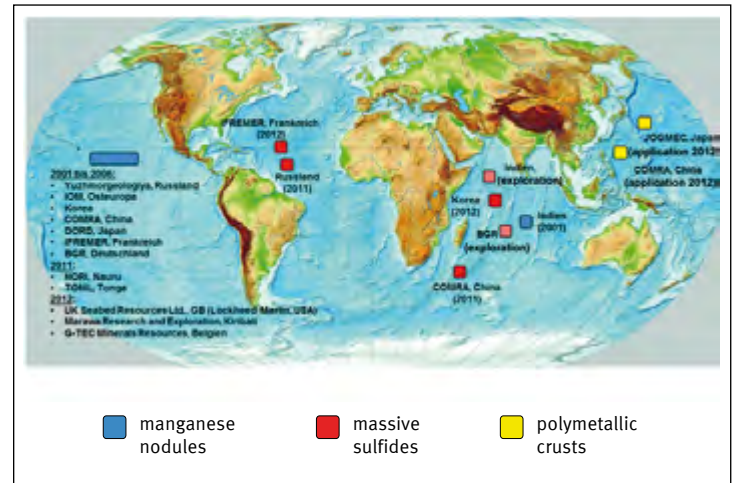
For this reason, the Federal Environment Agency recommends the development and use of environmental standards for the mining of marine metallic raw materials, in order to limit the aforementioned potential ecological risks. For example:

- ▶ Environmental impacts should be confined to the sea floor and water layers close to the sea floor.
- ▶ Potential mining fields should be ignored if they are too close together to allow the recolonisation of mined areas.
- ▶ Plumes of sediment arising close to the sea floor should be reduced by means of technical measures which induce the rapid deposition of agitated fine-grained sediment, for example by enclosing the mining equipment.

The United Nations Convention on the Law of the Sea states that the marine regions outside of the Exclusive Economic Zones (EEZ) and thus, their raw material resources in the sea floor are the heritage of all mankind. The International Maritime Bureau (IMB) based in Kingston (Jamaica) approves the allocation

of exploration and mining permits and monitors deep-sea mining projects. It has drawn up initial guidelines (Mining Codes) for the prospecting and exploration of manganese nodules, massive sulphides and ore crusts, including extensive environmental requirements.

Figure 75: Photograph and chart showing licenced territories



6.7.7 Fishing and marine aquaculture

Marine fisheries: A severe stress factor is changing

Short-term, yield-driven fisheries must be considered the most severe stress factor for the seas, given its adverse impacts on the marine ecosystem. Cautious estimates predict that unused discards of commercially fished species account for around 40 % of global fishing, at 38.5 million tons. These discards result, for example, from the fish caught being too small or from individual quotas having been exhausted already. According to the International Whaling Commission, some 650,000 seals and whales are by-catch and die in fishermen's nets worldwide each year. The OSPAR Commission describes fisheries as one of the main perpetrators of damage to marine habitats¹⁷².

According to the Council of Environmental Advisors (Sachverständigenrat für Umweltfragen, SRU), in 2011 only 11 of the 48 regulated fish stocks in Europe were not overfished¹⁷³. As per recent data from the EU Commission, the number of overfished stocks decreased from 47 % in 2012 to 39 % in 2013¹⁷⁴. Fish species such as the European eel or the southern bluefin tuna, however, remain at acute risk of extinction. 90 % of predatory fish are already lacking from the marine food web. Experts fear that commercially fished stocks worldwide could collapse by 2048 unless drastic changes are made to the way they are managed.

¹⁷² Quality Status Report (2010).

¹⁷³ SRU (2011) "Fischbestände nachhaltig bewirtschaften". Aktuelle Stellungnahme Nr. 16, p. 3.

¹⁷⁴ European Commission (2013): Communication from the Commission (COM). Consultation on fishing opportunities. COM(2013) 319 final. Brussels: European Commission, p. 11, Table 2.

Apart from the focus on short-term yield, this is due to the over-dimensioned fishing fleets and decades of excessively high catch quotas in defiance of scientific recommendations. Other reasons are the use of environmentally harmful, population-damaging fishing techniques, inadequate controls of fishing activities, and illegal fishing. The mismanagement can be blamed on the EU's fisheries policy, which was dominated by economic interests. Since the revised Common Fisheries Policy (CFP) entered into force in 2014, the following innovations are being pursued for a more sustainable and eco-friendly management approach:

- ▶ A ban on discards, which must be gradually enforced by the Member States by 2019, exceptions to which are rigorously controlled
- ▶ Professional management of fish stocks by 2015 and 2020 respectively, at levels which permit the maximum sustainable yield
- ▶ Annual analysis of Member States' capacities so as to ensure an equilibrium between fleet capacity and fishing opportunities
- ▶ Transparent distribution of fishing quotas based on ecological, social and economic criteria

EU fishing vessels will only be granted access to surpluses from third-party countries; EU regulations will also apply in external fishing.

Among assessed fish stocks, the situation appears to have gradually improved in recent years. The EU Commission believes that MSY (maximum sustainable yield) fishing is a realistic and achievable target, and therefore incorporated it into the updated CFP in 2013. In the North-East Atlantic, according to the EU Commission, the fishing of many pelagic stocks is now at MSY level. Meanwhile, in the Baltic Sea, negotiations by the Baltic Sea Fisheries Forum (BALTFISH) sent out a positive message in 2013. Sprat, cod in the eastern Baltic Sea and herring in both the western Baltic Sea and the Bothnian Sea are now fished at a level consistent with MSY. In the Mediterranean, according to studies during 2010–2012, 85 out of 113 stocks (i.e. 75 %) that are of interest to the EU were still being overfished¹⁷⁵.

Fishing activities must be adequately regulated, particularly in the NATURA 2000 areas of Germany's EEZ, in order to preserve endangered populations and habitats. The SRU believes that fisheries must be temporally and regionally restricted or even prohibited altogether in order to be able to meet the prescribed protection targets. This refers in particular to gillnet fishing in order to protect whales and seabirds, as well as to the use of mobile, ground-contact fishing equipment in areas with reefs and sandbanks.

The German fishing fleet is one of the smallest fleets in the European Union. According to the German Fishing Portal, as of 31 December 2012, it was comprised of 1,551 vessels with a total gross register tonnage of 63,701 and a total engine capacity of 146,058 kW. 320 vessels are dedicated to trawling and coastal fishing, and make up the core of the fleet, the majority (230 units) being beam trawlers. Small-scale coastal fisheries with passive fishing gear, such as gillnets and traps is practised almost exclusively on the Baltic Sea coast by a total of 1,174 vessels. The German fleet also includes nine deep-sea fishing vessels, 12 special vessels for catching mussels, and a further 36 small vessels for fishing species that are not quoted.

Aquaculture: Opportunities and risks

Aquaculture is the fastest-growing branch of the worldwide food industry, with growth rates averaging 8.4 % since 1970. In 2010, almost 60 million tons of fish and seafood were produced in freshwater and sea farms. Some 47 % of global production is now produced via the artificial farming of fish and other seawater and freshwater organisms. In many places, however, the intensive farming of fish and crustaceans poses major problems to the environment. Sustainable aquaculture cannot be guaranteed unless standards are observed.

Salmon farming in Norway and Scotland, for example, may imply eutrophication, together with toxic algal bloom in the narrow fjords or lochs, due to an over-supply of nutrients to the surrounding water as a result of food residues and excrement. The displacement of the wild salmon population due to the high escape rates among farmed salmon is also an ecological problem. The latter are generally stronger than their wild counterparts, and can furthermore transmit dangerous infections.

Overall, aquaculture in its current form contributes to the overfishing of the world's oceans. For example, up to four kilograms of wild fish are used as food to obtain one kilogram of salmon or cod. Tuna farming in the Mediterranean requires around 20 kilograms of protein per kilogramme of fish produced.

In Germany, mussel farming is the almost exclusive type of mariculture. Problems arise in particular with the extensive removal of seed mussels from natural stocks and the introduction of foreign breeding organisms from other regions. For example, farming of the Pacific oyster *Crassostrea Gigas* in areas of Holland and off the coast of Sylt has led to this species becoming established in the Wadden Sea and competing for habitats with the native common mussels.

There is no doubt that the importance of organic aquaculture is growing. Environmental organisations such as "Naturland" have been selling fish from organic aquaculture for some time now. Globally, in 2007 just 9,000 tons of fish was produced from

¹⁷⁵ European Commission (2013): Communication from the Commission (COM). Consultation on fishing opportunities. COM(2013) 319 final. Brussels: European Commission, p. 5.

organic aquaculture, primarily inland. This puts Germany in top place, but the volume produced is still minimal compared to fish from conventional farming. Drugs, hormones, growth accelerators and genetically modified ingredients in feed are prohibited in organic aquaculture. The fish have more space in the farms, and the proportion of organic fish food derived from plants is regulated. The essential animal protein component originates from the processing of fish for human consumption, which produces plenty of waste. Industrial fishing for the explicit purpose of fishmeal extraction is prohibited.

Activities by the EU and charitable organisations also help to support sustainable aquaculture. For example, in 2009 the EU Commission adopted the EU Organic Regulation implementing regulations for organic aquaculture¹⁷⁶. This is the first ever European-wide regulation on organic fish and seafood. Farmed fish bearing the new “Aquaculture Stewardship Council” (ASC) certificate were launched on the European market a few months ago. The ASC certificate was initiated by the World Wide Fund for Nature (WWF) in collaboration with various food retailers and fishing companies.

6.7.8 Marine litter

Litter is now found in marine and coastal habitats worldwide. From the pole to the equator, from coastal drift lines to estuaries, ubiquitously distributed over the sea surface down to the deep sea, even in the most remote and uninhabited regions of the Pacific archipelago, the detritus of our consumer society can be found everywhere.

Marine litter refers to all persistent, manufactured or processed materials which enter the marine environment either as discarded or ownerless material¹⁷⁷. This includes the transport of such materials into the oceans via rivers, discharges and wind.

Scientific evaluations of waste pollution in the North and Baltic Seas, as well as in other marine regions, conclude that plastics make up the bulk of this litter. On average, three-quarters of marine litter is comprised of plastics which take centuries to degrade. Calculations suggest that the world’s oceans are now polluted by between 100 and 142 million tons of waste. Each year, up to 10 million tons is added. Some 64,000 pieces of plastic waste now litter every square kilometre of the North Atlantic’s surface.¹⁷⁸ Three-quarters of the plastic pieces found on the beach of the German North Sea between 2002 and 2008 is

plastic and/or polystyrene¹⁷⁹. A comprehensive inventory has yet to be conducted for the Baltic Sea, but initial surveys indicate that here too, litter is dominated by plastics¹⁸⁰.

Plastics take centuries to degrade, and microorganisms are incapable of decomposing plastics fully. In addition to large-format waste such as plastic bottles and plastic bags, microplastics found in marine gyres, sediment and on beaches are increasing worldwide. Microplastics are defined as plastic particles less than 5 millimetres in size. These include secondary fragments arising from the breakdown of macroplastic parts such as packaging materials.

These “secondary microplastics” have to clearly be distinguished from those microplastic particles, being manufactured in microscopic sizes and used, for example, as granulates in cosmetics, hygiene and cleaning products, which enter the marine ecosystems directly as do basic pellets for subsequent production and fibres from textiles, as well as have to clearly be distinguished from marine litter.

On average, beaches in the southern North Sea are littered with 236 pieces per 100 metres of coastline¹⁸¹. Comparable quantities are found on heavily littered sections of beach on the German Baltic Sea¹⁸². Maritime activities, and particularly shipping and fishing, combined with leisure and tourism activities on the coast are the principal sources responsible for beach littering throughout the German North Sea¹⁸³. Surveillance flights over the German North and Baltic Seas have detected high densities of marine litter and a correlation between the density of shipping and the density of litter¹⁸⁴. The findings on the Baltic Sea coasts are primarily linked to losses from leisure and tourism activities on the coasts and rivers, while fishing activities also introduce substantial quantities of marine litter¹⁸⁵.

There is extensive documentation of animals becoming entangled in or swallowing marine litter, which could adversely affect their health or even kill them. A

176 Council Regulation (EC) No. 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No. 2092/91, OJ L 189, 1.

177 JRC 2010, Marine Strategy Framework Directive, Task Group 10 report Marine Litter, EUR 24340 EN-2010.

178 Law, K.L. et al., 2010, Plastic Accumulation in the North Atlantic Subtropical Gyre, Science Vol. 329 no. 5996 pp. 1185–1188.

179 Fleet, D.M., Untersuchung der Verschmutzung der Spülsäume durch Schiffsmüll an der deutschen Nordseeküste-Untersuchung der Müllbelastung an den Spülsäumen der deutschen Nordseeküste, 2003, Umweltbundesamt, FKZ 202 96 183, p. 166; Fleet, D.M., Untersuchungen der Verschmutzung der Spülsäume durch Schiffsmüll an der deutschen Nordseeküste-Auswertungen der regelmäßigen Untersuchungen der Verunreinigung der Spülsäume durch den Schiffsverkehr auf Kontrollstrecken der Nordsee, Umweltbundesamt, 2007, FKZ 204 96 100.

180 MARLIN, 2013: www.projectmarlin.eu

181 OSPAR, Quality Status Report 2010: <http://qsr2010.ospar.org/en/ch01.html>

182 UNEP, Marine Litter in the Baltic Sea region, Assessment of the marine litter, 2007; MARLIN, 2013: www.projectmarlin.eu

183 Fleet, D.M., see above, UNEP, Marine Litter: Global challenge 2009, Interview et al. 2013.

184 Herr, H., Vorkommen von Schweinswalen in Nord- und Ostsee – im Konflikt mit Schifffahrt und Fischerei? Dissertation, 2009.

185 HELCOM GEAR 2/2012, Document 3/8, Werner, S., Korpinen, S., Monitoring and Assessment of Marine Litter: Progress of Work. Planning Monitoring and Actions for Marine Litter in the Baltic Sea, www.helcom.fi; UNEP2009, see above; Interview, E. et al., Issue Paper to the “International Conference on Prevention and Management of Marine Litter in European Seas”, 2013, www.marine-litter-conference-berlin.info

recent analysis of the available study results in 2012 found that interactions with marine litter had been documented in 663 species worldwide. More than half of these reports documented animals becoming entangled in marine litter or swallowing litter pieces. This represents a 40 % increase compared with the most recent analysis of 1997, which recorded 247 affected species. Harmful chemicals may enter the food chain as a result of swallowing micro plastics.

Comprehensive data records from Germany's seas (including the North Sea) covering several years are available regarding plastic pieces in the stomachs of Northern fulmars. Analysis revealed that 95 % of beached birds had an average of 30 plastic pieces in their stomachs. Furthermore, during the 2005 breeding period, all of the 200 breeding pairs' nests in the colony on Helgoland contained plastic litter, particularly net fragments, in which numerous animals are strangled to death each year.

Marine litter is also a socioeconomic problem. Beaches and diving areas are spoilt by waste. There is a danger to human health and safety, for example if divers or propellers become entangled in the remainders of fishing nets, lines or similar. Last but not least, removing litter from the beaches is expensive; each year, the coastal communities in East Holstein face costs of between 750,000 and 1.2 million Euros in this connection¹⁸⁶.

The oceans also featured heavily on the agenda of the UN Summit "Rio + 20". The concluding resolution "The Future We Want" cites reducing the volume of marine litter as one of its objectives. Article 163 of the Resolution states that: "We further commit to take action to, by 2025, based on collected scientific data, achieve significant reductions in marine debris to prevent harm to the coastal and marine environment".

Ahead of Rio + 20, the United Nations Environment Programme (UNEP) in collaboration with the US government authority NOAA initiated a global strategic action plan to tackle marine litter, known as the Honolulu Strategy. On behalf of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and in collaboration with the European Commission's Environment DG, in April 2013 the Federal Environment Agency staged an International Conference on Prevention and Management of Marine Litter in European Seas, as Europe's contribution to the implementation of the Honolulu Strategy and the Rio + 20 resolution. The aim of the conference was to initiate or update regional action plans for the European marine regions (North-East Atlantic, Baltic Sea, Mediterranean and Black Sea) to prevent further inputs and to reduce existing litter. Suitable measures and current initiatives to prevent marine littering were

also documented and made available to facilitate a broad exchange of information between European Member States (www.marine-litter-conference-berlin.info). The Conferences culminated in the "Message from Berlin", a joint statement stressing the urgency of implementing solutions to the problem of marine litter and identifying priority action areas.

This includes the need for the complete implementation and updating of existing statutory provisions, the expansion of sustainable consumption and production structures, and greater producer responsibility. Supporting measures are needed to significantly reduce inputs from fisheries and shipping, such as the provision of adequate port reception facilities for ship-generated wastes.

Other points in the Declaration include enhancing our scientific understanding e.g. of the sources and impacts of marine litter, deriving ambitious targets for reducing the littering of the environment, the need for close collaboration at a global, regional and sub-regional level, and ecologically useful cleaning measures to remove litter from the marine environment. It is also important to raise awareness of this topic and to transform perceptions, so that waste is no longer seen as litter but as a usable resource.

The core aspect of developing regional action plans had already been successfully initiated. An action plan was adopted for the Mediterranean to reduce and limit marine litter; in the North-East Atlantic; the responsible parties are currently working intensively on this, with a view to completion by summer 2014; and an action plan for the Baltic Sea is due to be followed by 2015.

6.7.9 Underwater noise

Water is a good transport medium for sound. Acoustic waves move four times faster through water than through air. It is becoming increasingly noisier in the world's oceans as a result of anthropogenic noise. The "silent ocean" no longer exists. In the North and Baltic Seas, too, particular importance is attached to underwater noise among the various forms of energy inputs, because unlike heat, light or electromagnetic energy, whose effect is generally local, its impacts are spread over a large area.

Natural sound sources such as wind, waves and surf form the background noise in the sea. This natural "acoustic landscape" is joined by continuous anthropogenic noise input, including operating offshore wind farms, shipping traffic and other users, such as hopper-dredgers for sediment extraction. Shipping in general plays a particularly important role in this connection (see [chapter 6.7.2.2](#)). Together, these wide-band and generally low-frequency sound levels make up the marine region-specific background noise level.

¹⁸⁶ Kieler Nachrichten, EU hilft deutschen und dänischen Ostseebädern bei der Strandsäuberung, 14.12.2006.

In addition, temporary, pulse-like noise inputs can temporarily and often significantly increase the noise pollution in a marine region, e.g. via echo-sounders, fish sonar, pile-driving for the foundation structures of offshore wind farms, and munitions explosions.

In order to achieve a good environmental status, the EU Marine Strategy Framework Directive stipulates that the input of energy, including underwater noise, should remain within limits that do not have a negative impact on the marine environment. In order to achieve this target, it is important to ensure that the noise levels of the German North and Baltic Seas do not adversely affect the living conditions of the animals concerned. This means that all activities and uses that make noise must not significantly impact the marine environment.

Functioning, healthy hearing is vital for many marine creatures, such as marine mammals. In particular, toothed whales such as the native porpoise, which use echolocation based on high-frequency signals, are highly dependent on hydroacoustic signals for their orientation, communication, foraging, reproduction and avoidance of predators. Auditory impairments caused by temporary or permanent threshold shifts are therefore critical. Dual noise protection limits recommended by the Federal Environment Agency to protect harbour porpoises from pile-driving noise during the construction of offshore wind farms state that a peak sound level of 190 dB and a sound exposure level of 160 dB at a distance of 750 metres from the sound source must not be exceeded. These limits are already applied in the licensing of offshore wind farms.

At present, there is inadequate understanding of the actual extent of noise pollution in the North and Baltic Seas. The Federal Environment Agency (Umweltbundesamt, UBA) is therefore supporting a research project to develop software which will allow an individual and overall assessment of the natural and anthropogenic noise events occurring, based on real measurements. The aim is to illustrate their distribution and spread on interactive maps. Based on this, the biological impacts of both singular and cumulative noise inputs on selected marine mammals can then be depicted.

6.7.10 Cooling water

Cooling water is needed for many production processes and for energy extraction, since the primary energy carriers used, such as coal, cannot be converted entirely into electrical energy. In order to ensure the maximum possible efficiency during energy extraction, the heat generated must be removed from the process by means of cooling water. According to publications by the Federal Statistical Office, in 2010 around 25.2 billion m³ of fresh water were used to cool production processes and to generate electricity. Electricity generation alone accounts for around 80 % of the cooling

water used, at 20.4 billion m³. Most of the fresh water used is taken from rivers, lakes and reservoirs, as well as from bank filtrate and groundwater. After cooling, the water used is returned to the waterbody at an increased temperature. A certain proportion of cooling water evaporates during use; in the case of electricity generation this figure is around 3 %¹⁸⁷.

The water temperature is of crucial significance for the living conditions of all aquatic organisms. Most aquatic organisms are unable to control their own body temperature – in other words, all physiological processes are dependent on the ambient temperature. The direct negative impacts of increased water temperatures range from heat-related death, to organ damage, the displacement of egg-laying periods or disruption to feeding, through to the migration of species. Waste heat discharges from power plants can create thermal barriers which influence the migratory behaviour of fish. A number of indirect impacts, such as changes in the species spectrum or the encouragement of non-native species, can also result. As the water temperature increases, the solubility of oxygen decreases. Bacterial turnover and self-purification increase as the temperature rises, which in turn uses additional oxygen. If the level of pre-contamination with organic substance is high, a temperature increase can lead to critical oxygen concentrations, and potentially to fish mortality.

Figure 76: Cooling water discharge from a power plant



Photograph: Erik Schumann/Fotolia.de

Depending on the outflow conditions and water region, the abstraction of cooling water may be of varying intensity, but always represents an ecological pressure for the waterbody. The water authorities must therefore have a precise knowledge of the ecological status of the waterbody when licensing the use of cooling water. Key values include specification of the maximum waterbody temperature and limiting the

¹⁸⁷ Federal Statistical Office "Wassernutzung nach Einsatzbereichen der nichtöffentlichen Wasserversorgung 2010", in Statistisches Jahrbuch 2012 Wiesbaden 2012.

admissible temperature increase range. This describes the maximum tolerable deviation from the unimpaired temperature in the waterbody. Annex 6 to the Surface Waters Protection Ordinance (OGewV)¹⁸⁸ prescribes these values for watercourse types and the fish communities that occur in them. The abstraction of cooling water must not threaten a good ecological status. For a comprehensive evaluation of a cooling water discharge, it is necessary to consider the discharge of heat into the entire river basin. A recent LAWA guidance document provides an overview of the necessary background information and represents an important basis for the assessment of cooling water discharges into waterbodies from a water resources management and hydro-ecological viewpoint¹⁸⁹.

Water temperatures are expected to rise alongside rising air temperatures during the course of climate change. This means that the ecological problems associated with the use of cooling water will increase in future.

6.7.11 Leisure use of waters

Social changes (more leisure and higher disposable income) in recent decades have also led to changes in demand regarding the recreational use of waters, and German water protection policy must address the impacts of these changes.

Waters are ascribed a high leisure and experience value, which results in intensive and varied uses of waters including the associated infrastructure development (e.g. camp sites, marinas, bathing sites). This results, firstly, in opportunities for the general public to identify more readily with their waters, but also leads to significant potential for conflict vis-à-vis water protection and nature conservation.

Whereas recreational uses of waters were once primarily confined to the activities “bathing/swimming” and “sailing/canoeing/rowing”, these have been joined over time by a range of other activities associated with technological developments in sports equipment, such as surfing, angling/fishing, water touring, motor-boating, jet skiing/water bobsledding, river rafting, canyoning, water skiing, motorboat-towed paragliding, white-water rafting and diving/snorkelling.

The intensification and diversification of water-related leisure activities, and the related infrastructural development of transitional areas, can result in ecological stress for these bodies of water. Potential areas of conflict associated with the increase of boat traffic on inland waters include:

- ▶ The modified design of the exhaust pipe for motorised sports boats. Whereas in the past the exhaust gases were discharged above the surface of the water and not mixed with cooling water, in present-day outboard engines the exhaust gases are discharged below the waterline through the screw, which mixes them up with the surrounding water. In boats with inboard engines, the exhaust gases are mixed with the engine cooling water. Both systems cause greater pollution of the surrounding water.
- ▶ The intensive travelling over marginal bank areas and the waves created by motor boats and other motorised sporting equipment leads to impairments of the bank vegetation and bank reinforcement, as well as to disruption of the animals which live and breed in the bank area.
- ▶ A considerable number of leisure craft have chemical toilets, some of which discharge into the water. This additionally exacerbates pollution and eutrophication of the water and kills water-relevant microorganisms. The same applies to disposal of oily bilge water.
- ▶ The anti-fouling paints currently used in marine shipping work on the principle of a continuous discharge of a toxic, growth-preventing active ingredient into the waterbody surrounding the vessel. This may be copper, but increasing use is also being made of silicone paints or hard coatings to reduce the ability of organisms to adhere.
- ▶ The noise emitted by motor boats and other motorised sports equipment can impair human health and disrupt the fauna species living in and on the water.

In order to reconcile the conflict between leisure interests on the one hand, and water protection and nature conservation interests on the other, there is a need for suitable control and planning instruments as well as the application of administrative law – as in the case of jet skis, the areas for which are strictly regulated.

Initial attempts at mediation in the conflict area “water protection versus leisure use” have, at least in the field of organised sport (clubs), promoted a realisation and readiness to accept that “ecologisation of water sports” or their “water-compatible design” is vital for safeguarding water quality and minimising water pollution in Germany.

Examples of initial approaches include the following:

- ▶ Embodiment of environmental and water protection considerations in the rules of sports clubs,
- ▶ Promoting awareness of ecological problems within sports clubs and among private service-providers and tourist organisations, by means of more widespread public education

¹⁸⁸ Ordinance on the Protection of Surface Waters (Surface Waters Ordinance – OGewV) of 20 July 2011, Federal Law Gazette (BGBl.) I page 1429.

¹⁸⁹ LAWA (2012): Grundlagen für die Beurteilung von Kühlwassereinleitungen in Gewässer, as at 31.07.2012.

- ▶ Devoting greater attention to water protection issues in the planning and construction of water sports facilities on the basis of close cooperation between local planning authorities, sports clubs, tourist organisations and (private) service-providers
- ▶ Minimising water pollution by existing water sports facilities by means of ecological redesign,
- ▶ Ensuring that club-related sporting activities are tailored to the ecological conditions of the water
- ▶ Encouraging the active participation of sports clubs in the designation and management of water protection and nature conservation areas, in order to identify and, if possible, address conflicts at an early stage.

Reductions in water pollution have already been achieved by technical means as well. These include:

- ▶ Collection and special disposal of the water from hull cleaning on land,
- ▶ Much reduced use of “antifouling paints” in favour of less problematic types,
- ▶ Disposal of bilge oil in suitable facilities on land,
- ▶ In some cases, use of catalytic converters to reduce pollution due to exhaust gases from motorboats.

6.7.12 Bathing water

Bathing and swimming are among the most popular leisure activities in Germany. Bathing waters on rivers and lakes and along the North and Baltic Sea coasts attract large numbers of visitors in the summer months. Swimming is also good for one’s health, as it uses many muscle groups. This not only improves circulation and is good cardio-vascular exercise; it also helps improve posture, eliminate tension and eases joint problems.

Avoidance of health risks

However, bathing in natural waters may also entail a number of potential health risks, ranging from cuts and abrasions to drowning. The water itself can cause illnesses with fever, vomiting and diarrhoea if certain pathogens – for example from sewage discharges or agricultural runoff – enter the bathing water.

Nutrients are also discharged together with the sewage, particularly phosphorus and nitrogen compounds, which lead to a mass development of algae (algal bloom). Cyanobacteria (formerly known as blue-green algae), in particular, form toxins and allergens which may cause skin rashes and, in rare cases, poisoning. Furthermore, where the water is very turbid, apart from being an aesthetic problem, efforts to save someone who is drowning may be hampered.

In order to minimise and control the health risks associated with waterbodies, official inland and coastal bathing waters are monitored prior to and during the bathing season. In Germany, this is organised at Federal land level. Since the 2008 bathing season, bathing waters have been monitored in accordance with the new EU Bathing Waters Directive (Directive 2006/7/EC). In order to protect bathers from infectious diseases, this Directive requires the regular analysis of two microbiological parameters as indicators of pathogens: the bacteria *Escherichia coli* (*E. coli*), and intestinal enterococci. These usually harmless bacteria occur in the intestines of humans and animals. They enter waters through wastewater containing faecal matter, and are an indicator of such contamination. The EU Directive stipulates that bathing waters must not contain more than 900 *E. coli* bacteria or 330 intestinal enterococci in 100 ml of water in order to meet a sufficient quality (based on a 90 percentile analysis). More stringent limits apply to good and excellent bathing waters (on the basis of a 95 percentile analysis). After four bathing seasons, i.e. since the 2011 bathing season, the quality of bathing waters can be assessed under the new Directive.

Better health protection for bathers under the new EU Bathing Waters Directive¹⁹⁰

The new Directive contains some important new features for the improved protection of bathers, and calls for a comprehensive information and participation of the general public. One central aspect is that it requests transition from passive monitoring to active management of bathing waters via the compilation of so-called bathing water profiles, which include contamination sources that could influence the quality of the water, as well as any potential problems with cyanobacteria. These bathing water profiles must be available for all bathing waters by 2011. By the end of the 2015 bathing season, all bathing waters must at least have attained “sufficient” quality.

Annual reports on the status of bathing waters¹⁹¹

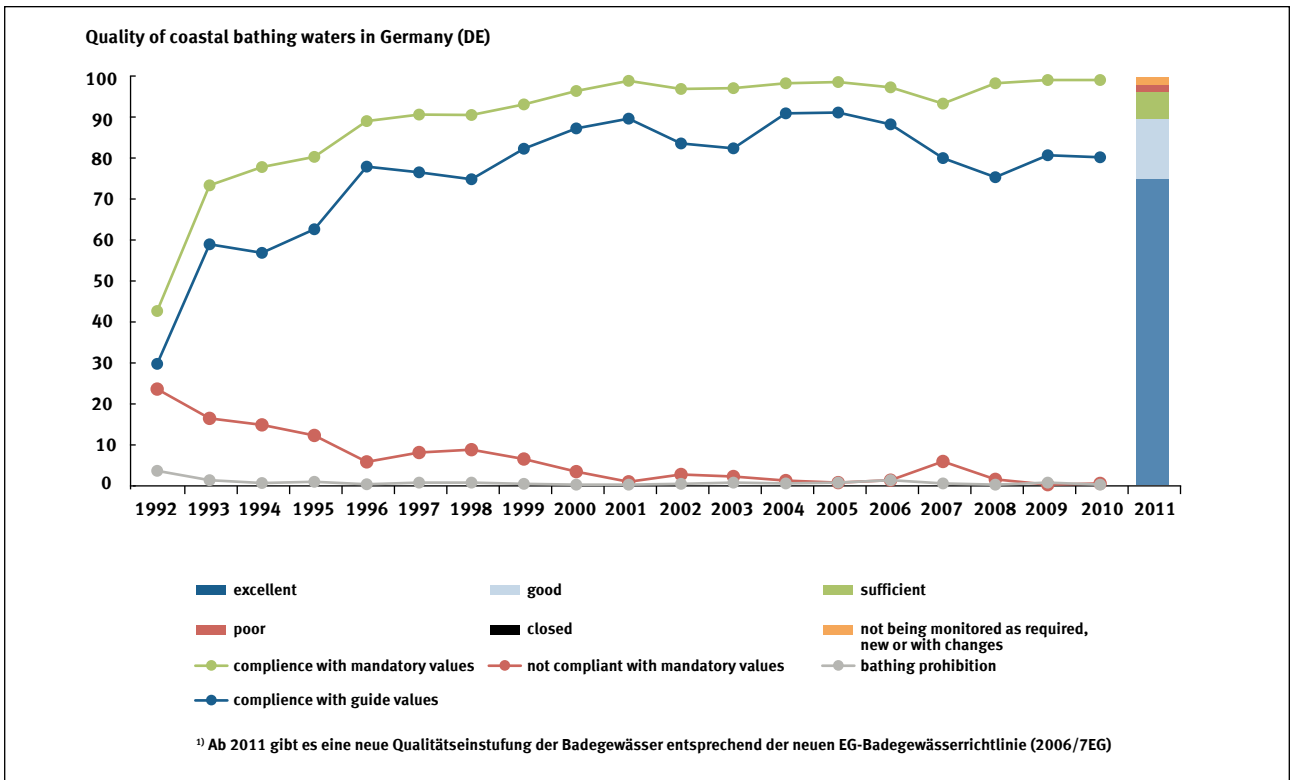
Each year in May/June, the European Commission publishes a report on the “Quality of Bathing Water” for the previous year’s bathing season. This is based on data on the hygienic quality of bathing waters collated by the Member States. In Germany, the data collected by the Länder is collated and checked by the Federal Environment Agency (UBA) and forwarded to the European Commission via the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

In Germany, a total of 2,310 bathing waters were monitored under the Bathing Waters Directive in 2011,

¹⁹⁰ Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality, OJ L 64, p. 37 ff.

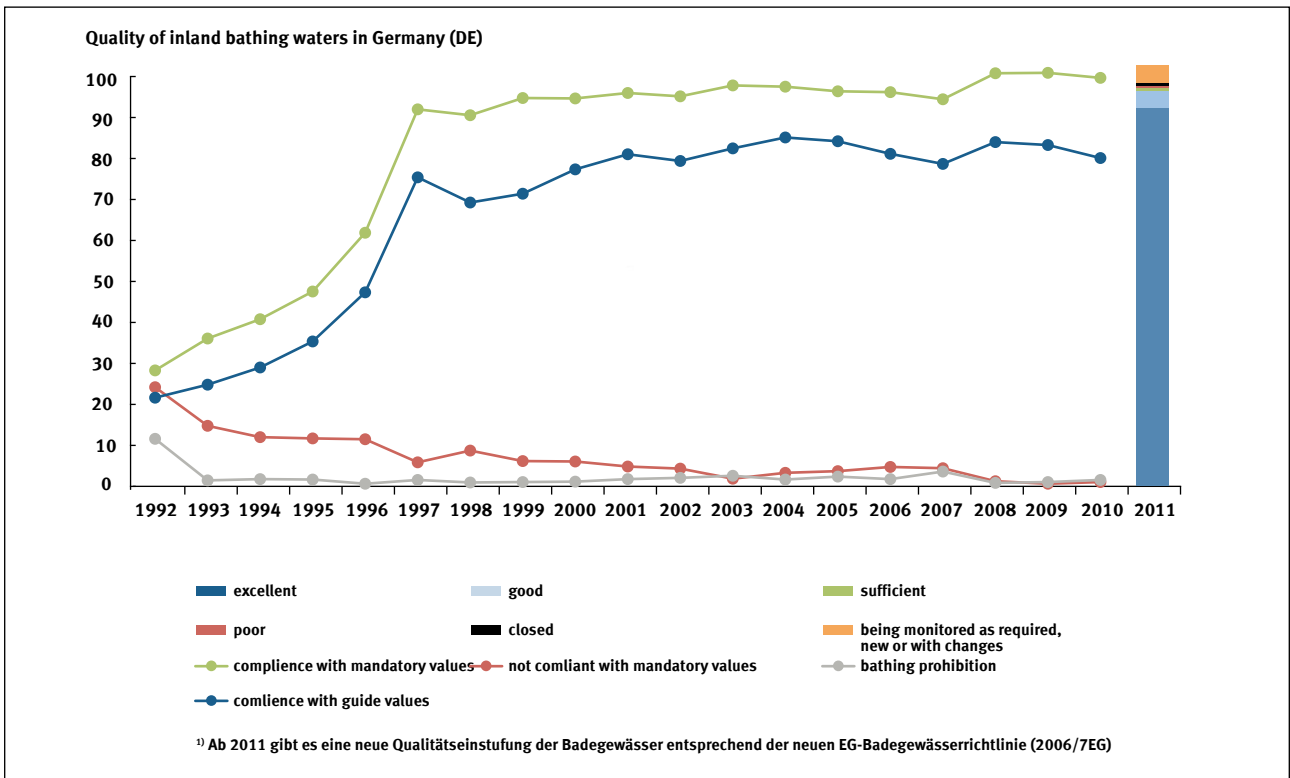
¹⁹¹ The most recent report for the 2008 bathing season is available for downloading on the website of the European Environment Agency (EEA): <http://www.eea.europa.eu/de/publications/qualitat-der-badegewasser-badesaison-2008>

Figure 77: Quality of coastal bathing waters in Germany, 1991 to 2011



Source: Federal Environment Agency (UBA)

Figure 78: Quality of inland bathing waters in Germany, 1991 to 2011



Source: Federal Environment Agency (UBA)

including 372 coastal bathing waters. Compared with the 2007 bathing season, a total of 418 additional bathing waters were reported.

Between 1992 and 2001, the number of cases where the guideline values and limits were exceeded, and hence of contamination of waters, continuously decreased (cf. **Figures 76** and **77**). Since 2001, the quality of bathing waters has remained consistently high. On average, 95 % of inland bathing waters met the microbiological parameters of the Directive, and 80 % the more stringent guideline values for very good water quality. Among coastal bathing waters, the figure was as high as 98 % and 85 % respectively for very good quality.

In the 2011 bathing season, 98.5 % of assessed bathing waters in Germany met the quality requirements of the EU Bathing Waters Directive. Almost 91 % of them also met the more stringent requirements for excellent quality and 5.9 % for good quality. This figure does not include new or modified bathing waters that have not yet been assessed.

In Germany, there were 69 new and 11 modified bathing waters in the 2011 bathing season. In the EU Commission's (COM) Bathing Waters Report, these are included in the total number of bathing waters, producing lower values for the percentage of excellent bathing waters (87.8 %) and bathing waters which meet the quality requirements of the EU Bathing Waters Directive (95.1 %).

Under the EU Bathing Waters Directive, inland bathing waters are assessed less stringently than coastal bathing waters. This is scientifically controversial, but has been so defined in the Directive. According to this definition only 76.7 % (75.3 % according to COM) of assessed coastal bathing waters meet an excellent quality, compared with 93.7 % (90.2 % according to COM) of inland waters. This is particularly problematic for bathing waters in the mouths of coastal rivers such as the Elbe or the Schlei, which tend not to have a very good water quality. In line with the WFD, since the 2008 bathing season such waters have been managed as coastal waters (WFD: transitional waters) rather than inland waters, as was previously the case, and are therefore assessed more stringently than bathing waters on the same river but further inland.

In the 2011 bathing season, only 15, i.e. 0.6 % of the 2,310 bathing waters exhibited a poor water quality. 23 bathing waters were temporarily closed or closed for the entire 2011 bathing season. Temporary closures occurred primarily as a result of problems with cyanobacteria (blue-green algae). The main reasons for longer closures were refurbishment work or changes of use. Only a few bathing waters were permanently closed due to poor water quality.^{192 193}

¹⁹² A summarising overview of the quality of each bathing water in Europe may be found on the European Environment Agency (EEA): <http://www.eea.europa.eu/themes/water/status-and-monitoring/state-of-bathing-water/bathing-water-data-viewer> and a report on the quality of bathing waters: <http://www.eea.europa.eu/www/de/publications/qualitat-der-europaischen-badegewasser-2011>

¹⁹³ Many Länder also publish up-to-date data during the bathing season. An overview of their offerings can be found on the following UBA website: <http://www.umweltbundesamt.de/gesundheit/badegewaesser/index.htm>

7 Glossary

Runoff	The proportion of precipitation that runs off into rivers and streams. It is measured as the volume of water per unit of time, and is quoted in cubic metres per second (m ³ /s). Runoff is measured indirectly via the speed of the water. Such measurements are carried out at large intervals with different water levels. From this data, a runoff curve is generated. Via this runoff curve, it is possible to allocate a runoff to every measured water level.
Elutriation	Procedure whereby substances contained in the topsoil are dissolved in rainwater and diffusely enter surface waters together with the surface runoff.
Wastewater	The water modified by domestic, industrial, commercial, agricultural or other forms of use, as well as the water that continuously runs off with this in the sewer system, and the precipitation that runs off from developed or sealed land.
Inorganic	Relating to the inanimate part of nature; in the natural sciences in general, refers to bodies derived directly from mineral substances, as compared to substances originating from the plant or animal kingdom (organic).
Anthropogenic	Caused by man.
Arid	Description of a climate zone in which the potential evaporation exceeds the annual precipitation. This results in a low level of humidity.
Estuaries	River mouths. Many of the rivers that flow into the North Sea have formed funnel-shaped mouths (estuaries) under the influence of the tides. On the German North Sea coast, this applies to the mouths of the Eider, Elbe, Weser and Ems. A natural area of brackish water and turbidity is formed, in which considerable quantities of sand and dead suspended matter is deposited and forms sand or silt sediment. Estuaries are transitional waters.
By-catch	By-catch refers to marine fauna which is caught in the net but is not part of the desired target catch. Most of these animals die painful deaths in the nets. They include many endangered species such as sharks and sea turtles, as well as seabirds and dolphins.
Flood level (HQ)	A certain flood event used as a basis for planning flood alleviation measures such as dykes. For example, HQ100 is a flooding event that will occur with a probability of once in 100 years. The variables “water level” and “runoff” allocated to this event will determine the height of a dyke dimensioned according to HQ100.
Benthos	Totality of organisms living on and in the soil of a waterbody.
Bentonite	Bentonite is often used as a rinse additive to stabilise drilled holes and to seal wells. As bentonite is readily pumped, it is also used to backfill geothermal heat probes. Bentonite is capable of binding large quantities of water; water-saturated bentonite will liquefy if the structure collapses under mechanical movement, and then forms a solid structure again when movement stops.
Management plan	Central control element for implementing the WFD; contains an analysis which must be regularly updated, site-adapted monitoring programmes, and binding programmes of measures for achieving the management/environmental objectives; from 2009 onwards, a management plan must be created every six years for every river basin.
Inland waters	All stagnant or flowing waters on the earth's surface and all groundwater on the landward side of the base line from which the width of sovereign waters is measured.
Bioaccumulation	Accumulation of substances in organisms, both from the ambient medium and via food.
Brackish water	Fresh water in estuaries that is mixed with seawater, containing high levels of bacteria.
Chemical status	As defined in Directive 2000/60/EC, the chemical quality of bodies of surface water and groundwater; defined by pollutant limits set by the EU; in the case of bodies of groundwater, other aspects of chemical quality must also be taken into account; the Directive makes a distinction between good and poor chemical status.
Colibacteria	Bacteria that live in human and animal intestines. Evidence of colibacteria in drinking water is an important indication of contamination with faecal matter and the possible presence of other pathogenic organisms.
Denitrification	Decomposition of nitrate into nitrogen and oxygen caused by bacteria. The bacteria remove the oxygen, while the nitrogen is absorbed by the air.
Direct dischargers	Direct dischargers refer to all municipal and industrial/commercial operators of wastewater treatment plants (sewage purification plants) that discharge purified wastewater directly into a waterbody.
Drainage	Discharge of soil water (dehydration) with artificial hollows or ditches into a body of surface water.
Fertilization Ordinance	Regulations governing good agricultural practice with the application of fertilizers, including transposition of the Nitrate Directive into national law.
Passability (also known as biological passability)	Migration option for fauna in a watercourse. Transverse structures such as weirs interrupt passability. Diversion streams and fish ladders restore the connection.
River basin	An area of land from which all surface run-off from surface waters flows into the sea at a single river mouth, estuary or delta.
Emission	Release of solid, liquid or gaseous substances which are harmful to humans, animals, plants, air, water or other environmental media.

Epidemiology	The study of epidemics or of the spread of diseases or pathogenic organisms.
Erosion	The wearing away of soil or rock, primarily due to the effects of water.
European Water Framework Directive 2000/60/EC (WFD)	Directive in force since December 2000 on the protection of European waters. The aim of the WFD is to manage the catchment areas of rivers and lakes and groundwater reserves in such a way that an existing very good or good status is maintained, or a good status is achieved. The WFD includes a detailed timetable for implementation of the water management requirements. For example, by 2015 all surface waters must have attained an ecological (biological and morphological) and chemical good status, and groundwater must have achieved a good chemical and quantitative status.
Eutrophication	Increase in plant production (algal bloom and large populations of aquatic plants) in waterbodies due to a high supply of nutrients. This is caused, for example, by discharges from agriculture or wastewater discharges.
River basin district	A main unit for the management of river basins defined as an area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, as defined in Article 7, paragraph (5), sentence 2 of the Federal Water Act (WHG).
River regulation	Correction of the course of a river to benefit agriculture, shipping, human settlements and hydropower use by means of river straightening, bank reinforcement and riverbed obstruction. Excessive depth erosion is prevented with the aid of transverse structures, low weirs, drop structures, weirs or dams.
Geothermal energy/geothermia	This term is derived from the Greek words geo = earth and therme = heat, meaning heat from the earth. Energy stored below the earth's surface in the form of heat (synonym: ground heat).
Waterbed	Comprises the waterbody bed and the bank as far as the top edge of the escarpment.
Waterbody management	Management of surface and underground waters. The emphasis here is on preserving or restoring the ecological balance in conjunction with the simultaneous optimum supply of drinking water and service water to the general public and/or to industry.
Water quality	Quality of a waterbody evaluated according to prescribed bio-chemical criteria.
Waterbody structure (hydromorphology)	The form diversity created by the natural flow process (undercut-slope banks and slip-off slope banks, meanders, gullies and islands) in a waterbed. The waterbody structure is decisive for ecological function: The more diverse the structure, the more habitats are available for fauna and flora.
Waterbody type	Waterbodies of a similar size, altitude, morphology and physico-chemistry in the same region are distinguished by similar aquatic communities. This allows individual waterbodies to be grouped together into waterbody types. The reference status which forms the reference point for biological evaluation is defined by the biological, chemical and hydromorphological properties of a waterbody type.
Waterbody monitoring	Waterbody monitoring is (usually) carried out by the water management authorities, either continuously or on a random sample basis. These controls are designed to monitor waterbody quality and promptly identify any irregularities.
Waterbody maintenance	Waterbody maintenance refers to the shaping and development of a waterbody and its banks and flood plains according to biological and landscape management aspects.
Groundwater	Underground water in the saturation zone that is in direct contact with the soil or subsoil. It fills the hollows in the earth's crust (pores, chasms etc.) in a cohesive manner. It is at a pressure equal to or greater than the atmosphere, and its movement is determined by gravity and frictional forces.
Body of groundwater	A demarcated volume of groundwater within one or more groundwater aquifers.
Groundwater aquifer	Loose (e.g. gravel, sand) or solid stone (e.g. chalk, sandstone), whose cohesive hollows (pores, chasms) are sufficiently large to allow water to flow through them easily. By contrast, rocks with very small or non-cohesive pores (e.g. clay) are groundwater inhibitors.
Groundwater recharge	New groundwater created from the seepage of precipitation.
Groundwater Directive	EC daughter directive on the protection of groundwater from contamination and deterioration.
Groundwater storey	A sequence of communicating groundwater aquifers.
Habitat	The natural home of a plant or animal.
Flooding	According to the Federal Water Act, flooding is the temporary coverage of land not normally covered with water by surface waters or by seawater penetrating in coastal regions.
Flood protection plans / flood risk management plans	Such plans aim to minimise, as far as possible, the risks of a flood expected to occur statistically once in 100 years. For example, the plans may contain measures such as: conservation and recovery of retention areas, relaying of dykes, conservation and recovery of water meadows.
Humid	Description of a climate zone in which the annual volume of precipitation exceeds the evaporation capacity. This results in a high level of humidity.
Immission	The effects of air contamination, pollutants, noise, radiation etc. on humans, animals, plants, air, water and other areas of the environment.
Indirect discharger	All industrial and commercial operations that discharge wastewater into a public sewer or public sewage treatment plant. Pre-treatment may be necessary, depending on the composition of the wastewater.
Cascade	In a sewage treatment plant, cascades are reactors consisting of reaction rooms through which the wastewater passes in sequence, and are used, for example, for ventilation in water processing.

Sewage treatment plant	Plant for the purification of industrial and household wastewater. Depending on the properties of the waste water, the design and capacity of the sewage treatment plant, wastewater purification is comprised of a mechanical stage (stage 1), a biological stage (stage 2) and a subsequent stage (stage 3). Mechanical purification also removes trace and suspended matter. It uses physical properties to retain the undissolved substances contained in the wastewater. In stage 2, the wastewater which has usually been pretreated mechanically is purified with the aid of microorganisms. In the subsequent stage, further substances such as phosphates and heavy metals are precipitated and flocculated via the use of chemicals, and thereby removed from the water.
Sewage sludge	Term for the sludge from sewage treatment plants that has rotted or been stabilised in some other manner. Sewage sludge from domestic wastewater contains a wealth of nutrients and humus, and under certain circumstances can be used as a fertiliser. Depending on the type of wastewater and treatment technique, sewage sludge may contain substances that are harmful to the environment and/or human health.
Coastal waters	The sea between the coastal line at mean flood level or between the seaward limit of surface waters and the seaward limit of coastal waters.
Coastal zone	The coastal zone is a dynamic and natural system which extends seawards and landwards from the coastal line. The boundaries are determined by the geographical expanse of the natural processes and anthropogenic influences occurring there. In the coastal zone, as a unique and limited component of the physical environment, there is a complex interrelationship between the land and the sea.
LAWA	The Bund-Länder-Arbeitsgemeinschaft Wasser (LAWA) is a working body of the Conference of Environment Ministers (UMK) within the Federal Republic of Germany. Members of LAWA are the heads of department of the supreme Land authorities for water management and water legislation in the Federal Länder, and since 2005 the Federal Government, represented by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). http://www.lawa.de
Legionella	Legionella are rod-shaped bacteria that live in the water. They can occur in both fresh water and salt water. Because of their natural dispersion, they also occur in small quantities in drinking water. There are various different measures for avoiding legionella, such as chemical and thermal disinfection.
Limnology	The study of inland waters, research and study of stagnant and flowing inland waters and groundwater, particularly substance balance.
Macrophytes	Aquatic plants visible to the naked eye.
Macrozoobenthos	Invertebrates visible to the naked eye that live on the water bed.
Mixed water	Wastewater collected in mixed water. This includes household wastewater, commercial and industrial wastewater, foreign water (groundwater that has seeped into the sewer system) and precipitation water.
Modal split	In transport statistics, the distribution of transport volumes among various modes of transport.
Monitoring	Observation or monitoring of natural phenomena to obtain data and knowledge, to test hypotheses, and to aid understanding thereof.
Morphology, morphological	In general, the study of constellations, forms, shapes and structures. Here: The course of a river; its width and depth, its bed and banks, and the properties of the adjoining land.
NATURA 2000	The NATURA 2000 network refers to a transnational system of protected areas within the European Union. It comprises the protected areas under the Habitats Directive of 1992 and the protected areas pursuant to the Birds Directive of 1979. Accordingly, NATURA 2000 areas are areas of Community importance or Special Protected Areas within the European Union that have been designated by the European Union Member States.
Low water	Low water refers to the water level of waterbodies that is below the defined normal level. It is necessary to distinguish between low water in a tidal area and in inland waters.
Surface waters	Inland waters (with the exception of groundwater) plus transitional waters and coastal waters; sovereign waters are exceptionally included for the purposes of chemical status.
Off-shore	Abbreviated term for the exploration of petroleum and natural gas reserves off the mainland coast, on the continental shelf, and in large inland waters. Around 37 % of the world's known oil reserves are located in offshore regions. In the North Sea, some 1,000 exploratory drillings were carried out between the late 1950s and 1978. In order to fully exploit petroleum reserves, it is thought that several thousand more drillings will be necessary. Such activities pose a constant threat to our seas and rivers.
Ecology	Ecology is the science of the natural balance. As well as the interrelations between organisms and their environment, it is also concerned with the reactions and developments of complex systems containing many different microorganisms, plants and animals.
Ecological status	The structural quality and functioning of aquatic ecosystems relating to surface waters.
Ecosystems	System of community and dependencies between various types of creatures and their environment.
Organic	Belonging to animate nature, produced by living creatures.
Phytobenthos	Benthic algae, i.e. algae that live on the water bed.
Phytoplankton	Algae suspended in the water.
Priority substances	List of currently 33 pollutants or pollutant groups that the WFD considers relevant for determining the good chemical status of surface waters. Some of these substances are classified as priority hazardous substances.
Rain basin	Rain basins are artificial basins used to retain and/or treat rainwater or mixed water, such as rain retention basins.
Rain retention basin	A rain retention basin is a form of rain basin used to store precipitation water rather than allowing it to flow directly into the outfall.

Rain overflow	A rain overflow is an overflow structure in a mixed water sewer used for rain relief. Sewage treatment plants are generally designed for the inflow of dirty water and for the same volume of rainwater. As rainwater outflow can be up to 100 times the dirty water outflow in heavy rain conditions, it is necessary to limit the inflow into the sewage treatment plant.
Renaturation	Generally, the restructuring of a developed waterbody into a semi-natural, ecologically effective form. Here: Returning an unnatural river landscape caused by human intervention to a semi-natural state, particularly by restoring or significantly improving the waterbody structure.
Restriction	Restrictions are derived from the framework conditions and have a limiting effect on the potential measures regarding an improvement in the waterbody status.
Untreated water / pure water	Water taken by the water plant from a water resource (groundwater, spring, surface water) for use as drinking water. Where no processing is necessary, untreated water and pure water are identical.
Salt water	Salt water is generally seawater containing on average 3 % dissolved salts. It is unsuitable for human consumption. Special forms include spring water and groundwater that has been in contact with salt deposits and absorbed considerable quantities of salt from them (brine, mineral springs).
Saprobies	Aerobic, i.e. oxygen-consuming organisms that live in waterbodies and mineralise dead organic substance, thereby achieving biological self-purification of the water. Saprobies include certain species of worms, bacteria, fungi and algae.
Saprobic system	The individual species of saprobies are, inter alia, characteristic of a certain degree of contamination with degradable organic substances. The traditional system according to Kolkwitz and Marsson classifies saprobies into 4 different levels of contamination in waterbodies or parts thereof. The traditional system was later refined via the introduction of interim or transitional stages. For example, the watercourse quality mapping regularly carried out in the Federal Republic of Germany indicates 8 levels of water quality.
Suspended matter	Undissolved, dispersed mineral and organic solids (particles) that are suspended in the water due to their density and flow speed in the water.
Sediment	Deposits in waterbodies created as a result of the sedimentation of mineral and/or organic solid particles. Depending on the type of deposition, we distinguish between sea (marine), lake (limnic) and river (fluvatile) sediments. Some pollutants (e.g. heavy metals such as cadmium) can accumulate in high concentrations in sediment, but can also be released from the sediment, posing a threat to biotic communities in waterbodies.
Self-purification	Refers to the ability of a body of water, with the aid of plant and animal organisms (saprobies), to break down organic substances originating from natural sources or introduced by humans. This process consumes oxygen. For example, if more unpurified wastewater is discharged into a waterbody than there is oxygen available for degradation, the self-purification potential of the waterbody is exceeded. This leads to a lack of oxygen, higher and lower organisms die, and the water goes "off".
Freshwater	Generally speaking, freshwater refers to water that can be drunk by humans, i.e. precipitation water, surface waters on the continent, and groundwater with less than 500 mg/l dissolved salts.
Sub-basin	An area of land from which all surface run-off flows through a sequence of overground watercourses to a particular point in an overground watercourse.
Drinking water	Water suitable for human consumption and use that meets certain quality criteria as defined in laws and other legal standards. The basic requirements for safe drinking water is that it should be free from pathogens, have no health-damaging properties, be low in germs, appetising, colourless, cool, odourless, pleasant-tasting, and have a low content of dissolved substances. Moreover, drinking water must not cause excessive corrosion damage to the pipe network and should be available in adequate quantities at sufficient pressure.
Transitional waters	Bodies of surface water close to estuaries which have a certain salt content due to their proximity to coastal waters but which are essentially influenced by fresh water flows.
Flood plain	Areas that flood in high water. Legally designated flood plains must be taken into account by the local authorities in their zoning plans.
Area at risk of flooding/risk area	Areas at risk of flooding/risk areas are areas that extend beyond flood plains or which could be flooded if public flood protection devices were to fail.
Bank filtrate	Groundwater formed by the outflow or seepage of stream and river water (infiltration).
Environmental quality standard (EQS)	Environmental quality standards specify limits for priority substances. Environmental quality standards are designed to minimise the occurrence of certain chemical substances in surface waters that pose a significant risk to the environment or human health.
Environmental compatibility	Extent of the effects of a project on the protected assets soil, water, air, climate, humans, fauna and flora, including the respective interrelations.
Environmental impact assessment (EIA)	An environmental impact assessment (EIA) is a systematic testing procedure to ascertain, describe and evaluate the direct and indirect effects of a project on the environment at the planning stage.
Pretreatment	In-house purification measures for commercial and industrial wastewater prior to discharging into public sewers or sewage treatment plants.
Water properties	The physical, chemical or biological properties of the water in a body of surface water or body of coastal water and groundwater.
Water abstraction fee	The water abstraction fee is levied in certain Federal Länder for water abstraction and use. This fee is added to the regular cost of water. The revenues are used to protect drinking water and water resources.

Remote water supply	In the catchment area of certain conurbations, the water supply is no longer sufficient to supply the local population, industry and commerce with adequate good water. Often, local water abstraction plants are no longer viable due to growing human settlements or intensive agricultural use. In many cases, use is instead made of water supplies some distance away with favourable site conditions. However, such water abstractions can adversely impact the ecology of the area from which the water is taken.
Substances constituting a hazard to water	Chemical substances and mixtures of substances or their reaction products that are capable of contaminating waterbodies or adversely altering their properties in some other way. These include solvents, residues containing petroleum, pesticides, heavy metals (e.g. cadmium, mercury), phosphates and halogenated hydrocarbons, acids, lyes and PCBs.
Water hazard category (WGK)	The potential of substances and preparations to adversely alter the properties of water are evaluated in a classification system based on biological test techniques and other properties. The water hazard is divided into 3 categories: WGK 1 = low water hazard WGK 2 = hazardous to water WGK 3 = highly hazardous to water
Federal Water Act (WHG)	Act regulating the water balance with provisions for the management of water resources aimed at public well-being. For example, it outlines requirements on water abstraction, water storage and wastewater disposal in order to avoid any impairments. It also defines the management requirements of the WFD for waterbodies.
Waterbody	Significant, uniform sections of a surface or coastal water and demarcated volumes of groundwater within one or more groundwater aquifers (bodies of groundwater).
Water cycle	Water is in a constant cycle due to solar energy. It evaporates on the surface of seas and land masses. The rising water vapour cools down at altitude and condenses into clouds. When these clouds cool down further, they discharge their humidity as precipitation.
Water use	Defined by Directive 200/60/EC as water services and any form of human activity having significant impacts on water properties. Water services refer to services such as wastewater disposal or water supply.
Water protection area	Part of a catchment area or the entire catchment area of a drinking water abstraction plant in which usage restrictions are imposed in order to protect the abstraction of drinking water. Designation of a water protection area requires a formal procedure.

8 What can each and every one of us do to help? Tips on water conservation

Buy organic produce!

Nitrogen discharges and pesticides from agriculture impair the quality of our groundwater, as we discovered in **Chapter 5**. Organic farming aims to avoid substance discharges from agriculture into groundwater and surface waters by banning the use of chemical-synthetic pesticides. Nitrogen mineral fertilisers are replaced by cultivating legumes in conjunction with more diverse crop rotation – as a result of which, problematic nitrate deposits in the groundwater are a rare occurrence. An intact soil and soil water balance are a key requirement of organic farming, and consequently achieve superior groundwater recharge as well. By buying suitably labelled organic produce, you can make a valuable contribution to groundwater protection.



Photograph: Volker Gerstenberg – Fotolia.de

Avoid using chemical pesticides and biocides in your own garden, and use fertiliser sparingly!

Even in your own garden, avoiding the use of chemical pesticides and biocides and using fertilisers sparingly will help to minimise pollution of the groundwater. Remember: Less is often more!

Minimise wastewater

Each of us can help to protect our water resources, by ensuring that substances that cannot be removed by filtering or which require costly treatment techniques do not enter our sewers and sewage treatment plants. Only in this way are we able to effectively protect our rivers, lakes and seas, since active water protection does not begin with sewage purification, but with avoiding the creation of wastewater in the first place!

1. Solid waste such as

- ▶ Textiles
- ▶ Disposable nappies
- ▶ Hygiene products
- ▶ Cotton wool
- ▶ Cotton buds
- ▶ Razor blades
- ▶ Cigar and cigarette residue
- ▶ Pet sand etc.

should never enter the public sewers.

2. Never dispose of substances such as **lacquers, paints or pharmaceuticals** down the toilet!

Chemical residues, tablets and unwanted medicines should never be flushed down the toilet or sink. Take chemical residues to designated collection points, and bring pills and liquid medicines to any pharmacy for disposal. If flushed down the toilet, the chemicals and active ingredients in pharmaceuticals will enter the sewage treatment plant via the sewer. Sewage treat-



Photograph: Regina Kaute – pixelio.de



Photograph: Thorsten Schon – Fotolia.de



Photograph: Mark Huls – Fotolia.de

ment plants are unable to completely remove such substances. For example, undecomposed pharmaceuticals and their degradation products will enter surface waters together with the purified wastewater, and subsequently enter the groundwater via soil passage or bank filtration.

3. Used **household oils and fats** should not enter the public sewers, since they combine with the ballast of wastewater and solidify into a glutinous mass. Used frying oil (e.g. chip fat) and other roasting fats should be disposed of in the biowaste bin.
4. Use dense **detergents** sparingly in compliance with the instruction manual and at low washing temperature, if possible. This will save water and energy, which in turn will save you money. Pay attention to the recommended quantities on the packaging for the relevant water hardness. This can vary from place to place; your water plant or local authority can provide further information. Use phosphate-free or low-phosphate detergents.
5. Excessive use may cause residues of **cleaning products**. Therefore use cleaning products sparingly in compliance with the instruction manual! Abstain from a preventing use of cleaning products with a sanitise effect. Of course, the same applies to bathing products.

Always clean your car at the car wash!

From an environmental viewpoint, generally speaking it is advisable to always wash cars at designated car washes, ideally those with the “blue angel” eco-label. The wastewater produced from washing a car contains various chemical substances and compounds that can damage groundwater – even if you only use clean water for washing. By washing your car on unsealed ground, you are placing the groundwater at risk, and usually committing an administrative offence at the very least.



Photograph: Franz Haindl – pixelio.de

Avoid land sealing or use permeable surfacing materials!

Rainwater normally seeps into the subsoil where it falls, but in developed or sealed areas this cannot usually happen. In such areas, only some precipitation water is able to enter the water cycle via the natural route, while a significant portion is discharged via the sewer system. In order to minimise impairments to the groundwater balance, the first step should therefore be to examine the need for sealed and developed land. In many cases, a usage no longer applies or a planned usage has failed to materialise, and these areas may be reconverted into grassland. In the case of land which needs to be stabilised due to the way it is used, there are various opportunities for minimising the extent of sealing. For example, paths, roads, parking spaces and terraces may be stabilised with water-permeable coverings.



Photograph: Thomas Max Müller – pixelio.de

Have your sewage tanks and private sewer connections checked for leaks, and upgraded where necessary!

Wastewater can seep into the soil and groundwater from leaking pipes and sewage tanks if they are located above the groundwater level, and could potentially contaminate the soil and groundwater. Cracks in tanks or pipes, tree roots, faulty connections and leaky seals are potential sources of leaks. The land owner is responsible for ensuring the proper operation of wastewater pipes that traverse private land.

Ensure that rainwater seepage meets the best available technology!

Decentralised rainwater management in human settlement and transport areas is considered the best available technology. There is no good reason for not applying this principle. For the seepage of minimally to moderately contaminated precipitation, the best available technology is considered to have been met if it has an adequately dimensioned soil zone covered in vegetation, or infiltration facilities with proven substance retention effectiveness.

Further information on rainwater seepage and use may be found at: <http://www.umweltbundesamt.de/publikationen/versickerung-nutzung-von-regenwasser>.



Have your own wells and geothermal installations installed by a specialist!

The drilling of wells and the exploration of geothermal heat requires a knowledge of the subsoil. Proper use of the subsoil for groundwater and geothermal purposes must be carried out in accordance with the best available technology. In order to avoid damage to the soil and groundwater and to the operation of the facility, the planning, drilling and construction of facilities must be carried out by recognised experts.

Avoid the use of salt in winter!

Salt damages the roadside flora and fauna. Salt water that seeps into the soil can impair valuable groundwater. As well as contaminating our waterbodies, salt also contaminates the sewage treatment plants, as melting ice and snow enters them via the sewers. Salt is also damaging to the paintwork of cars. Eco-friendly alternatives include salt-free grits and sands.



Photograph: M. Großmann – pixelio.de

Dispose of batteries and accumulators properly!

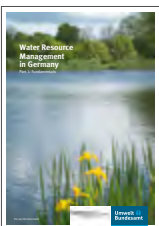
Batteries and accumulators should never be mixed with domestic waste or simply thrown away! If this happens, the pollutants they contain can contaminate the groundwater from waste incineration or landfill. Batteries containing the heavy metals mercury, cadmium or lead are particularly harmful to the environment.

In Germany, well over a billion batteries were sold for use with appliances in 2004. These contained around 4,700 tonnes of zinc, 1,500 tonnes of nickel, 700 tonnes of cadmium, 7 tonnes of silver and 3 tonnes of mercury. Although the law states that all unusable accumulators and batteries must be collected, each year only around one-third of the volume sold is returned.

For everyday appliances, always choose nickel metal hydride (NiMH) accumulators or lithium ion accumulators over nickel cadmium accumulators, since they do not contain toxic cadmium. Nickel cadmium accumulators should no longer be sold.





Collect all end-of-life batteries and accumulators, and take them to a battery collection point at a retailer or your local authority, where they will be accepted free of charge. Further information is available at: www.umweltdaten.de/publikationen/fpdf-1/3057.pdf.



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