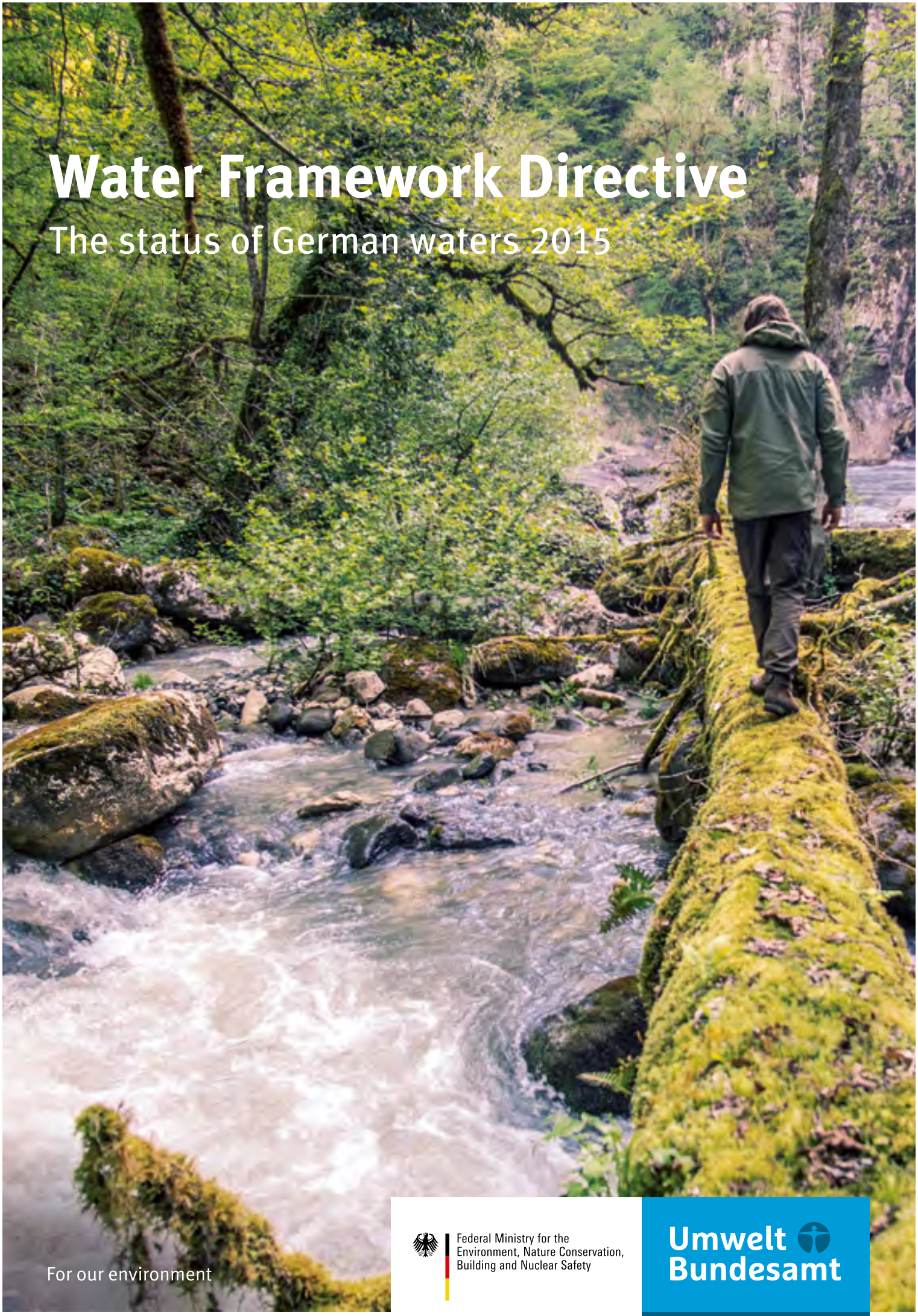
Water Framework Directive

The status of German waters 2015



For our environment

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

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Water Framework Directive

The status of German waters 2015

Foreword

Dear Reader

The Water Framework Directive stipulates that good status is to be achieved for all European water bodies – which means achieving high water quality and good living conditions for aquatic flora and fauna. Ecological considerations such as protecting and improving biodiversity are matters of priority. However, likewise falling within the scope of the Water Framework Directive are the various uses of water bodies, including for a quality drinking water supply and for shipping. Both ecological concerns and water body uses are the underpinnings of sustainable water body management.

The 2009 German water management planning outcomes in 2009 and the initial management plan show that the goals mandated by the Water Framework Directive have yet to be met for the vast majority of German water bodies. But a great deal of progress has been made since then. Additional sewage treatment plants have been built or existing ones expanded, the agro-environmental program has been carried out, rivers and streams have been restored to a near-natural status, structures that hinder the movements of migratory species have been reconfigured, and dikes have been relocated.

Our federal state governments have also accomplished a great deal in this domain. Water body monitoring and assessment, planning and implementing the relevant measures, and elaborating management plans require a considerable amount of human and financial resources, and great dedication. In the water body protection domain, federal state water management officials work closely with members of the general public. Numerous informational events, workshops, reports and extensive online documentation create transparency and promote public awareness of the advantages of living water bodies. This in turn makes a major contribution to public acceptance of water body protection.

This report discusses the results of the first management period and what has transpired since 2009, and provides an overview of the management cycle that began in 2015. The report also describes how comprehensive and integrated river basin management for purposes of protecting our water bodies works, and provides answers to a broad range of questions: Which pressures are our water bodies subject to? What is the status of German water bodies today? What progress has been made thus far? Which measures are currently in the pipeline? Which actors will carry out these measures and how much will they cost?

I trust that after having read this report, water body protection will become a matter of concern to you as well.

Dr. Barbara Hendricks
Federal minister for the Environment,
Nature Conservation, Building and Nuclear Safety

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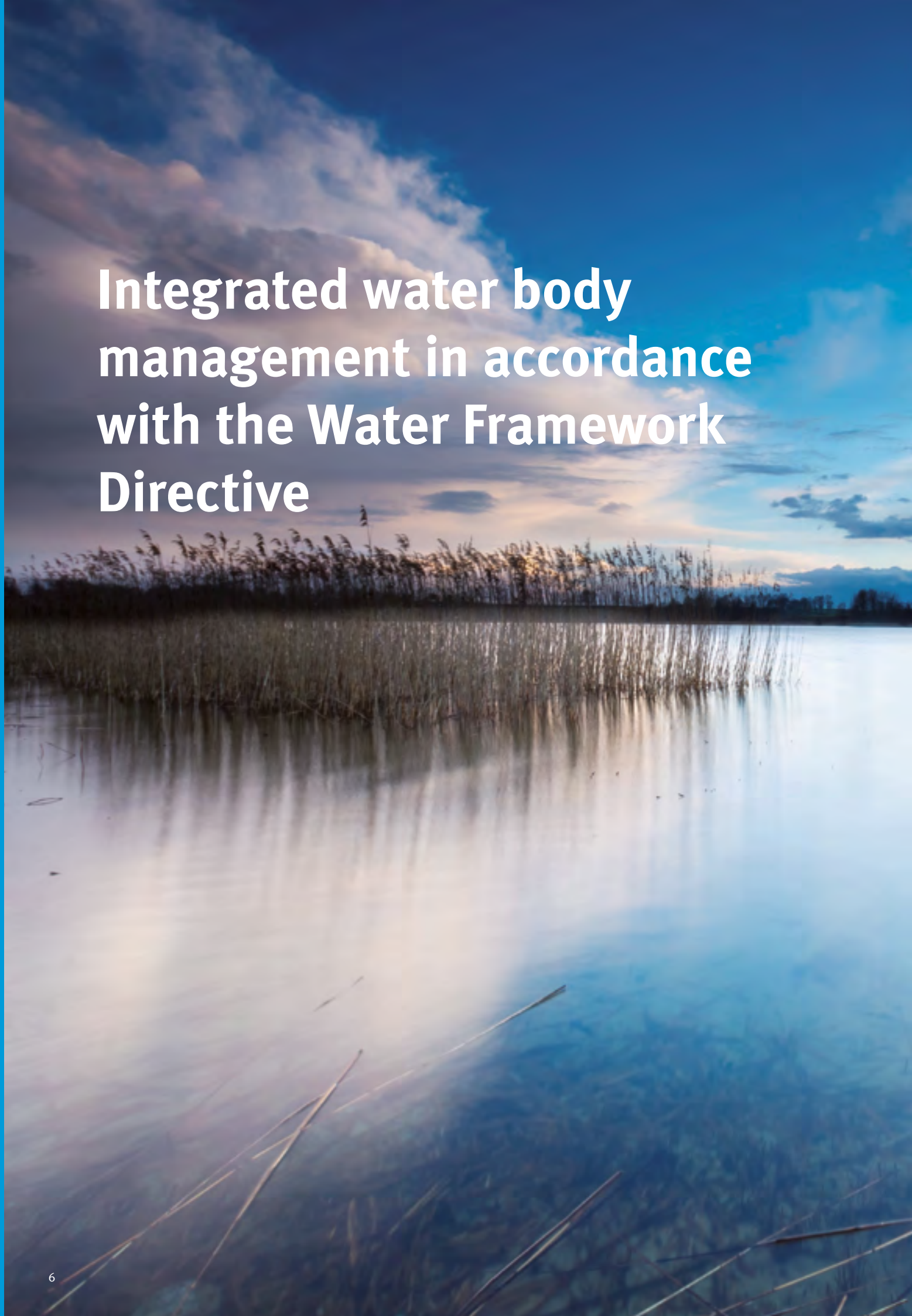
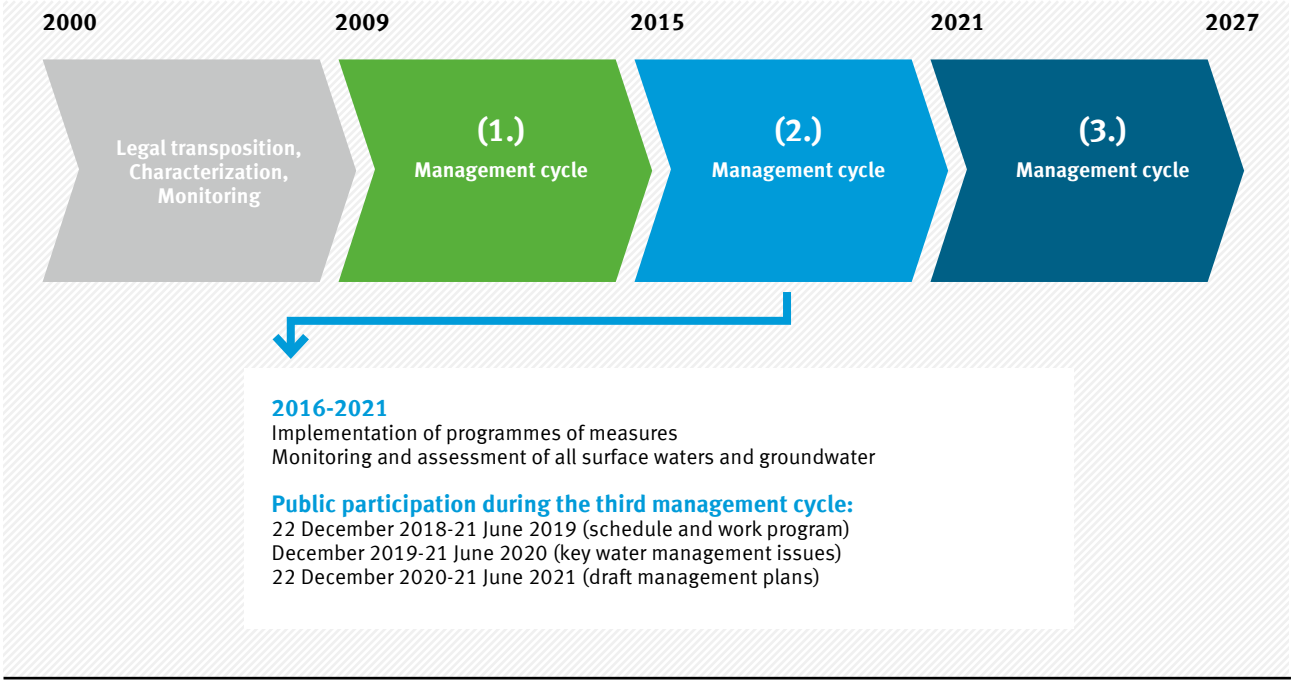


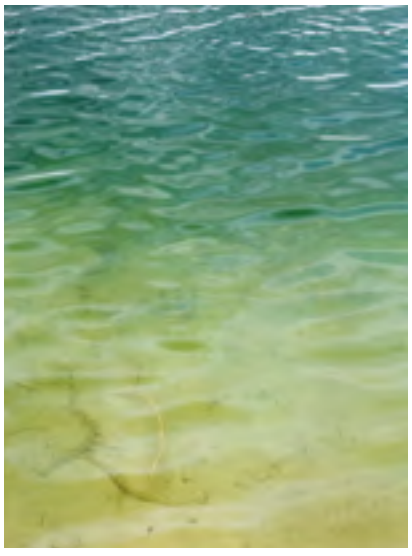
Integrated water body management in accordance with the Water Framework Directive

The Water Framework Directive stipulates that rivers, lakes, transitional waters, coastal waters, and groundwater are to achieve good status by 2027. To this end, the European Union has promulgated a clearly defined timeline and three six-year management cycles for the member states (Figure 1). The main management instruments in this regard are the management plans, which contain stipulations concerning matters such as status, inputs, goal achievement, and measures. We are currently at the beginning of the second cycle, which ends in 2021. The management plans and programmes of measures that have been elaborated for this period were published in December 2015 and were submitted to the European Commission in March 2016. Hence in effect, these plans constitute a monitoring tool for the European Commission.

Figure 1

Implementation timeline for the Water Framework Directive.





A look back: The first management cycle

During the first management cycle, whose management plans and programmes of measures were completed in late 2009, it emerged that Water Framework Directive management objectives for Germany had only been reached in just under 10 percent of surface water bodies (rivers, lakes, transitional waters, coastal waters) and in 62 percent of groundwater bodies. For the major part of German water bodies (82 percent of surface water bodies and 36 percent of groundwater), deadline extensions or exemptions were invoked, as it was deemed unlikely that the mandated objectives could be reached by the end of 2015. The deadlines for achieving the objectives after 2015 were mainly extended, due to the fact that, owing to the numerous objectives that were failed, measures could not be implemented concurrently for all water bodies, or it would take longer for the measures to have the desired effect; and thus it was not expected that good water body status could be achieved by the end of the first management cycle.

The management plans contain descriptions of the river basin districts, as well as reports on Water Framework Directive implementation status, new developments and the anticipated success of implementing the measures. The updated management plans, for 2015-2021, also give an account of implementation of the measures from the previous management cycle.

The key elements of these management plans are as follows:

- A description of the characteristics of the river basin districts and a summary of significant anthropogenic pressures and their impact on the status of surface water and groundwater bodies
- An overview of the protected areas
- A map of the relevant monitoring networks and the results of the monitoring programs
- A list of management objectives
- A summary of the economic analysis of water use
- A summary of the programmes of measures
- A summary of the public information and consultation measures taken

The programmes of measures address the need for action necessary to reduce identified pressures and improving water body status. To this end, each of the various measures must be commensurate with (a) the nature and scope of the anthropogenic pressures involved; and (b) existing usage modalities.

The key elements of the programmes of measures are as follows:

- Strategies for the achievement of management objectives
- Lists of basic and supplementary measures
- Proof that the measures will be cost efficient
- Descriptions of the measure implementation procedures, e.g. via the relevant bodies

EU river basin management plans are elaborated for extensive river basin districts rather than for individual water bodies. Inasmuch as a river basin district comprises all of the water bodies in a river basin, in most cases two or more EU member states are in charge of managing the area. Germany has ten river basin districts: the Danube, Rhine, Maas, Ems, Weser, Oder, Elbe, Eider, Warnow-Peene and Schlei-Trave. Eight of them extend across at least one international border. Only the Weser and Warnow-Peene river basins are confined to Germany and are thus managed in Germany alone (Map 1).

Map 1

Germany’s ten river basin districts.

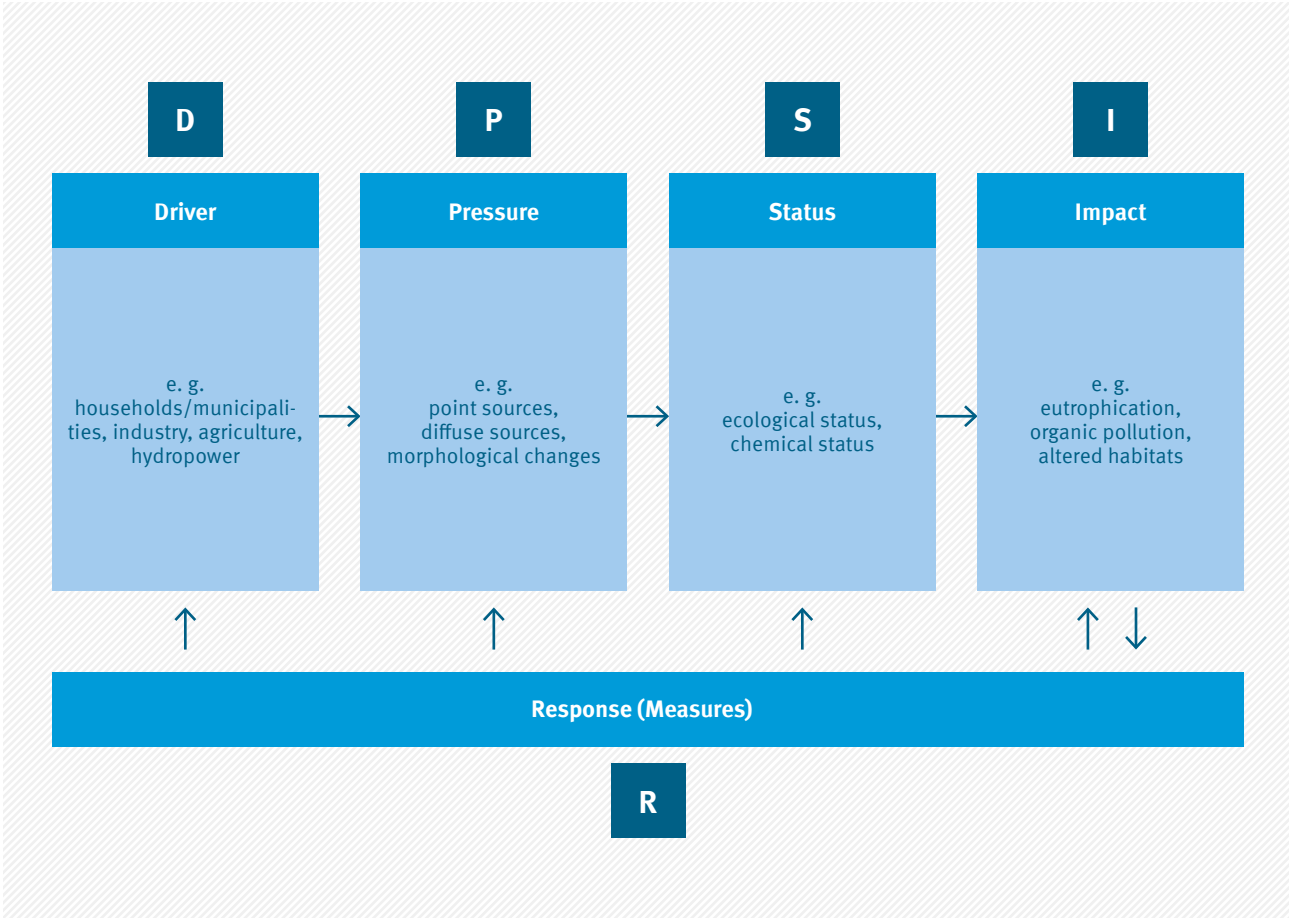
Map source: Länderarbeitsgemeinschaft Wasser (LAWA), Bundesamt für Kartographie und Geodäsie (BKG)

Source: Umweltbundesamt, June 2004.

How water body management works: The DPSIR framework

The various management plans and elaboration of the programmes of measures are based on the DPSIR framework, which was drafted by the OECD in 1993 and updated by the European Environmental Agency (EEA) in 2007 (DPSIR stands for Driving Forces-Pressures-State-Impacts-Responses). This framework describes the interactions between uses and their environmental impact, the resulting water body status, the resulting impact on environmental assets, and the necessary measures to reduce pressures.

This framework is used for Water Framework Directive implementation, via various work steps. In characterizations, uses (D) and significant pressures (P) are designated and assessed – for example agriculture (D), which results in diffuse nutrient and pollutant inputs into water bodies (P). Following water body status assessments based on extensive measurement results (S), the impact of pressures (I) such as water body eutrophication is analysed. Efficient and targeted measures are elaborated based on these findings (R). These procedures constitute not a fixed sequence of actions, but rather a continuum on which various steps are continuously adjusted to each other and that are sometimes performed concurrently. The DPSIR framework is illustrated by the following graphic:



Coordination and public involvement

Inasmuch as water body protection is a Community undertaking, in order to meet the Water Framework Directive objectives the EU member states need to coordinate their river basin management plans and programmes of measures in a cross-border fashion. This is the only way to ensure that water management problems can be evaluated and managed based on uniform or comparable criteria. In Germany, federal and state government agencies likewise need to coordinate their actions. And EU member states in a given river basin need to engage in extensive cooperation when it comes to the following: elaborating cross-border monitoring programs; developing and harmonizing comparable assessment procedures; jointly defining cross-border water management issues; implementing programmes of measures.

This coordination process is chiefly a managerial task that necessitates a centralized body that can control the relevant efforts. To this end, international river basin commissions such as the international commissions for the protection of the Rhine (IKSR), Elbe (IKSE) and Danube (ICPDR) have been established. In Germany, bodies have also been established that undertake overarching coordination efforts across state boundaries, e.g. the Elbe and Rhine river basin associations, which the relevant states and the federal government participate in. This results in intermeshing of the national and international entities, by virtue of the fact that the German positions for international discussions are determined in the river basin associations.

Public participation

However, responsibility for implementing the Water Framework Directive is not merely confined to the member states and the various German states. The inclusion of municipalities, water users and water protection officials, as well as the general public, also plays a major role – one that is also expressly called for by Article 14 of the Water Framework Directive. Including the general public in the process of implementing the Water Framework Directive not only raises public awareness of environmental issues and water body status at the local, national and regional levels; it also improves planning and measure quality in that the knowledge and experience of various stakeholders are leveraged. Public involvement promotes long term acceptance, by all concerned, of management planning solutions, and helps to avoid potential conflicts, management problems and costs.

The Water Framework Directive provides for a three-stage process of public hearings that are held during the management plan drafting phase. Hearings on the timeline and work program are held three years before a given management plan takes effect. A year later, hearings are held on the key water management issues. And a year after that the draft management plans are made available for discussion. For each of these three phases, the public has six months to submit requests for additions and changes to the plans. Subject to review, these requests are then incorporated into the final draft. In addition to these public hearings, the federal states have undertaken numerous successful activities with a view to

The key water management issues in Germany (national and international)

The key water management issues, as at the beginning of the current management cycle, were as follows:

Hydromorphology improvement and **restoration of** surface water body **continuity.**

Reducing nutrient and pollutant inputs into surface waters and groundwater, from diffuse and point sources.

For certain river basin districts, additional specific regional water management issues have been defined such as pressures attributable to mining and changes in water resources.

disseminating information concerning implementation of the Water Framework Directive, holding public hearings, and actively involving the public in the implementation process. The Directive also stipulates that the member states are to strengthen active participation of interested parties.

Information concerning the Water Framework Directive is disseminated via instruments such as brochures, flyers, calendars and posters. The German states also maintain informational websites containing elements such as interactive maps concerning water body ecological quality and the planning of measures. In addition, informational events concerning water protection in the various regions, as well as environmental protection project contests, are held in venues such as schools.

In many federal states, regional informational events have been held concerning the drafting of management plans and programmes of measures, with a view to informing the relevant stakeholders and the general public, and moti-vating them to express their views on the relevant issues.

More extensive eliciting of the views of, and active participation by, associations and municipalities, as well as members of the industrial, agricultural, forestry, fisheries, environmental protection and nature conservation communities are achieved through regularly held Water Framework Directive advisory committees meetings, roundtable discussions, and meetings of other committees, some of which focus on specific issues. For such activities, each of the various federal states has developed procedures that suit their specific needs.

Initiatives such as the “Wassernetz” in North Rhine-Westphalia, “Gewässernachbarschaften” in Bavaria, and “Patenschaften für Gewässer” in Baden-Württemberg also promote implementation of the Water Framework Directive as well as the involvement of local citizens in this process.

Newest developments; and what have we accomplished thus far in terms of implementing the Water Framework Directive?

Interview with Peter Fuhrmann, who is head of section of the Baden-Württemberg Ministry of the Environment and currently head of Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) from 1 January 2016 to 31 December 2017.

1. The first Water Framework Directive management cycle has come to an end. At the same time, issuance of the updated management plans and programmes of measures has now ushered in the second management cycle. Which changes have taken place?

The Water Framework Directive brought about a number of fundamental changes in water body management that have since become a fixture of water management practice. Among these changes are that surface waters are now regarded as ecosystems and water body management is now coordinated across state and national borders. We now have at our disposal robust monitoring and assessment procedures for the various quality elements. These procedures form the basis for efficient planning of programmes of measures. Coordination and harmonization in connection with Water Framework Directive implementation in national and international river basin associations, and particularly within Bund/Länder-Arbeitsgemeinschaft Wasser, have worked quite well.

In Bund/Länder-Arbeitsgemeinschaft Wasser, already at the beginning of the first management cycle, we elaborated the river basin management work program, and it is being updated in the current period. We have compiled a list of issues that require further coordination and harmonization. Thanks to close cooperation between the states and the federal government and robust support from Bund/Länder-Arbeitsgemeinschaft Wasser commissions and teams of experts, methods have been developed, assessment procedures have been modified and optimized, recommendations for action concerning various matters have been elaborated and text modules for management plans have been drawn up – to name just a few of the actions that have been taken. This has helped to substantially optimize and standardize the various management plans.

2. Many German water bodies still fail the Water Framework Directive management objectives. What has been done to achieve these objectives in recent years?

The Water Framework Directive's directive goal of achieving good water body status – i.e. a status that differs only slightly from the natural reference status – is quite ambitious. Particularly in Germany, owing to our nation's high population density and its economic development, many water bodies are strongly affected by human activities. Compared to other European countries such as Sweden, this situation presents us with an enormous challenge.

In drawing up the management plans for the first management cycle, owing to the scope of the requisite measures it was clear that implementing these plans within a few years was beyond the realm of possibility. Thus, where necessary, deadline extensions were invoked and substantiated in the management plans. Moreover, it also takes some time until the measures that are implemented translate into quantifiable improvements. For example, fish and other biota do not immediately re-colonize a watercourse segment that has been rendered near-natural.

Moreover, the fact that the worst elements are the determining factors for the chemical and ecological status assessments of a given water body undoubtedly causes many water bodies to continue to formally fail the mandated management objectives, despite improvements in individual elements. But in point of fact, considerable progress has been made. For example, many water bodies now exhibit a moderate ecological status, rather

than the poor or even bad status that they exhibited in the past. Hence the objective of good ecological status has nearly been reached, and it's clear that we're on the right path.

The focus over recent years has been implementation of a host of measures that were entailed by the 2009 programmes of measures, with a view to improving the status of surface waters and groundwater. To this end, hundreds of kilometres of water body stretches were rendered near-natural; fish ladders have been incorporated into many transverse structures so that fish can migrate unimpeded; sewage treatment capacity have been continuously built out; and fertilizer use regulations have been tightened.

The programmes of measures have been and continue to be implemented vigorously in the various German states. But unfortunately, not all of this success is reflected by the Water Framework Directive's assessment system, and is substantiated only if individual measures are assessed. Owing to habitat fragmentation, fish such as salmon that migrate over long distances have virtually disappeared from all of Germany's major river basins. Internationally coordinated programs such as the Rhine program have enabled salmon to return to their native spawning grounds and breed there, after a decades-long absence. Thus I'm glad to see that lighthouse projects for Water Framework Directive implementation purposes are discussed in this report, as their success is clearly visible.

3. In your view, which problems need to be urgently addressed in the short term, and what plans have been made in this regard?

The current priority is of course implementation of the programmes of measures envisaged for the current management cycle. Well over 100,000 individual measures are slated for implementation in the various German states by 2021. This is a monumental task – one that can only be accomplished via close cooperation between government officials, users and the relevant bodies. Crucial to achieving this is the availability of adequate financial and human resources from the state and federal authorities.

It is often impossible for smaller municipalities to carry out Water Framework Directive tasks on their own. These municipalities need additional financing options, or should receive planning support from environmental officials.

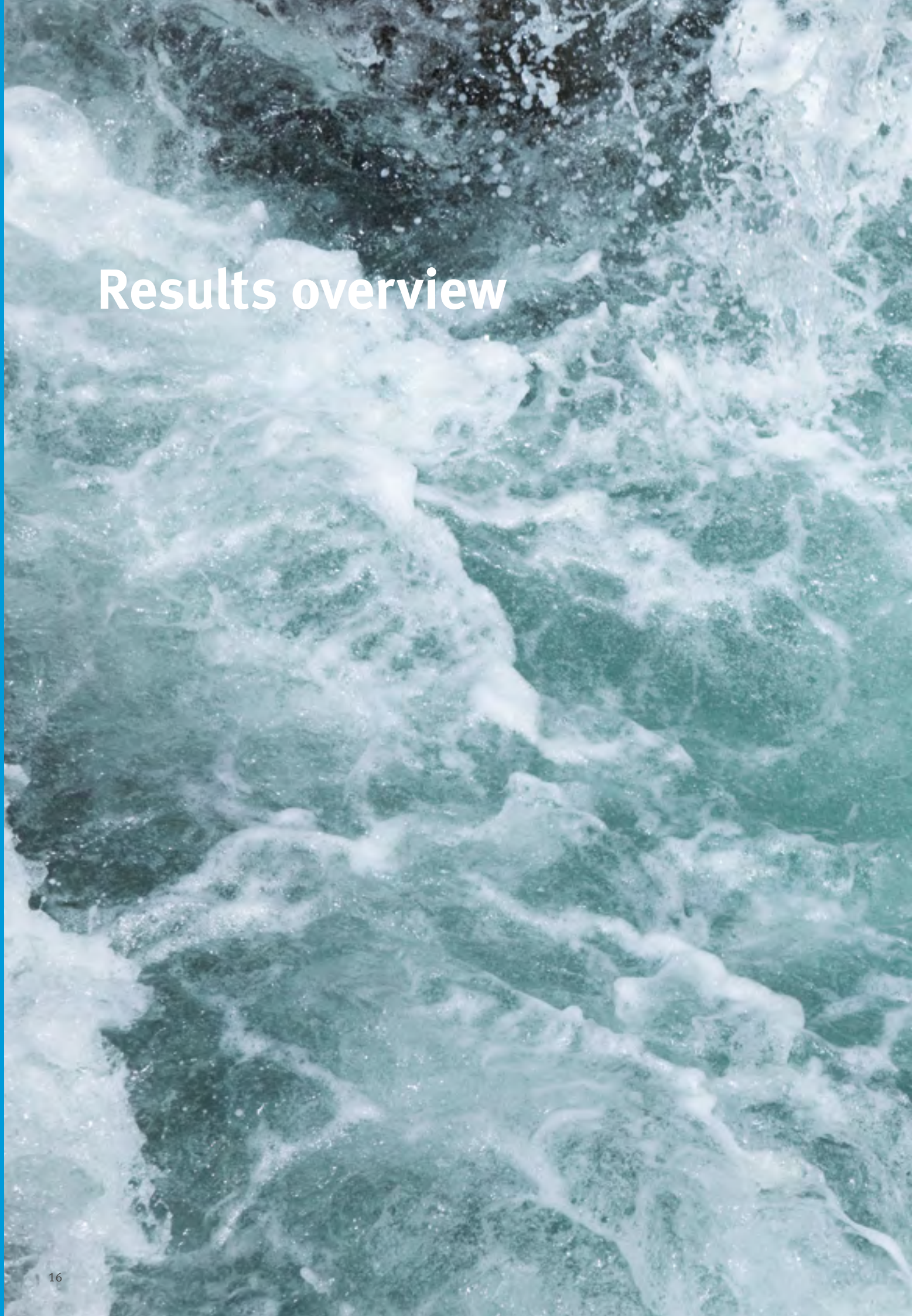
Agricultural nutrient inputs are a major problem. Excessive nutrient inputs in groundwater as well as in surface and coastal waters oftentimes prevent the mandated management objectives from being met. To address this problem and meet the mandated objectives, society as a whole will need to change its mindset; plus we need a federal fertilizer law and an EU agricultural policy that is keyed more robustly to water protection.

In order to heighten public acceptance of Water Framework Directive implementation, it is crucial that water protection and the attendant objectives become the subject of public discussion and debate. For unless we gain the support of the relevant local populations, the Water Framework Directive will not achieve the desired success.

4. What's in the offing for water bodies that may not have achieved good ecological status by 2027? Also, how do you see implementation of the Water Framework Directive shaping up in the post-2027 period?

The Water Framework Directive stipulates that exemptions and deadline extensions may be invoked for water bodies that fail to achieve good status. In Germany, we have agreed to mainly invoke deadline extensions – which, as things now stand, will be prohibited in the post-2027 period. Thus in the run-up to the third management cycle, less stringent management objectives will need to be elaborated and substantiated for all waters that fail to meet the mandated objectives by 2027. But doing this would substantially reduce the level of ambition entailed by implementation of the Water Framework Directive and would be highly undesirable in my view. Hence I feel it's important for the European Commission to address this issue in a timely manner, to promulgate additional management cycles and to amend the Water Framework Directive accordingly. It would be a shame if we stopped in midstream. Germany intends to support the European process constructively, and at an early stage. To this end, a uniform position should be elaborated within Bund/Länder-Arbeitsgemeinschaft Wasser.

But even if no further Water Framework Directive management cycles are promulgated, there will still be a legal framework for water protection in the post-2027 period. One thing is certain: long-term protection of water resources will remain a top German priority going forward as well.



Results overview

The results of implementation of the first management plans and programmes of measures are available as of spring 2016. The updated management plans contain an overview of the current status of surface waters and groundwater. The status assessments, which were based on extensive monitoring, involved measurement and analysis of the following: biological community (composition and abundance) chemical and physico-chemical quality elements; pollutants; and groundwater levels. Surface waters and groundwater have been monitored at nearly 20,000 monitoring sites over the past six years. A comparison of the latest results with those of 2009 shows how water body status has changed in the interim, and the progress that has been made in terms of water protection.
The management plans and programmes of measures indicate which measures will be necessary over the next six years and beyond in order to achieve the mandated objectives. The latter comprise "good" water body status; whereby anthropogenic inputs occasion only minor deviations from the reference (i.e. natural) status. The pressures monitored for this purpose are discussed in the box titled "The key water management issues in Germany," in section 1 of this report.

The implementation of pressure-reduction measures is contingent upon the availability of adequate financing. In Germany, most of these costs are covered by revenues from taxes, fees and duties. Hence revenue from sewage fees and water abstraction fees are a key source of financing in this regard. This in turn means that most of the requisite financing needs to come from federal state and municipal coffers. Funds are also available via co-financing of measures from (a) EU funds and subsidies such as the European Agricultural Fund for Rural Development (EAFRD); and (b) the federal government, via sources such as Gesetz zur Verbesserung der Agrarstruktur und des Küstenschutzes (GAK; Act on improvement of the agricultural infrastructure and of coastal protection).

In substantiated cases, deviation from "good ecological status" is allowable, or deadline extensions can be invoked for achievement of the objectives of certain water bodies or stretches of water. In Germany, deadline extensions are often invoked, owing to the pressures to which the water body in question is subject. Less stringent management objectives come into play as exemptions only insofar as the water body in question is so polluted or its hydromorphology has been changed to such a great extent that achieving the relevant objectives within the foreseeable future (by 2027) with reasonable measures lies outside the realm of possibility. Objectives, deadline extensions and exemptions are subject to review every six years.

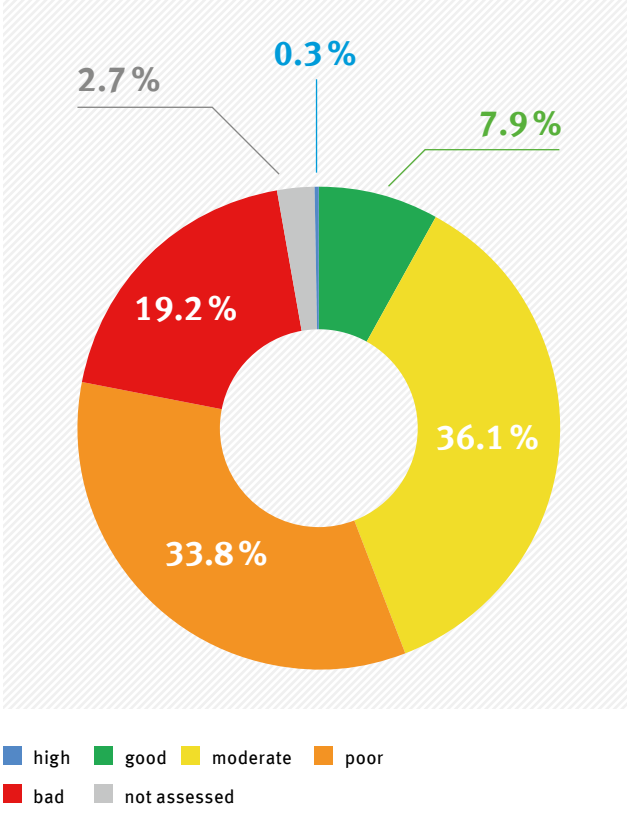
Surface waters: status, measures, deadline extensions, exemptions

Status (Section 4)

In the current management cycle more than 9,800 surface water bodies[1] are being managed in Germany. According to the assessments of these water bodies, just 8.2 percent of them have reached the mandated Water Framework Directive management objectives and currently exhibit "high" and "good ecologcial status or potential".[2] 36.1 percent exhibit "moderate status", 33.8 percent "poor status", and 19.2 percent "bad status". It has not yet been possible to reliably assess a minor number (2.7 percent) of surface water bodies.

Figure 2

Ecological status of Germany's surface water bodies.



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

1 A water body is a part of a river, sea or aquifer that can be regarded as a uniform entity as regards its natural properties and current state.

In Germany, a river failing "good ecological status" is in most cases attributable to degraded hydromorphology. In other words, the river is lacking a near-natural habitat for flora and fauna, and / or the river's continuity has been disrupted by transverse structures. Other causes are excessive nutrient inputs from agricultural activities and wastewater treatment – which are mainly responsible for the failure of lakes, transitional waters and coastal waters to reach the mandated objectives.

The improvement in ecological status relative to the 2009 results is mainly attributable to water bodies with "moderate status", many of which had previously exhibited "poor" or "bad" status. The poorer rating of water bodies whose previous status was "high" or "good" is attributable to, among other things, optimization of the assessment procedure or new information concerning pressures.

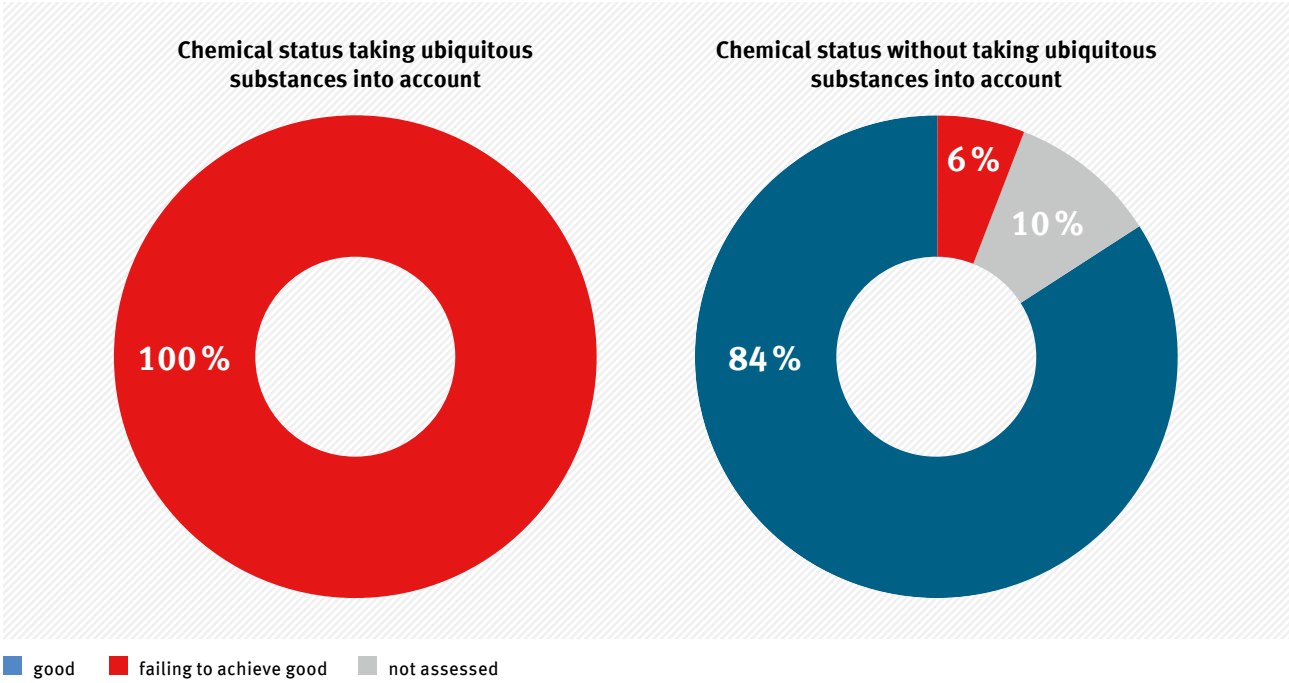
All German water bodies are rated as failing to achieve "good chemical status". This is attributable to the omnipresence of pollutants (e.g. mercury, or polycyclic aromatic hydrocarbons resulting from combustion), which exceed the mandated standards in all German water bodies.

By way of comparison, if ubiquitous substances were omitted from surface water body status assessments, 84 percent of them would exhibit "good chemical status" and 6 percent "failing to achieve good". Given that under the new chemical status assessment rules, such assessments for water bodies without taking account of ubiquitous substances are optional, 10 percent of all water bodies were not assessed.

The 2009 and 2015 chemical status results do not lend themselves to a head to head comparison, owing to the fact that the EU directives on priority substances from 2008 and 2013 each promulgate numerous new quality standards, and environmental quality standards were substantially tightened.

Figure 3

Chemical status of Germany's surface water bodies.



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

2 Surface water bodies can be divided into natural, heavily modified and artificial water bodies (see Section 4.2). Ecological status is assessed for natural surfaces, whereas ecological potential is assessed for heavily modified and artificial water bodies. For reasons of clarity, these two status are referred to in this report as ecological status.

Measures, deadline extensions and exemptions (Sections 5.1 and 6.1)

In the interest of uniform presentation and reporting for the planning and implementation of programmes of measures, Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) has developed a list of measures containing more than 170 types of measures, allocated to either drivers, pressures or effects. For purposes of the present report, the number of water bodies for which the federal states plan to implement each of the various types of measures was determined.

Of the measures envisaged under the current management cycle, 41.5 percent are assessed under "flow regulation and morphological changes" (hydromorphology). It comprises measures such as the following: restoration of ecological continuity, such as adding fish ladders to existing transverse structures; hydromorphology improvement; inherently dynamic river development; and hydrological regime improvement through measures such as achieving minimum flow.

38 percent of the envisaged measures relate to diffuse sources. The majority of these measures aim to reduce agricultural nutrient inputs into surface waters.

19 percent of the envisaged measures aim to reduce point source pollution, via the following: measures carried out for municipal sewage treatment plants; treatment of combined sewage and rainwater discharges; overhauling damaged sewers; reducing pressures from mining and abandoned industrial sites.

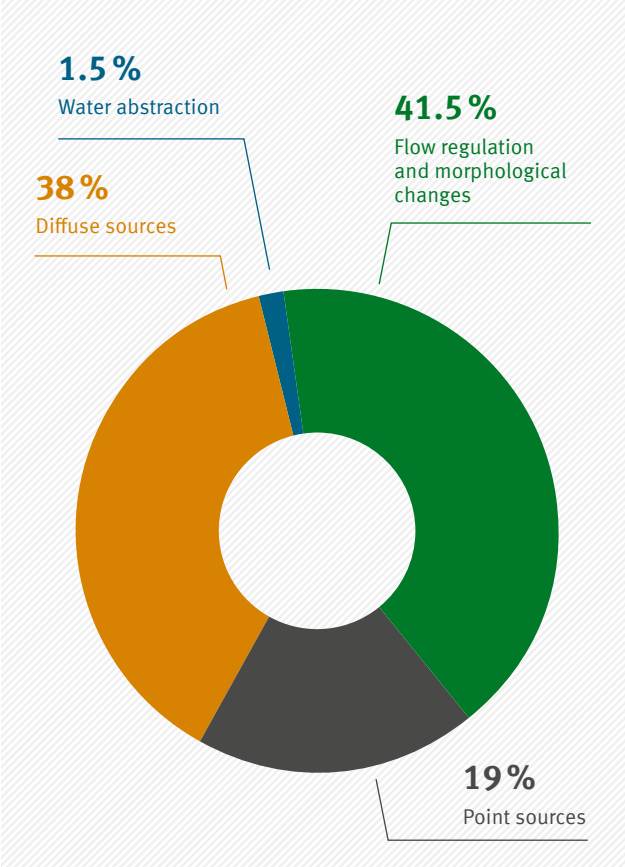
The focus-of-pressure category "water abstraction" plays a minor role in that it accounts for only 1.5 percent of the envisaged measures.

For nearly 92 percent of all surface water bodies, deadline extensions (until 2021 or 2027) and management objective exemptions will be invoked, in cases where the desired ecological status has not yet been achieved. It is anticipated that 18 percent of all German surface water bodies will have achieved their management objectives by 2021. Inasmuch as the desired chemical status will not be achievable for all surface waters, deadline extensions and exemptions will be invoked for them. The envisaged measures are unlikely to improve chemical status quickly enough, however, owing in particular to mercury.

The aforementioned deadline extensions and exemptions are attributable to numerous causal factors. For surface waters, technical non-feasibility is often mentioned in this regard (62 percent). What is meant by this are, for example, procedures that (a) are highly time consuming owing to factors such as the imperative succession of the measures in question; or (b) whose elaboration would take more time. Or further research may be needed in order to optimize the measures.

Figure 4

Proportion of planned measures for surface waters, for the current management cycle (2016-2021).



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Groundwater: Status, measures, deadline extensions, exemptions

Status (Section 4.3)

Of the nearly 1,180 German groundwater bodies that have been assessed, 95.7 percent exhibit “good quantitative status”. Most of the relatively few water bodies that exhibit “poor status” have been negatively effected by mining activities. Continuous water abstraction in such cases often results in extensive recession.

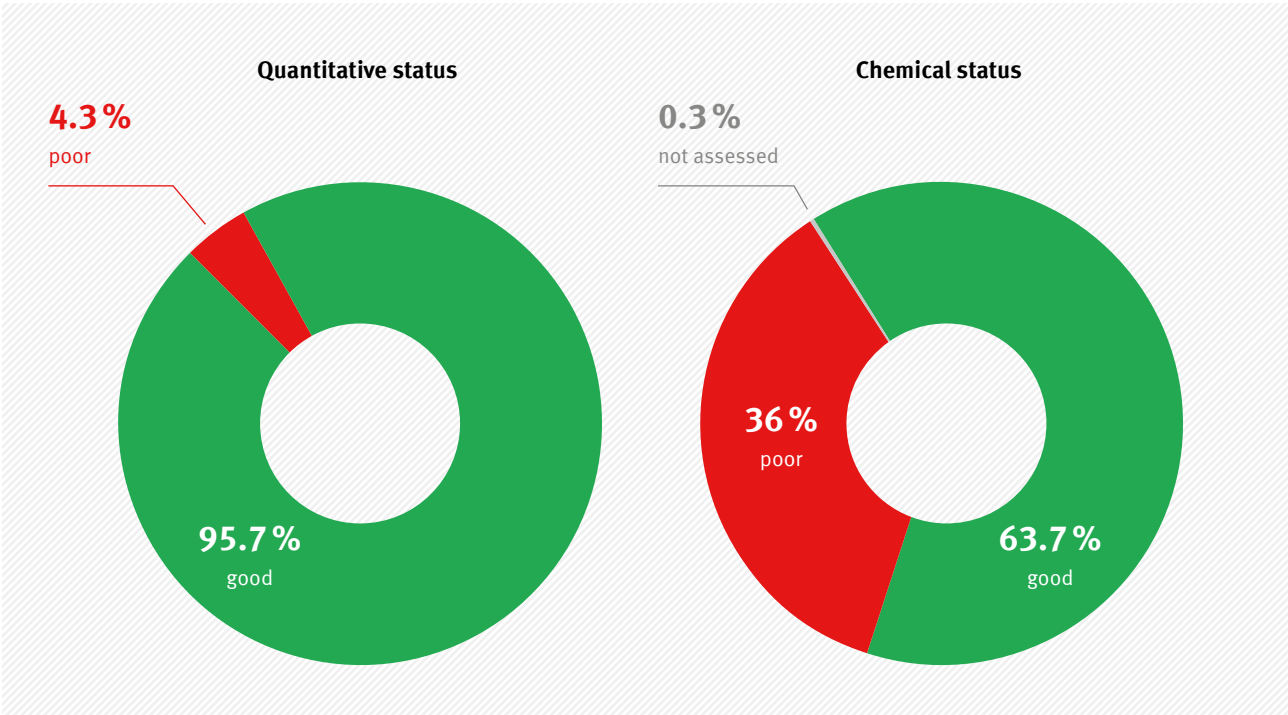
63.7 percent of groundwater bodies exhibit “good chemical status” and 36 percent exhibit “poor status”; relatively few of the water bodies (0.3 percent) have yet to be assessed. Failure to achieve the mandated management objectives is mainly attributable to the presence of nitrates in groundwater. Of the groundwater bodies that exhibit poor status, nearly 74 percent fail the management objectives owing to unduly high nitrate concentrations.

Besides quantitative and chemical status, another assessment parameter is whether groundwater pollutant levels are rising or falling. In 23 percent of groundwater bodies that exhibit “poor chemical status”, rising levels of pollutants and nutrients (significant upward trend) were observed. During the previous management cycle, a decrease in pollutant levels (trend reversal) was achieved in 4 percent of groundwater bodies that exhibit “poor chemical status”. No trend either way has been detected to date in 73 percent of groundwater bodies.

These results are approximately the same as for 2009, mainly because groundwater status has not substantially improved, for two reasons, one of them being low groundwater recharge rates. It often takes years for measures in this domain to exhibit a measurable effect, and new pressures are often only measurable until long after they have actually occurred. Another reason for the lack of improvement in groundwater status is (as has been the case in the past) excessive agricultural nutrient inputs into groundwater, resulting from factors such as rising energy crop cultivation. Further efforts to reduce these types of inputs are needed.

Figure 5

Quantitative and chemical status of Germany’s groundwater bodies.



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Measures and exemptions (Sections 5.1 and 6.1)

Given the fact that groundwater nutrient inputs are mainly attributable to diffuse sources, 89 percent of all envisaged measures aim to reduce this focus of pressure. Most of these measures are aimed at the agricultural and mining sectors, or other diffuse inputs.

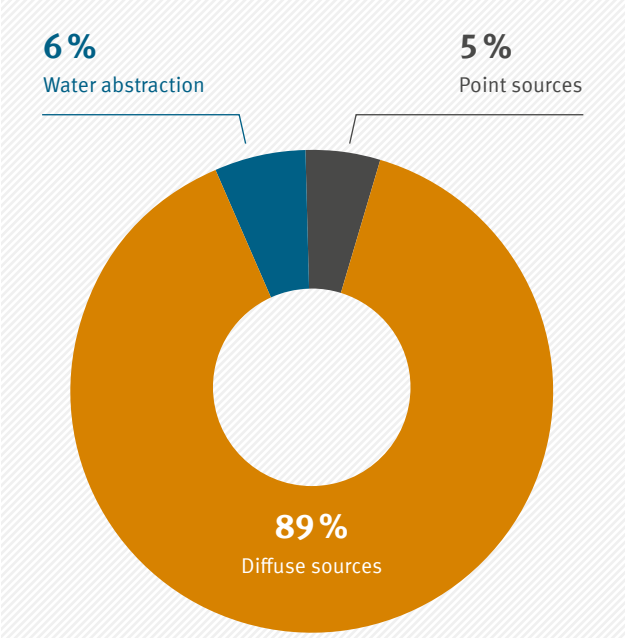
Only 5 percent of all envisaged measures are aimed at point sources, while 6 percent relate to water abstraction.

Deadline extensions and exemptions have been invoked for 4 percent of groundwater bodies that exhibit "poor quantitative status" and for 36 percent of such bodies that exhibit "poor chemical status". The goal is for 1 percent more of these water bodies to achieve "good quantitative status" and 1.5 percent more to achieve "good chemical status" by 2021.

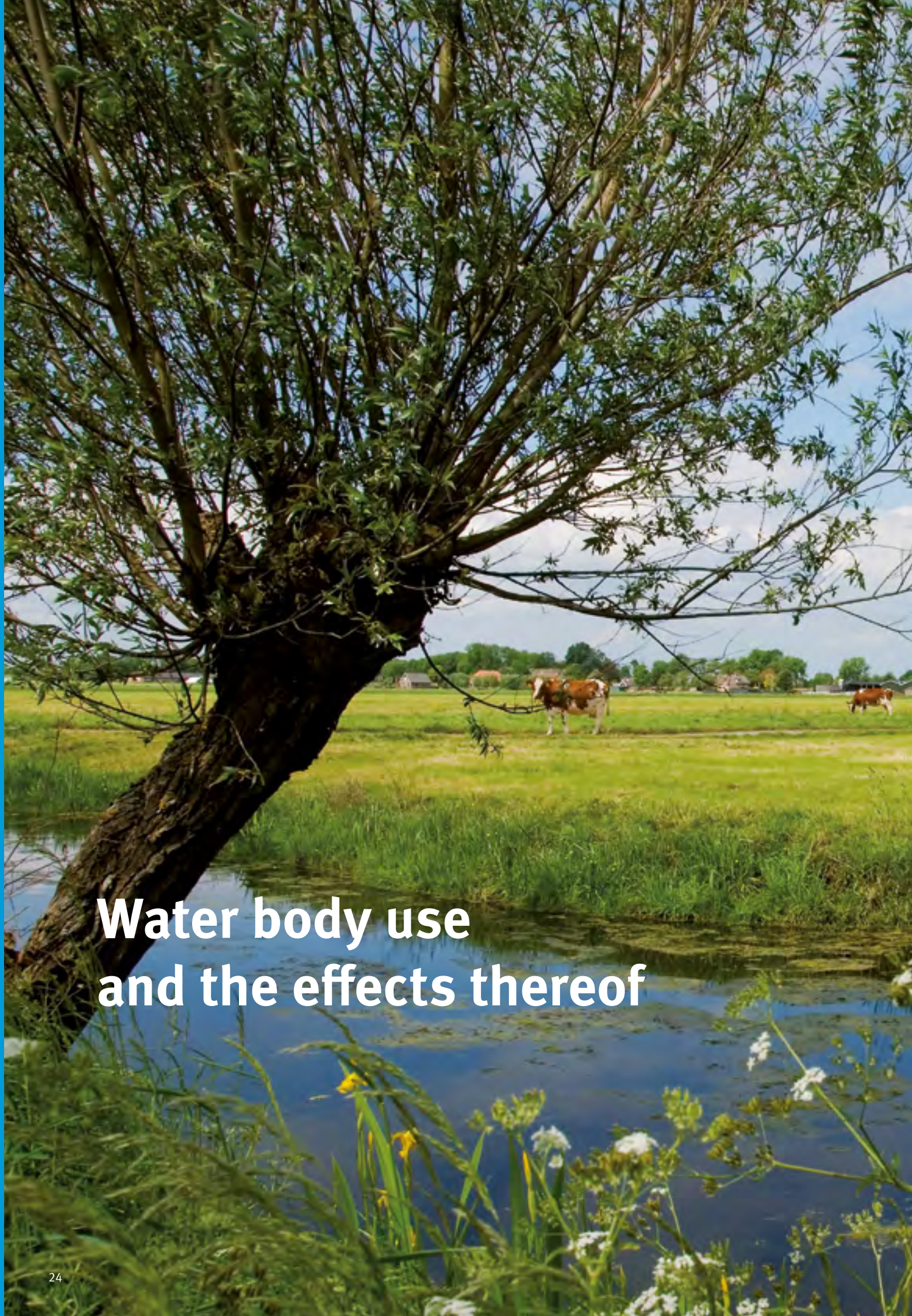
Deadline extensions and exemptions for groundwater are invoked on account of natural conditions in 57 percent of cases. This means that the effects of measures are oftentimes not measurable until long after they have been implemented. For example, it takes decades for groundwater to be replaced. Deadline extensions and exemptions are also invoked owing to the disproportionate costs entailed by the relevant measures.

Figure 6

Proportion of planned measures for groundwater, for the current management cycle (2016-2021).



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.



Water body use and the effects thereof

Water use and poorer rating of water body status is attributable to a host of factors – namely agriculture, municipalities, households, industry, shipping, hydropower and mining. The impact of these uses varies. In most cases, multiple users benefit from a given water body, and thus the impact of such use reflects aggregate use.

Figure 7 provides an overview of key water body users. The interconnections in the graphic indicate examples of the main effects on water bodies. The uses and impacts illustrated in the graphic are discussed in the next section.

Figure 7

Overview of key users and their impact on water bodies.

3.1 Water body uses and pressures

Agriculture

47 percent of Germany's surface area (the equivalent of 16.7 million hectares) is used for agriculture (as at 2015). The lion's share (12 million hectares) of this land is used as cropland, whereas nearly 5 million hectares are used as permanent grassland, predominantly as pasture. As at 2015, Germany had around 281,000 farms, with an aggregate workforce amounting to 1 million (i.e. 2 percent of the German workforce) – although for the majority of these workers, farm work is a second job. Around 6.5 percent of these farms were organic farms.

Germany's agricultural sector currently accounts for only 0.8 percent of GDP. Domestic farm products are the backbone of Germany's food industry. The food processing and supplying industries, which are officially part of the agricultural sector, contribute to value creation and job creation.

A 100 kg per hectare surplus of nitrogen pollutes the environment

In addition to the agricultural products produced by Germany's farms, the sector also generates an average of

100 kilograms per hectare of surplus nitrogen annually (from fertilizers). Hence only slightly more than half of the nitrogen used by German farms is absorbed by crop plants and is transformed into biomass or crop yields. The remainder stays on German farmland, and ends up in water bodies or the atmosphere. Levels of surplus nitrogen have decreased considerably since the 1970s and 1980s, from more than 150 to around 100 kilograms per hectare and year. In 2009, thanks to a nitrogen per hectare level of 84 kilograms, the 2010 nitrogen per hectare sustainability target of 80 kilograms per hectare was nearly reached. However, as nitrogen surplus levels subsequently began climbing again, the objective was failed, due to, among other things, extensive tilling of permanent grassland and the ensuing cultivation of biomass (oftentimes corn). The humus layer of pastureland contains anywhere from 1,000 to 7,000 kilograms of nitrogen per hectare, the majority of which is converted over a period of a few years, after plowing. As these figures have not changed significantly since 2010, no conclusions concerning a trend can be reached. From an ecological perspective, efforts should be made to achieve a level of less than 50 kilograms of surplus nitrogen per hectare – a level that farms that use their land judiciously are already able to adhere to.

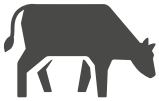
Nearly 80 percent of all surface water nitrogen inputs are attributable to the farming sector. This sector now accounts for about half of all phosphorus inputs as well, once phosphorous removal from sewage treatment plants takes effect. The main causes of agricultural nutrient inputs into water bodies are as follows: uneven livestock herd distribution, which results in appreciable soil inputs of nutrients and organic fertilizer at the regional level; the failure to comply and monitor compliance with the Fertilization Ordinance (Düngeverordnung); massive nutrient use for certain types of crops such as vegetables.

The German agricultural sector uses nearly 35,000 tons of active pesticide agents annually. Between two and six of such substances are used for grains, and more than 30 are used for certain fruit crops. Although the substances that cause the most water body pollution have already been taken off the market, atrazine and above all its breakdown product desethylatrazine still constitute substances whose groundwater levels exceed the 0.1 microgram per litre threshold value.

The German agricultural sector is subject to a series of environmental regulations. The 1996 Düngeverordnung (Fertilization Ordinance), which is based on the EU nitrate directive, was enacted with a view to reducing agricultural inputs into water bodies. This regulation is currently being revised owing to the unsatisfactorily low impact it has had in practice. In addition, nationwide rules concerning storage facilities for substances hazardous to water such as liquid manure, slurry and silage effluent are currently being drafted with a view to avoiding environmental hazards such as inputs attributable to leakage. Pesticide use is governed by Regulation No (EC) 1107/2009 and by Germany's Pesticide Act (Pflanzenschutzgesetz), underpinned by an action program.

Farming has a range of water body effects, which vary from one setting to another. In conventional-farming settings, nutrients and pesticides are particularly likely

to be input into groundwater or surface waters as the result of wash-out, spray drift, erosion or percolation into the soil. Levels of these agricultural diffuse inputs are particularly high in regions with large numbers of livestock, in cases where, via liquid manure, more nutrients are applied to fields and pastures than the crops actually need for their growth. In areas with permeable soil, nutrients are input into groundwater along with percolating water. In purely cropland regions, on the other hand, oftentimes a need for humus reproduction via the use of animal fertilizers arises – the main problem here being the failure to relate livestock herd size to hectares cultivated and the uneven distribution of livestock farming across the relevant areas. Trans-regional liquid-manure balancing, i.e. transporting liquid manure from areas with surpluses to areas with shortfalls has begun; but such efforts entail logistical problems and costs.



The uneven distribution of livestock herd size is a serious problem

In areas dominated by farming, many areas that are too wet for farming are drained. To achieve more rapid flows, water bodies are often straightened, deepened or narrowed, or flood protection facilities such as polders and slide gates are installed in them. Floodplains and inundation areas are often lacking, as are buffer strips, which provide for retention of nutrients and eroded soil. The lack of embankment vegetation giving shade causes water body temperatures to rise. All of these factors result in the shrinkage of, or major changes in, the habitats used by many aquatic flora and fauna. Plus little land is available for natural water body development.

Buffer strips reduce nitrogen inputs

Since 1 January 2005, EU farmers have been required to meet cross compliance requirements – the upshot of which is that farmers' eligibility for bonus payments is contingent upon their meeting certain requirements. In terms of environmental and water body protection, these requirements fall within the scope of the following: EU directives such as the nitrate directive; and rules aimed at preventing water and wind erosion, reducing percentages of grassland use, and promoting humus preservation. The 2013 agricultural reform ushered in a concept known as greening, which entails the following three requirements: crop diversification; ecologically sustainable land use (providing a certain percentage of farmland as ecological priority areas); and preservation of permanent grasslands. Farmers only receive 30 percent of the direct payments if they meet these requirements. Farms with more than 15 hectares of cropland are theoretically required to designate five percent of as an ecological priority area. However, in reality farmers are allowed to use such priority areas in various ways. Hence the extent to which such areas will or can make a significant contribution to surface water body protection is still unclear. From a water body perspective, ecological priority areas are best able to contribute to nutrient and pesticide input reduction when they are created as buffer strips adjacent to water bodies. Such buffer strips can be up to 10 meters wide. Long term use of pesticides on such strips is prohibited, as is their year round use for the production of agricultural goods – although grazing and mowing are allowed. However, such buffer strips need only be maintained during funding periods; whereas permanent buffer strips are needed for water body protection. Farmers who undertake voluntary water body protection measures are subsidized via agri-environmental programme funds (see Section 5.2).

But the fact remains that despite demonstrable improvements, the current levels of nutrient and pesticide inputs into water bodies are still unduly high. Apart from the aforementioned contamination of groundwater from nitrates and pesticides, nutrients also result in a poor status for many watercourses, lakes, and all coastal waters. Hence agricultural inputs of nutrients such as nitrogen and phosphorous need to be reduced to far lower levels than is currently the case.

Municipalities, households, and the industrial sector

Each year, Germany's municipal sewage treatment plants handle around 10 billion cubic meters of sewage. Half of this sewage is actual sewage, and the remainder is infiltration water and rainwater. This wastewater is treated at nearly 9,400 municipal sewage treatment plants before being discharged into water bodies.

Despite the considerable advances that have been made in the sewage treatment domain, point source pollution from certain nutrients and pollutants remains unduly high and thus needs to be reduced. This applies, for example, to phosphorous, as well as non-readily degradable industrial and household pollutants that in many cases cannot be adequately filtered out at sewage treatment plants. But inputs from combined sewage and rainwater discharges are also still a problem in certain water bodies.

Inputs of pollutants into water bodies should be avoided at their source, whenever possible. According to Germany's Federal Water Act (Wasserhaushaltsgesetz, WHG), the pollutant load in any given discharge must be reduced to the lowest level allowed by state of the art technology and that is necessary in order to meet management objectives. Germany's Waste Water Ordinance (Abwasserverordnung) stipulates which substances are to be filtered out of sewage, and which are not allowed to end up in it in the first place. Inasmuch as household water and industrial wastewater contain widely differing pollutants, this ordinance differentiates between the various types of sewage sources. The substances contained in industrial food-processing sewage from slaughterhouses, breweries, distilleries, dairies and the like are for the most part readily biodegradable – and thus such facilities are often connected to the public sewage grid. But this is not the case with sewage from the chemical, mechanical engineering and automaking sectors, whose discharges contain substances that are not readily biodegradable and that thus are for the most part treated in proprietary facilities, using special processes.

Heavy rains wash increased amounts of impurities into water bodies; quasi natural rainfall management helps in this regard

Combined sewage and rainwater discharges can also cause water pollution. As a result, during heavy downpours in particular, a mixture of rainwater and sewage may be discharged into rivers. This in turn engenders a situation where – apart from the consequent organic pressures on watercourses and lakes – zinc, copper and the like from roofs, rain gutters and tire wear particles may be carried by the water in both compartmentalized and hybrid systems. Hence rainwater management needs to be improved.

Apart from substance inputs, urbanization also has an impact on the habitat characteristics of water bodies, because it used to be the case that water bodies were mainly used in order to meet the needs of residential areas, industrial uses, and infrastructure measures and were modified by straightening them, re-locating them or canalization. Moreover, flood protection measures such as embankments result in extensive losses of floodplain and inundation area. Given the fact that abrupt discharges on paved surfaces following heavy downpours can generate hydraulic pressures, insofar as possible such rainwater should be handled in a near-natural manner, particularly in densely populated areas, e.g., via percolation systems or by increasing evaporation. If this is not possible, then rainwater runoff should be collected in sufficiently large retention basins, temporarily stored there, and then discharged in a controlled fashion.

Excessive land use and land development for households, industry, and traffic infrastructures have a devastating impact on the natural environment and the countryside. In Germany, land use amounts to roughly 69 hectares each day; the government's goal is to reduce this to 30 hectares. If land use remains at such a high level, it will be difficult to reduce rainwater discharges.

Industrial pollutants pose a particular problem when they are discharged into the environment and accumulate, for example, in lake or river sediments, and are amenable to little or no biodegrading. Some of these chemical substances are also bioaccumulative, i.e. they accumulate in living organisms. The list of such substances is long. The widespread failure of surface water bodies to achieve good chemical status is mainly attributable to mercury and polycyclic aromatic hydrocarbons. The latter are discharged into the environment during all combustion processes involving organic materials such as wood, coal or oil; or they are elements of fossil fuels, and thus are also found in many petroleum-based products.

Mercury is also discharged into the environment, mainly by energy companies and fossil fuel combustion. Because mercury barely reacts with other substances in the atmosphere, it spreads over great distances to areas of varying sizes. Mercury can also enter the atmosphere via the extraction of this substance, as well as through the metal-working industry.

Shipping

90 percent of EU foreign trade and more than 40 percent of EU domestic trade are carried out via sea lanes. The North Sea and Baltic Sea are among the world's most heavily trafficked seas. Germany has 23,000 square kilometres of sea shipping routes, and the Hamburg, Wilhelmshaven and Bremen/Bremerhaven North Sea ports are among the busiest in Europe. In the Baltic Sea, Lübeck, Kiel and Rostock are key ferry ports, and are also ports of call for cruise ships.

The Rhine: number 1 waterway

More than 10,000 kilometres of Germany's waterways network are used for commercial shipping and recreational boating in motorized vessels. Around 7,300 kilometres of these watercourses are under federal control, and in their capacity as federal waterways, interface with major seaports and industrial centres. Up to 240 million tons of goods annually are transported on German waterways, and thus account for an average of 9 percent of overall annual traffic capacity in Germany. Most inland shipping occurs in the Rhine corridor, amounting to around 88 percent of inland commercial shipping transport volume. However, other federal waterways such as the Oder, Weser, Elbe and Ems rivers are of lesser and in some cases declining importance in this regard.

Hence sea and inland shipping are of fundamental economic importance, but also have an effect on hydrological regimes. Because ships mainly sail near coastal areas, environmental pollution has the greatest effect on these waters. This pollution is mainly attributable to the following: air and water pollutant and particle emissions; noise emissions; port construction and facilities; and the introduction of foreign species. The Baltic Sea is a prime example of a regional body of water that is particularly vulnerable, but that is also heavily trafficked. Given the fact that it only undergoes seawater exchange every 30 years or so, which means that fresh, oxygen-rich water can only flow into it via the North Sea, Baltic Sea shipping regulations have been tightened. In order for a natural river to be used as a modern shipping lane, numerous changes have been made in these rivers and their floodplains. In conjunction with urbanization and agricultural uses, this results in narrowing of the river, its being cut off from its natural floodplains by flood prevention structures, and in certain stretches, its being dammed. Hence, these federal waterways now contain more than 340 impoundments, few of which adequately allow for fish migration. In these river stretches, damming slows the river's flow rate, resulting in nutrient and pollutant accumulation; plus natural sedimentation transport no longer occurs. This is in turn results in the fragmentation of aquatic habitats. The low water flow rate causes river water temperature to rise more rapidly, disrupts flow dynamics and promotes algae growth. More than 90 percent of the hydromorphology of federal waterways has been altered either substantially or completely. According to a Federal Agency for Nature Conservation floodplain status report, on Germany's major rivers (the Rhine, Elbe, Danube and Oder) only 10 to 20 percent of their original

inundation areas for flood-water retention remain, and only 10 percent of existing river basin floodplains larger than 1,000 square kilometres in size can be assessed as being natural or near-natural.

Thus characteristic aquatic habitat organisms no longer find the conditions necessary for survival, and the objectives mandated by the Water Framework Directive are barely reached in federal waterways.

340 impoundments in federal waterways are an impediment for migratory fish

Hydropower

One of the main causes of greenhouse gas emissions is electricity generation, which today accounts for nearly half of all carbon dioxide emissions. Thus electricity generation using emission-free renewable energy can make a substantial contribution to climate protection and is therefore of great importance. Renewable energy, which is derived from wind power, solar power, biomass, geothermal energy and hydropower, also promotes security of supply and helps to avoid raw materials conflicts.

80 percent of Germany's hydropower is generated in southern Germany

By virtue of Germany's long tradition of hydropower use, the usable potential for this energy source has largely been exploited. Thanks to hydropower, over the past decade between 18 and 23 terawatt hours of largely emission-free electricity have been generated that have met between 3 and 3.6 percent of gross electricity demand and have avoided 16.7 million tons of carbon dioxide emissions. More than 90 percent of all hydropower comes from 5 percent of hydropower plants. Germany has around 400 such large plants, with installed power of more than 1 megawatt. The country's remaining hydropower is generated by around 7,300 small hydropower plants. However, the environmental impact of each such plant is oftentimes not much lower than that of the larger plants. Hydropower prevalence varies from one river basin to another. Favourable conditions for hydropower are found in all major rivers, and in the regions of the Alps, Alpine foothills and highland areas that abound in rivers and slopes. Hence more than 80 percent of Germany's hydropower is generated in the southern German states of Bavaria and Baden-Württemberg. Around 86 percent of the operational capacity of Germany's major hydropower plants is located on nine rivers, which in descending order of capacity are the Inn, Rhine, Danube, Isar, Lech, Moselle, Main, Neckar and Iller.

Hydropower plant construction and operation nonetheless have a considerable impact on watercourses – an impact that can only be reduced to a limited degree. Most of this impact is attributable to weirs construction and turbine operation. Hydropower weirs hinder or disrupt fish and invertebrate spawning, dispersal and feeding migration – and thus are detrimental to river continuity, which is crucial. Moreover, hydropower facilities interfere with natural bed load transport. In addition, weir-induced backwater formation, insufficient throughflow and dried out diversion stretches also cause considerable habitat loss, because the rivers lose a considerable amount of their dynamics. Turbine operation and other hydropower plant elements can potentially injure or kill fish of all ages, during downstream migration. In impoundment chains containing a succession of hydropower plants, the sum total of the aforementioned effects can endanger whole fish populations; whereby Water Framework Directive management objectives are failed in large stretches of such rivers, owing to the substantial changes that fish fauna have undergone. The species most affected include eels, allis shad, and salmon, which migrate over lengthy stretches and need to transition from saltwater to fresh water.

Mining and water abstraction

Mainly lignite, rock salt and potash are mined in Germany. From a water body protection perspective, however, the impact of past hard-coal mining activities in the Ruhr and Saar regions and past ore mining in the Erzgebirge and Harz regions and elsewhere in Germany is also a major factor. Germany's three largest lignite deposits are located in the Rhine, Lausitz and Middle German mining districts. Economically important salt deposits comprise the large mining areas in the states of Hesse and Thuringia.

Opencast-mining induced lowering of groundwater levels has serious delayed effects

Mining activities can have a considerable impact on surface waters and groundwater during the active life of a mine and for many years thereafter. Mining oftentimes entails major interventions in the natural water cycle, particularly in the case of open pit mining, which necessitates lowering of the groundwater level – which can be deleterious for adjacent aquatic and terrestrial ecosystems. Restoration of natural groundwater levels in Germany's lignite mining regions will take decades (including after the mines in question are abandoned) due to the fact that such mining has been going on for more than a century in some areas. In addition, recession induced by lignite mining is responsible for the poor quantitative status of groundwater in certain portions of the Maas, Rhine, Elbe and Oder river basins.

Hard-coal mining in some parts of the Ruhr region has resulted in large scale mining subsidence that would in turn result in large scale inundation if groundwater levels returned to their natural state. Hence it is necessary to lower the groundwater level on an ongoing basis in order to keep it sufficiently below ground level. Other necessary measures in this regard include diverting watercourses or building embankments and flow regulation via the construction of transverse structures and the construction and operation of pumping facilities.

Potash mining pollutes rivers and ground water

Potash is mainly mined in the Weser river basin district. Apart from the dry salt waste yielded by this activity, a portion of the saltwater generated by it is discharged into the ground, while the remainder is discharged directly into the Werra river. Studies have shown that naturally occurring water in rock pores containing underground saltwater rises to the surface or to higher groundwater levels, whereupon some of this water is discharged into the Werra river as a diffuse input. There are also concerns that salt inputs could contaminate aquifers.

Ore mining in the Weser river basin district was discontinued for the most part in the 1930s. Although the last mine closed in 1992, diffuse heavy-metal inputs from the Harz region induce significant water body pressures in the Leine and Aller sub-basins of the Weser river basin district. These pressures are attributable to emissions from mine dumps, contaminated floodplain soil and metal-containing river sediments.
When mining is discontinued, the question often arises as to what is to be done with the landscapes that is significantly altered. The abandoned mining areas in the Lausitz and Middle German regions have been turned into a recreational zone containing 46 artificial lakes amounting to 25,000 hectares of water body surface area. Hence it is necessary to keep the opencast mining pits filled with river water at all times. To do this, large amounts of water must be abstracted from the nearby surface waters. Moreover, mine dumps contain sulfur-containing minerals such as pyrite and marcasite, which exhibit a strongly acid reaction on contact with water. This often results in the formation of lakes such as Lake Scheibe (near Hoyerswerda) with extremely acidic water (pH ranging from 2 to 4), rendering them completely unusable. The pH of this lake, which was inundated by groundwater, is 2.9. The lake was treated using quicklime, thus neutralizing its pH for tourist use. In this way, numerous recreational areas and excellent refuges for rare animal and plant species have been created in former mining areas.

3.2 Impact on water bodies

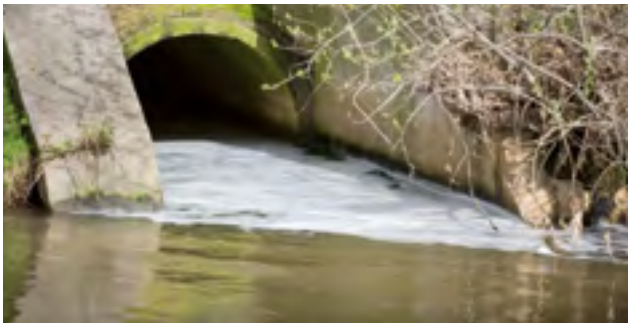
Eutrophication (nutrient oversupply)

All plants need nutrients such as nitrogen and phosphorus in order to grow. Despite the considerable progress that has been made thanks to input avoidance, the still excessive inputs of nutrients into many water bodies from agricultural activities and municipal sewage treatment plants induce high levels of algae and aquatic plant growth. This results in a high level of nocturnal oxygen consumption. When these algae and aquatic plants die and sink to the bottom, they are broken down by microorganisms. These microorganisms need a considerable amount of oxygen for the breakdown process, as is also the case with organic inputs such as those occasioned by fecal matter. But aquatic organisms cannot survive without oxygen. Consequently, a lack of oxygen in water bodies always has a negative impact on fish and small organisms and thus on water body ecobalance – and can be fatal to such organisms in extreme cases. The consequences of excessive nutrient inputs are also observed in large bodies of water such as the North Sea and Baltic Sea, and are clearly evident in coastal areas, by virtue of algae that washes up on the beach, or foam in the water. Foam occurs in cases where, owing to the physical destruction of algae by wave impacts, cell protein is released and is transformed into foam by the natural motion of the water. Other possible consequences of excessive nutrient inputs are reduced transparency, limited depth distribution of macrophytes, lack of oxygen, zoobenthos damage and fish death.

In lakes, high nutrient concentrations can induce potentially toxic blue-green algae proliferation. Because blue-green algae results in clouding, it induces a hazardous reduction in transparency, and also forms toxins that can provoke skin rashes, as well as diarrhoea if the lake water is ingested. Hence it is necessary to prohibit swimming in lakes with high levels of blue-green algae. The toxins can also interfere with purification treatment of surface waters to produce drinking water.

The main pollutant found in groundwater is soil-derived nitrate. Elevated nitrate concentrations are detrimental to water body ecology and reduce drinking water quality – and thus can constitute a health hazard. Groundwater containing nitrates can also be emitted into surface water bodies that are fed by groundwater.

Pollutant inputs



Water body pollutant inputs are mainly attributable to the following: industrial, commercial and municipal treatment plant discharges; diffuse inputs from farmland, shipping and mining.

The most prevalent pollutants are heavy metals and pesticides. Micropollutants such as hormones and pharmaceutical drug residues are input into water bodies via domestic sewage because they cannot be fully removed at sewage treatment plants. Some pollutants undergo little or no breakdown. They often end up in sediments, where under certain conditions such as flooding, are released and enter the water cycle and food chain. This can result, for example, in high concentrations of mercury in fish entering the food chain.

Pollutants can also reach groundwater via surface waters and after being washed out of contaminated soil. High concentrations of pesticides, as well as veterinary drugs residues, are found, for example, in the groundwater in regions with intensive farming. Groundwa-ter pollutants are particularly problematic in case of substances or inputs that do not occur in nature, that are hazardous to human health or water body ecology, or that do not break down or break down very slowly in groundwater. Cleaning up polluted groundwater often takes years – if it can be cleaned up at all. But groundwater always needs to be a suitable drinking water resource and should not pollute surface water bodies.

Changes in and lack of habitats

Aquatic organisms need not only clean water, but are also adapted to many different types of aquatic habitats such as the following: shallow and gravelly water beds; deep potholes; shelters beneath roots; aquatic plants; deadwood (branches or twigs lying in or floating on the water); loose sand that organisms can very easily entrench in. Hence the more diverse habitats are, the greater the number of fish, plants and small organisms in water bodies. But unfortunately, over the past 50 years these habitats have been altered or destroyed by river and stream straightening, embankments and damming for urbanization, agriculture, shipping and hydropower use. The upshot is that only a handful of German water bodies still exhibit an adequate level of biodiversity.

The habitat diversity of a water body and its structure (e.g. whether a river is straight or curved) is referred to as water body hydromorphology. The more varied a water body's hydromorphology is, the greater the number of different types of habitats it will have – and thus the more diverse its biota will be. Hydromorphology assessments (i.e. determining the extent to which a water body deviates from a natural or near-natural state) are based on hydromorphological quality. Virtually all uses of a given water body degrade its hydromorphology. Such non-substance pressures have a major impact on the ecological functionality of a given water body. In addition to modifying the landscape, such changes also rob aquatic organisms of their habitats and hence their means of survival.

Deficient continuity

Both upstream and downstream as well as transverse to the current and up to the accompanying floodplains, a natural river will enable migratory aquatic organisms to move through the river without impediment; and thus sloping stretches will allow for the unimpeded transport of both solid and dissolved substances. This unimpeded movement is referred to as continuity. In our artificial landscape, river continuity is disrupted by numerous technical structures that allow for hydropower use, shipping, drinking water abstraction, irrigation, ground reinforcement, and the creation of artificial lakes for recreational purposes. Such structures often create water body impediments that are several meters high and wide.

For spawning and feeding in particular, it is crucial that fish be able to migrate over extensive water body stretches, in order to find the conditions that they need for their survival, and in their various life cycle phases. For example, a suitable spawning habitat may be located many kilometres upstream in a shallow and gravelly stretch of a river; whereas feeding grounds may be located far downstream in deeper and warmer waters; and winter retreats may be sited far downstream in deep oxbows or potholes. Upstream continuity is particularly important for species that undertake lengthy migrations between saltwater and fresh water. Moreover, such species need to be protected against hydropower plant turbines and water abstraction facilities that are hazardous to these organisms during downstream migration. Unimpeded movement in water bodies is also a key factor for species propagation and re-colonization after flooding.

Elevated water temperatures

Many power plants use river or lake water as a coolant. The heated coolant is then discharged back into the river or lake, and can cause their temperatures to rise. The main focus of freshwater biology includes, among other things, water body temperature increases resulting from a lack of shoreline trees that would normally create shade. Climate change can also be a causal factor in rising water temperatures.

Such increases have an impact on aquatic organisms, in that water body oxygen content is reduced, fish migration patterns change, spawning periods change and species migrate in search of the colder and more oxygen-rich waters that they need. These phenomena can alter the entire species spectrum and promote colonization by alien species.

Falling groundwater levels

Extensive water abstraction arising from activities such as mining, as well as potential groundwater overuse attributable to drinking or utility water abstraction cause groundwater levels to decrease. If the groundwater regeneration rate is lower than the abstraction rate, recession ensues. This in turn impacts ecosystems that are dependent on groundwater (particularly floodplains) and groundwater quality.

In Germany as in other regions around the world, groundwater is a vital and indispensable resource. The drinking water for more than two thirds of the German population comes from groundwater. Both groundwater abstraction and water consumption have been decreasing in Germany for years now. According to the hydropower industry association known as Bundesverband der Energie- und Wasserwirtschaft (BDEW), annual groundwater abstraction for the public drinking water supply decreased from 4.79 to 3.53 billion cubic meters between 1990 and 2010.

In 2010, in addition to the 3.53 billion cubic meters of groundwater that were abstracted for the public drinking water supply, 1.21 billion cubic meters were abstracted for mining and quarrying products, 0.75 billion cubic meters for the manufacturing sector, 0.12 billion cubic meters for energy production, and an aggregate 0.22 billion cubic meters for all other economic sectors, including agriculture. Hence, the fact that a total of 5.84 billion cubic meters of groundwater (including well water) were abstracted in Germany in 2010 means that around 12 percent of the average amount of regenerated groundwater (48.2 billion cubic meters) was consumed.

Apart from the possible impact of various groundwater uses on groundwater levels, climate change can also have an impact on groundwater. Effects on water availability are most likely to be felt over the coming seven to eight decades. Water is likely to grow scarcer in eastern Germany in particular, owing to declining groundwater regeneration rates.

2015 water body status

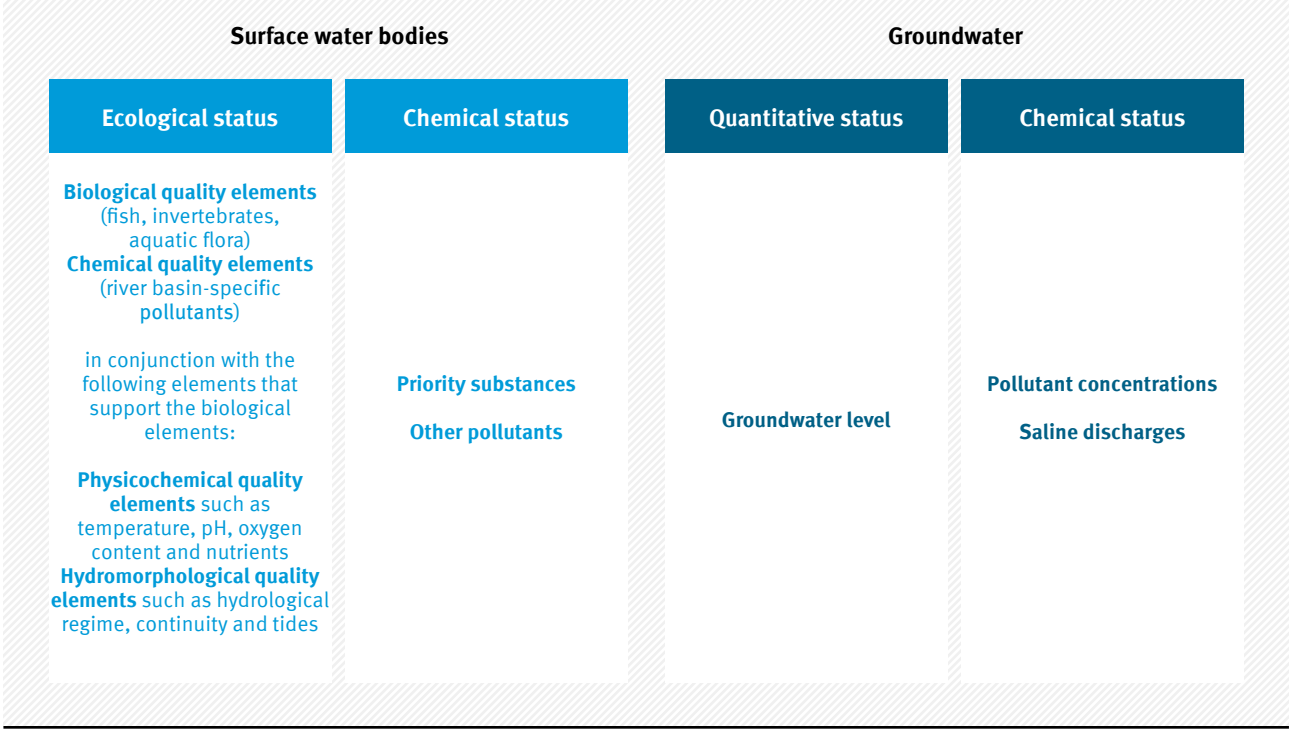
The quality of Germany's water bodies has greatly improved in recent decades. However the multiple uses to which German water bodies are put has occasioned changes in their status and continues to do so. But in order to comparatively assess these changes and water body status, a uniform yardstick and a shared understanding as to what makes for good water body status are needed.

The Water Framework Directive is the result of a consensus that has been reached in the EU to the effect that the better the status of a given water body, the more natural and pristine it is. For lakes and rivers, such assessments are based on the presence and diversity of flora and fauna, as well as structure, channel flow and quality (i.e. free of pollutants). In case of groundwater, the assessment criteria are pollutant load and possible changes in groundwater volume, because this is also a metric for a balanced hydrological regime. Good status means that relatively few changes have been occasioned by human activity in the past.

Figure 8 provides an overview of the criteria that form the basis for water body status assessment, as per the Water Framework Directive.

Figure 8

Overview of surface water body and groundwater status assessment criteria, as per the Water Framework Directive.



For the biological quality elements, procedures are used that shed light on various pressures based on biota composition. This, for example, has allowed for the elaboration of standardized assessment methods such as Perlodes for invertebrates, fibs for fish, and Phylib for aquatic flora. Guide values have been developed for the classification of physicochemical and chemical characteristics. River basin-specific pollutants are contaminants that are discharged in large amounts into the relevant watershed – an example being heavy metals in mining regions. Environmental quality standards – whose values are not to be exceeded in water, sediment or biota (e.g. fish muscular meat) – have been elaborated for these substances, as well as for priority substances and other pollutants. Priority substances are contaminants or contaminant groups that pose a severe risk for aquatic environments.

Inasmuch as the methods used for assessing the various elements and for pollutant analyses are standardized throughout Germany and are consistent with the methods used by other EU member states, German results can be compared with those obtained throughout the EU.

4.1 Water body monitoring

Water body status assessments in Germany are based on extensive monitoring programs, for which numerous water body investigations and measurements are necessary. To this end, in Germany and the other EU member states, countless water samples are analysed, water bodies are mapped and assessed over distances of thousands of kilometres, and fish, plankton, invertebrate and plant samples are collected. These organisms are then counted and identified, and all observations are evaluated. The purpose of surface water and groundwater monitoring is to obtain conclusive results for water body status assessments, along with an overview of chemical pollution pressures. Such monitoring serves as a basis for measure planning and outcome evaluations, with a view to determining whether the measures in question are having the desired effect.
A given water body is also monitored if it is unclear why it has failed the objectives, or if long term trends involving nitrate concentrations or the like in groundwater come to light. This also applies to determinatnts of the scope of pollution engendered by accidents or hazardous incidents.
The Water Framework Directive distinguishes between the following three types of monitoring:

- Surveillance monitoring
- Operational monitoring
- Investigative monitoring

600 Surveillance monitoring sites provide an overview of surface water bodies

The results of surveillance monitoring chiefly allow for assessment of overall status in any given river basin area or sub-basin. They help to supplement and validate pressure estimates and shed light on long term changes in a given river basin. Most of the monitoring sites used for investigative monitoring are located in major rivers, at the mouths of major tributaries and in large lakes. All Water Framework Directive quality elements are measured at the various surveillance monitoring sites at least once during every six year management cycle. In 2015 the federal states defined just under 600 surface water monitoring sites for this type of monitoring.

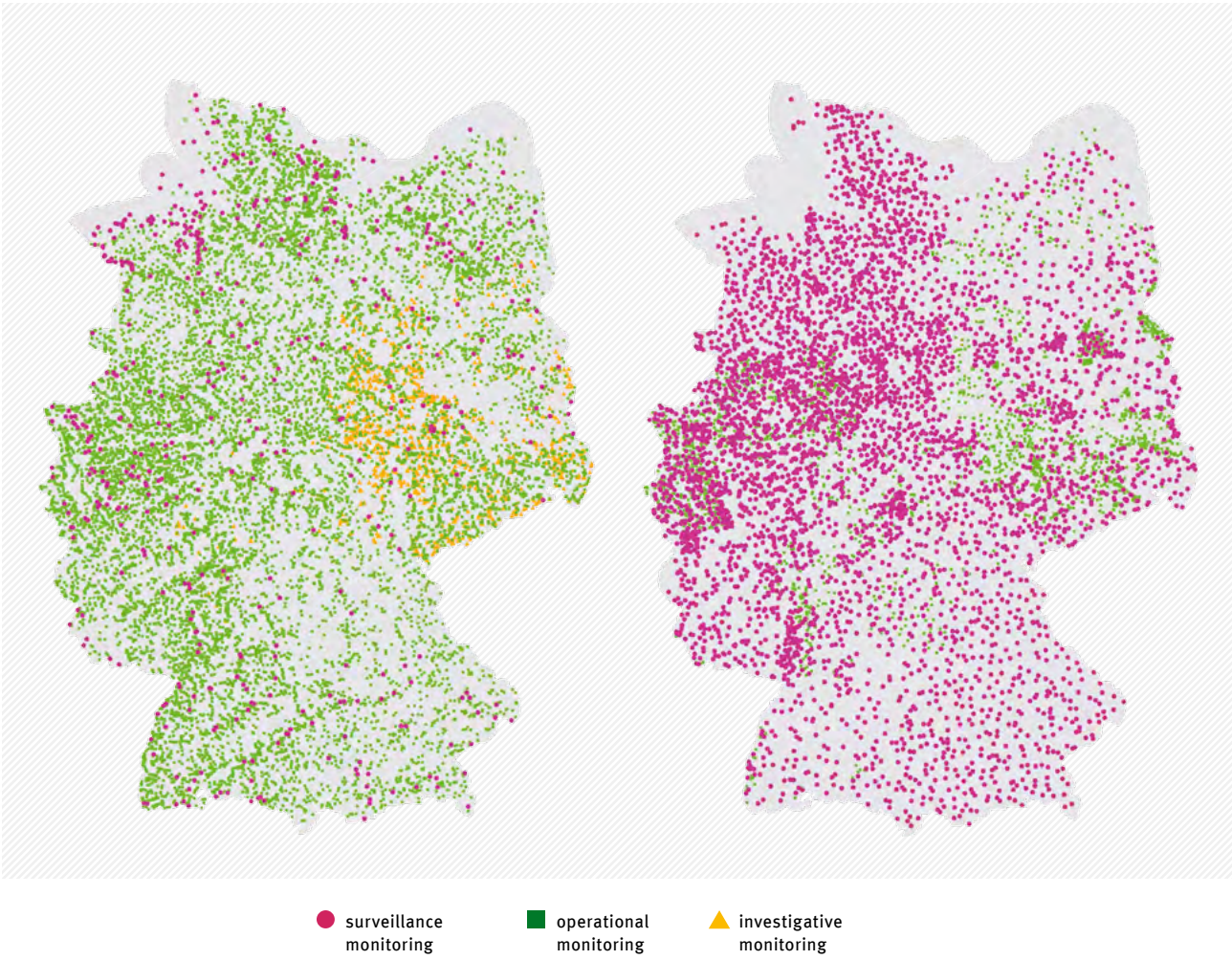
The purpose of operational monitoring is to establish the status of those bodies (a) that are assessed as being at risk of failing to meet their management objectives; or (b) into which significant amounts of priority substances or specific pollutants are discharged. Operational monitoring is also carried out in order to assess any changes in the status of the relevant bodies resulting from the programmes of measures. Given that operational monitoring centres around pressures, and that it becomes more finely meshed in the presence of increasing pressures and depending on water body status, the measurement network can be made less finely meshed

Map 2

Surveillance, operational and investigative monitoring sites in Germany's surface waters.[3]

Map 3

Surveillance and operational monitoring sites in Germany's groundwaters.[3]



Spatial base data: Geo-Basis-DE/BKG 2015

Technical data: Berichtsportal WasserBLIcK/BfG; last updated: 23.03.2016 and 02.02.2015 (groundwater); Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

insofar as water body status improves. Operational monitoring is used solely to monitor the quality elements of the water bodies being assessed that are subject to high pressures. The biological quality elements are monitored in most cases. In 2015 the German states defined 14,000 surface water monitoring sites for this type of monitoring.

3 Monitoring stations can serve several functions, e. g. as surveillance monitoring and operational monitoring sites (depicted in the maps as surveillance monitoring stations). This dual function is found in about one third of all monitoring sites for groundwater, less frequently in monitoring stations for surface waters.

Problematic water bodies are monitored at more than 16,000 monitoring sites

Monitoring for measurement purposes is carried out solely in surface waters for which the causes of high pressures are unknown, or where the goal is to measure the impact of pollution resulting from events such as accidents. The German federal states have defined around 1,250 surface water monitoring sites for this type of monitoring. Map 2 shows the monitoring sites that are used for surface water monitoring.

A 5,000-site groundwater surveillance monitoring network and an operational measurement network for chemical status assessment purposes have also been established (Map 3).

As with surface waters, surveillance monitoring is realized at least once during each river basin management cycle, whereas operational monitoring is carried out at least once a year. A monitoring network, with monitoring sites in each groundwater body, has also been implemented for quantitative groundwater status. Measurements intervals are defined in such a way that both short and long term fluctuations occasioned by aquifer recharge, water abstraction and discharges are monitored. This network is intended to allow for the monitoring of natural and long term changes in quantitative water status and consists of nearly 6,000 monitoring sites in Germany.

The number of surface water monitoring sites has increased relative to the first management cycle, particularly for operational monitoring in rivers, with a view to optimizing monitoring of the pressures and impacts on these water bodies; whereby the number of groundwater monitoring sites used for operational monitoring has also been increased in some regions (Table 1). Monitoring sites can be used for both surveillance and operational monitoring (Table 1 mentions each monitoring site only once).

Table 1

Overview and numbers of monitoring sites for the various monitoring types and water body categories in Germany 2009 and 2015.

Water body category	Year	Surveillance	Operational	Investigative
Rivers	2009	290	7,178	328
	2015	**313**	**13,256**	**1,232**
Lakes	2009	67	449	0
	2015	**163**	**663**	**25**
Transitional waters	2009	5	19	0
	2015	**43**	**13**	**0**
Coastal waters	2009	32	85	0
	2015	**75**	**76**	**0**
Groundwater	2009	4,756	1,783	0
	2015	**4,892**	**2,273**	**0**

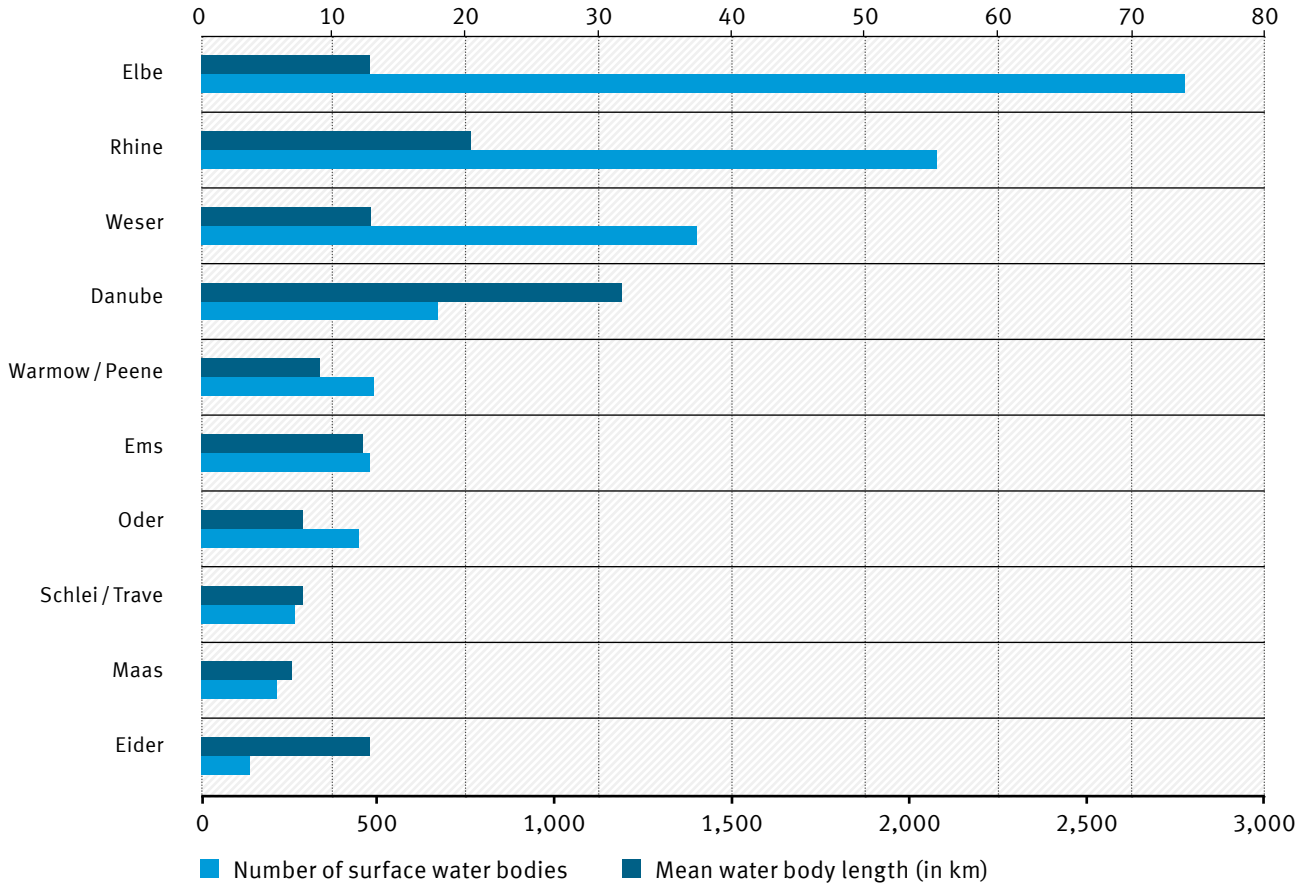
Source: Berichtsportal WasserBLIcK/BfG; last updated 22 March 2010, 23 March 2016 and 2 February 2015 (groundwater).
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

4.2 Surface water status

The assessments of surface waters – e.g. rivers, lakes, transitional waters and coastal waters – refer in all cases to a water body, which is the basic management unit of the Water Framework Directive. A water body can be one or more interconnected streams, a river, a lake, a river reach, a reservoir, or a portion of a canal. In Germany, more than 9.800 surface water bodies have been designated and are currently being managed. The vast majority of them (92 percent) have rivers and streams. In Germany, 137,000 kilometres of river fall within the purview of the Water Framework Directive. These rivers, whose length averages around 15 kilometres (Figure 9), are distributed across just under 9,000 water bodies. There are also 732 water bodies for lakes, five for transitional water bodies and 75 for coastal water bodies.

Figure 9

Number and mean flowing length of river water bodies in the 10 river basins that are relevant for Germany (n=8,995).



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Heavily modified and artificial water bodies

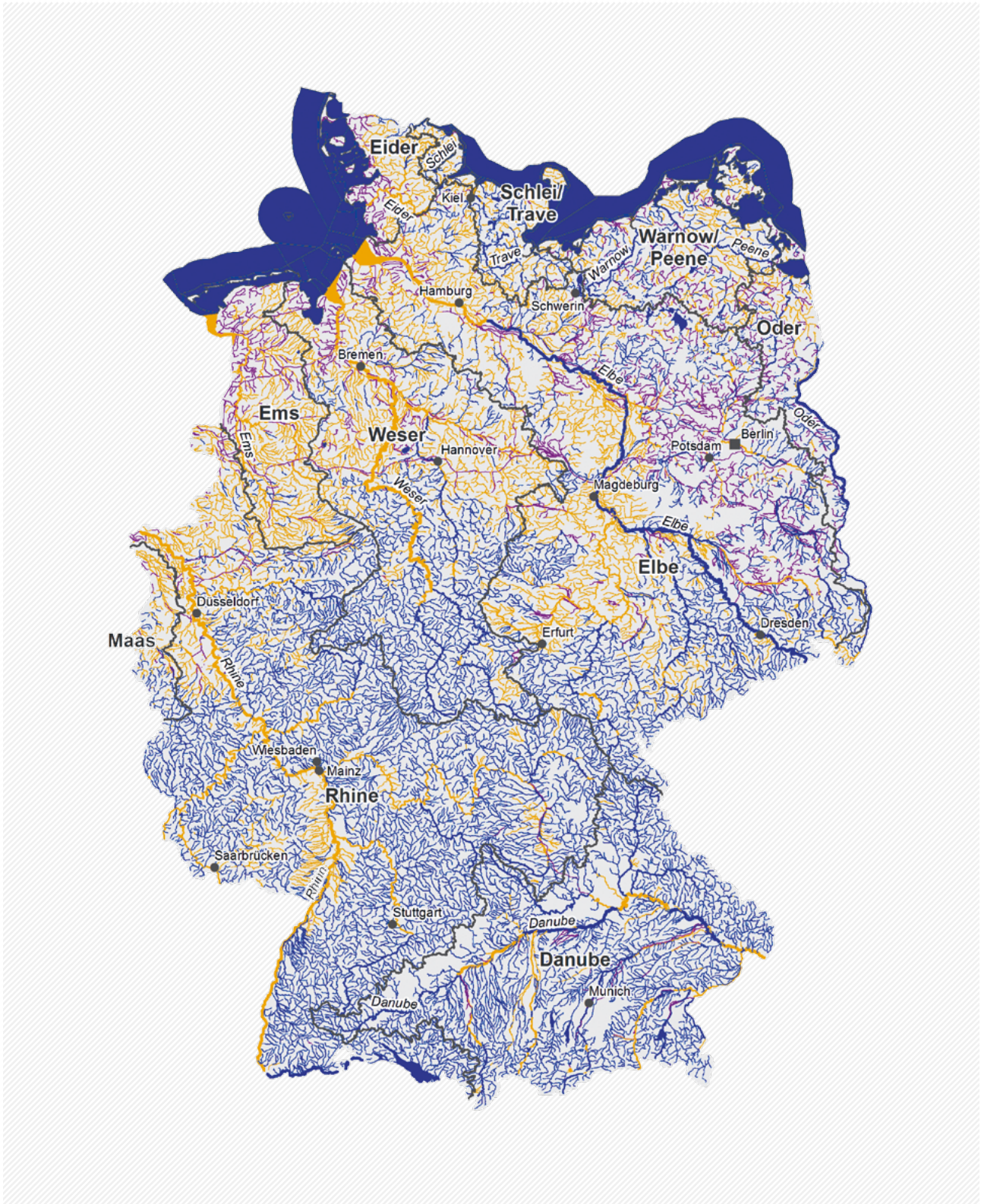
The Water Framework Directive differentiates between natural, heavily modified and artificial water bodies. A heavily modified water body is one whose use has altered its hydromorphological structure to such a degree that it can no longer achieve "good ecological status" owing to a lack of characteristic habitats without significantly interfering with its use – which is also irreplaceable, however. Such water bodies often include major rivers that are used for shipping, water bodies in lowland areas that are heavily drained for agricultural purposes, marsh water bodies and reservoirs.An artificial water body is a water body such as a canal or an opencast mine lake that has been created by human beings in a location where no water body previously existed.
As regards the ecological status of heavily modified and artificial water bodies, these are subject to a different water quality management objective – namely the highest possible ecological status (referred to as "good ecological potential") in the presence of intensive use for activities such as shipping or agriculture. The chemical status requirements are the same as those for natural surface water bodies.

Heavily modified water bodies need to achieve "good ecological potential"

In Germany, 35 percent of all surface water bodies are assessed as being heavily modified and 15 percent as artificial (Map 4). Hence 50 percent of Germany's surface water bodies need to attain "good ecological potential" in lieu of "good ecological status". The aforementioned figures are essentially the same as they were in 2009.

Map 4

Natural, artificial, and heavily modified water bodies in Germany.



natural water bodies

heavily modified water bodies

artificial water bodies

Spatial base data: Geo-Basis-DE/BKG 2015

Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23.03.2016;
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Surface water ecological status

Whether or not a surface water body exhibits “good ecological status” is chiefly determined by its biological quality elements. Moreover, the water body is not permitted to exceed the environmental quality standards for river basin-specific pollutants. Even if only one such standard is exceeded for a given water body, the highest ecological status it can be granted is “moderate.” The quality of the water body’s chemical, physicochemical and hydromorphological elements must be such that they allow its biological communities a “good status”. This is because intact biota can be established in a given water body only insofar as its hydromorphological and chemical conditions are conducive to such establishment.

Ecological status assessments are based on the following five-level classification system, which allows for uniform and transparent representation of water body status:

- Class 1: high
- Class 2: good
- Class 3: moderate
- Class 4: poor
- Class 5: bad

Class 1 constitutes a reference status, i.e. a water status with little or no disruptive factors or pressures. For class 3 to 5, action needs to be taken.

Biological quality elements

Biota reactions to changes in environmental conditions can take the form of phenomena such as one species being driven out by another. In extreme cases, species may even disappear locally, or die out. Because biota adapt to changing environmental conditions over the long term, water status can be extrapolated from species composition.

In assessing the status of a given water body, the status of the biological quality element that is relevant for the type of water body in question is assessed, and is assessed within the range of “high” to “bad”. The definitive ecological status classification is determined, according to the worst case principle, by the poorest individual finding for a given biological quality element.

Fish, which are particularly susceptible to hydromorphological abnormalities, reveal the presence of pressures such as river bank constructions, inadequate shelters beneath roots and poorly structured water beds – as well as species composition, species incidence or age structures that deviate from the reference standard. In addition, salmon and many other fish species that migrate from the sea to river headwaters to spawn are dependent on river continuity. Hence changes in fish fauna often reveal the presence of degraded river continuity.

Benthic invertebrates (fauna that inhabit the bottom of the water body), which are visible to the naked eye, comprise the vast majority of fauna found in streams, rivers lakes, seas and estuaries. These quality elements include organisms such as aquatic insects, crustaceans, snails and mussels. Benthic invertebrates are a key source of food for fish fauna. Substance pressures and oxygen deficiencies reveal the presence of species-composition deviations from benthic invertebrates reference status. Benthic invertebrates are also highly susceptible to a lack of habitats, water body acidification, fine-sediment pressures, and inputs from agricultural pesticides.

Aquatic flora comprise small algae that grow on rocks and other substrates (phytobenthos that are visible to the naked eye, and diatoms), aquatic plants (macrophytes and angiosperms), and large algae. Water body flora are particularly susceptible to elevated water body nutrient concentrations – above all fresh water phosphorus and salt water nitrogen. Phytoplankton (free floating microscopic algae), which constitute a standalone biological quality element, also reveal the presence of nutrient balance disturbances in a given water body.

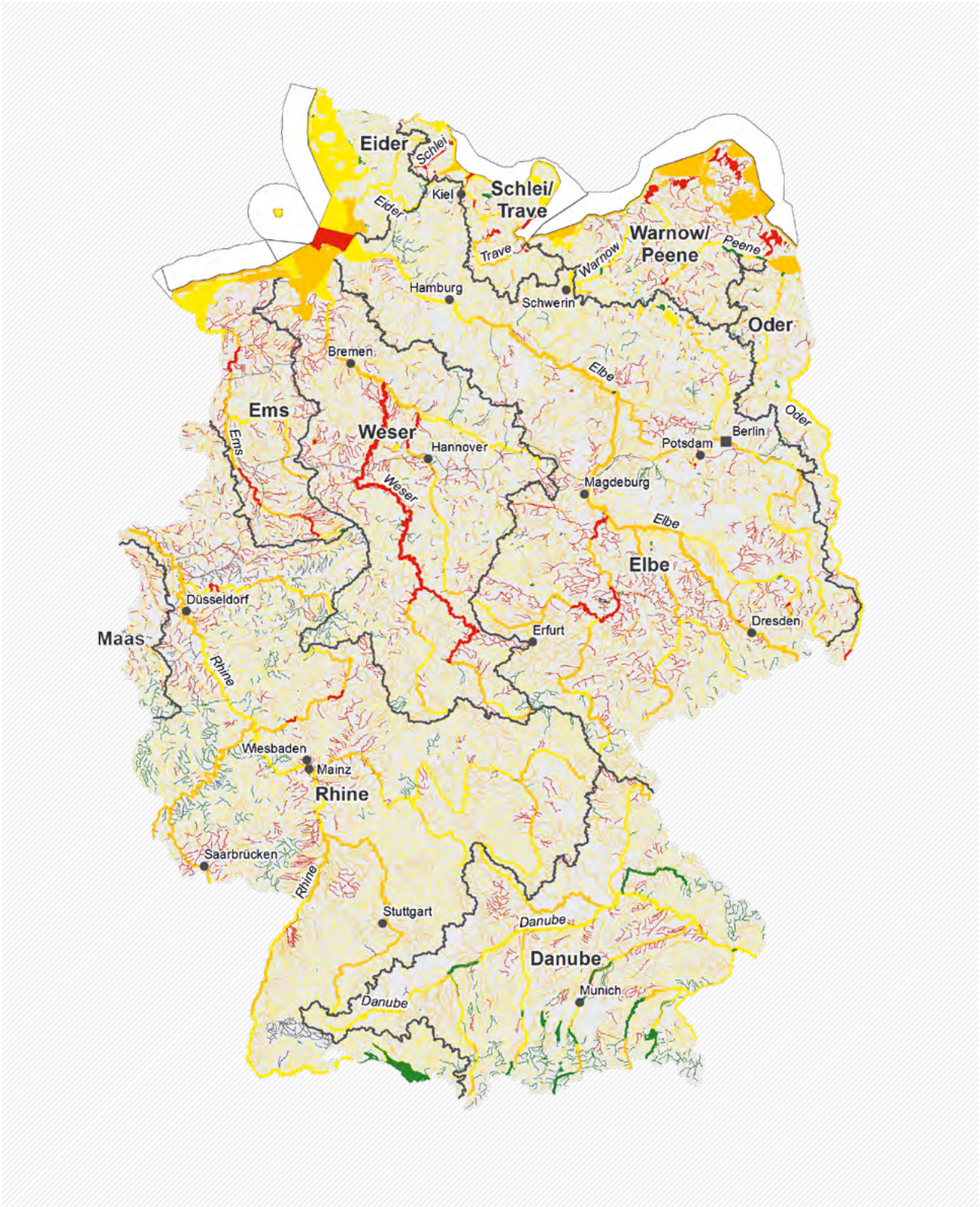
In Map 5, ecological status assessment is broken down in accordance with the various water body categories illustrated in Figure 10, and for the ten German river basin districts illustrated in Figure 11. The predominance of yellow, orange and red in the maps and diagrams is clearly indicative of the fact that many German water bodies currently fail Water Framework Directive objectives. This finding in turn reflects the fact that German water bodies are intensively used for agricultural, industrial, shipping, hydropower, public water supply and sanitation, and recreational purposes.

A total of 799 German water bodies (8.2 percent) currently exhibit “good” or “high ecological status”. Water bodies whose biota are still one classification below the Water Framework Directive objective (i.e. water bodies that exhibit “moderate status”) constitute the lion’s share of the assessment (36.1 percent). German water bodies with “poor” or “bad" status currently account, respectively, for 33.8 and 19.2 percent of such water bodies. 2.7 percent of German water bodies have yet to be definitively assessed.

The overall ecological-status results are for the most part consonant with the characterization of German rivers, since the latter comprise the majority of the country’s surface water bodies. The results for German lakes are more positive in that 26 percent of them have achieved “good” or “high ecological status”, whereas the situation is worse for coastal and notably transitional waters, most of which still fail “good ecological status”.

Map 5

Ecological status of Germany's surface water bodies.



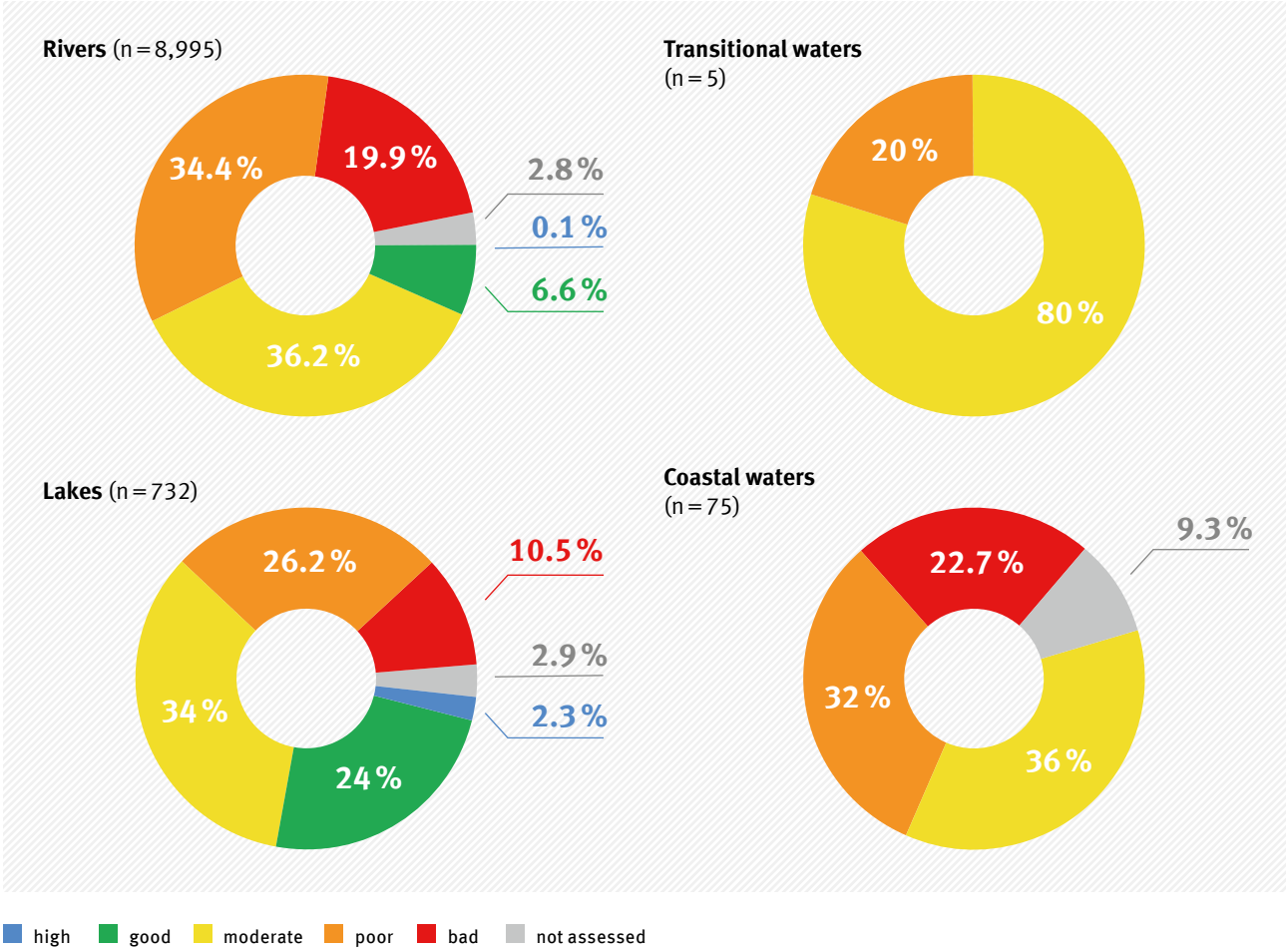
high good moderate poor bad not assessed no ecological status assessment necessary

Spatial base data: Geo-Basis-DE/BKG 2015

Technical data: Berichtsportal WasserBLIcK/BfG; Last updated 23.03.2016;
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Figure 10

Ecological status of Germany's water body categories.



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

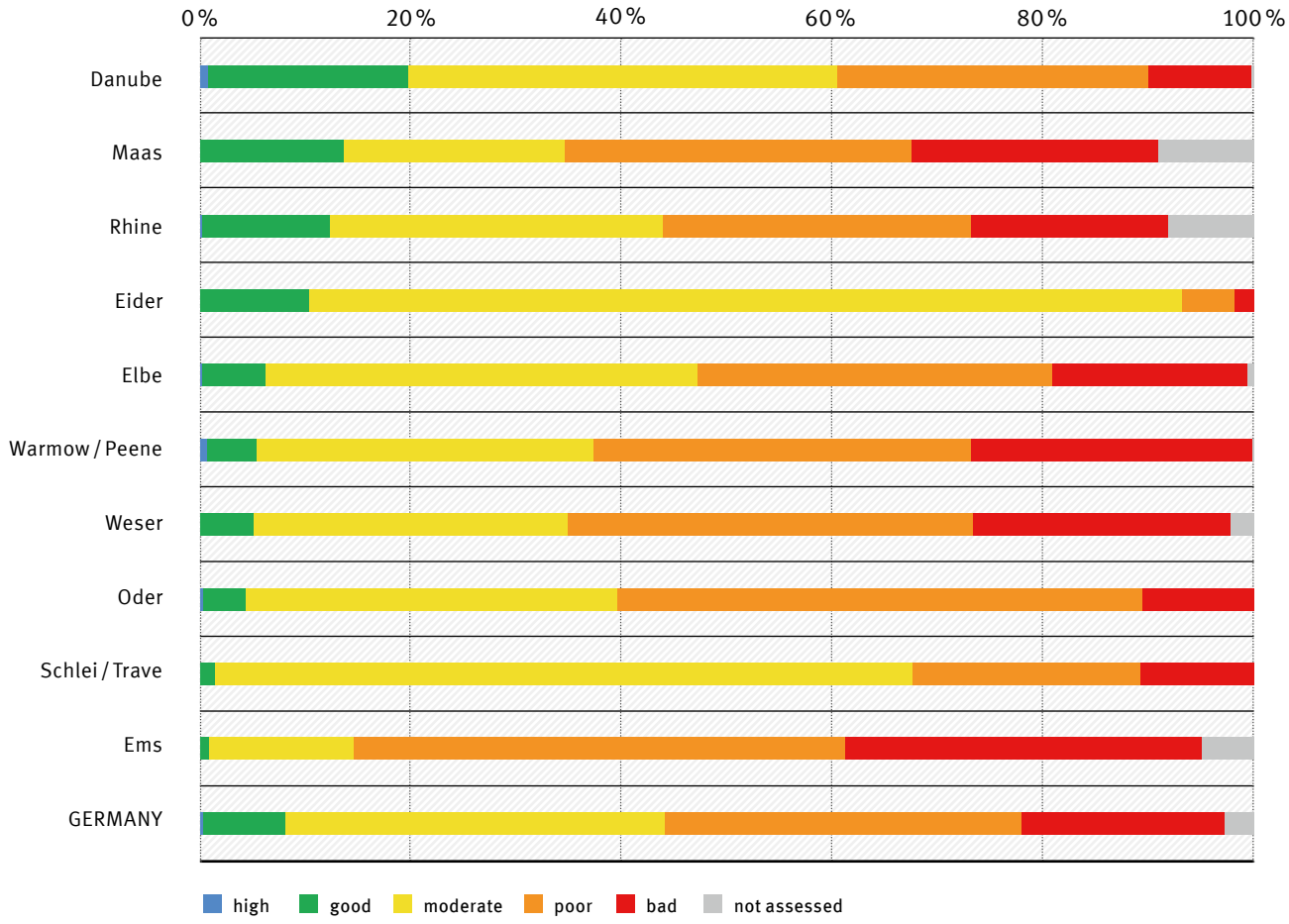
The water body status of all 10 river basin districts are essentially the same. In Germany, 26 water bodies currently exhibit "high ecological status", while 773 exhibit "good ecological status". Less densely populated river basins rich in woodlands exhibit a higher proportion of water bodies with "good ecological status". Water body protection is more problematic in areas characterized by intensive agricultural and urban use.

It is worthwhile to take a closer look at the water body biology and individual sources of ecological pressures for the various surface water body categories. The nature of the biota that are relevant for assessment purposes vary according to whether the water bodies in question are rivers, lakes, coastal waters, or transitional waters.

Figures 12 and 13, which illustrate the findings for each of the various biological quality elements, show that it was not possible to assess the entire range of biological quality elements in all water bodies. According to the Water Framework Directive, operational monitoring is to confine itself to those informative quality elements that best indicate the main sources of ecological pressures. For example, the status of river invertebrates (benthic invertebrates), macro-phytes/phytobenthos and fish fauna are assessed most frequently, whereas lake phytoplankton are assessed least frequently. The same holds true for the supporting quality elements. Nearly all of them are monitored for virtually all water bodies, but not used in every case for ecological status assessments. Moreover, these quality elements are assessed under only

Figure 11

Surface water body ecological status in the ten river basins that are relevant for Germany.



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

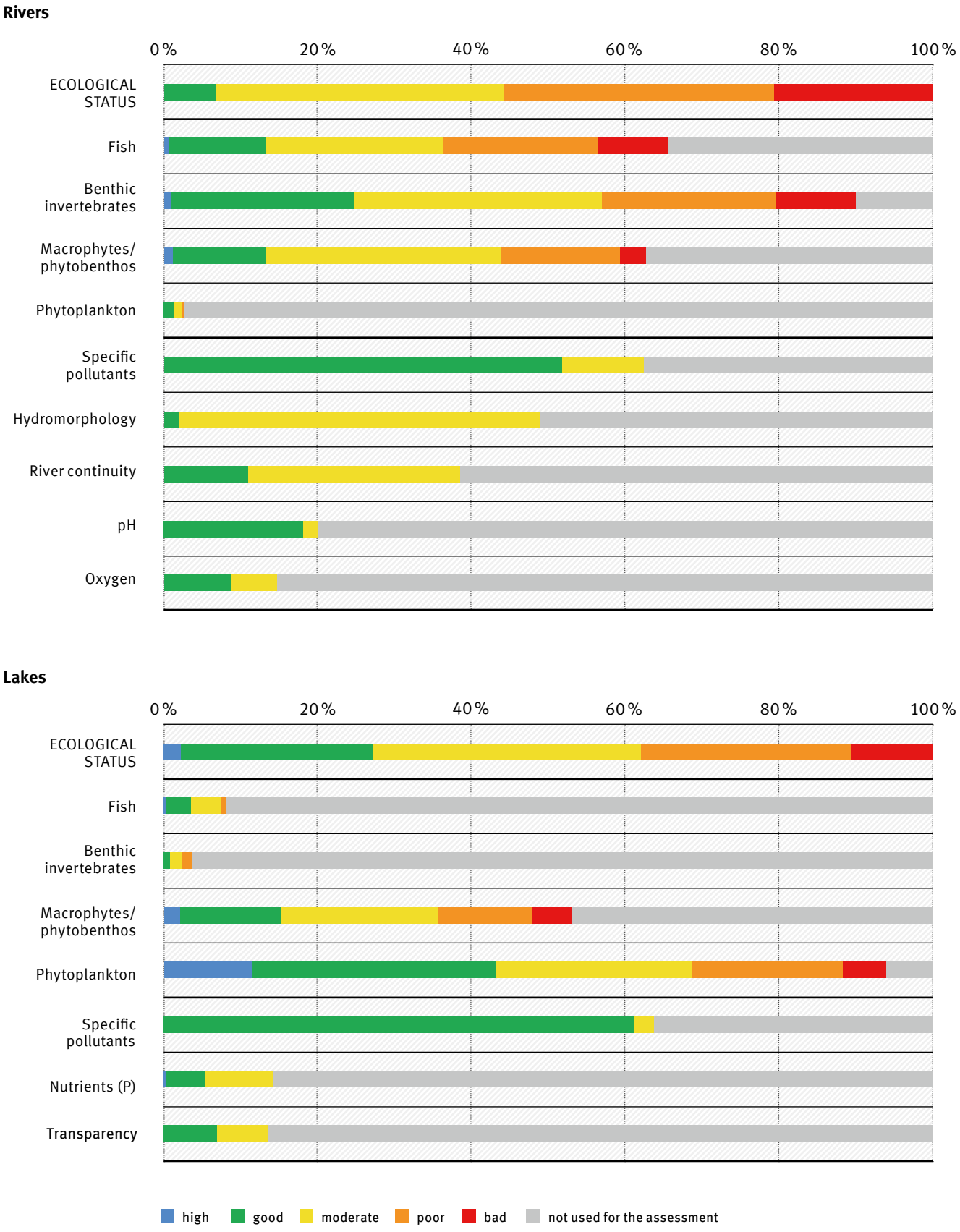
three categories: “high”, “good” and “less than good”. River biological quality elements – namely fish, benthic invertebrates and macrophytes/phytobenthos – are in many cases rated higher, relative to overall ecological status. Only a small proportion of rivers exhibits “less than good ecological status” for river basin-specific pollutants. Only just under 5 percent of all German water bodies reach “good status” according to hydromorphology – which is one of the main reasons why German rivers fail management objectives. The assessments for river continuity are somewhat better, in part owing to the many continuity restoration measures that have been undertaken for barrage weirs with locks and transverse structures. The pH in virtually all assessed water bodies is unproblematic, whereas oxygen concentrations in one third of all water bodies can be deemed deficient.

Pressures on lakes from sewage and farms have been greatly reduced by sewage treatment plants and ring sewer systems. This success is reflected by the fact that 26 percent of German lakes have already met the Water Framework Directive objectives. However, high levels of nutrient inputs from watersheds and the resulting eutrophication still constitute a major pressure on lakes. As is the case with rivers, river basin-specific pollutants exceeding the standards are of little relevance.

The supporting quality elements show that nitrogen concentration is the main element that prevents water body biology from reaching “good ecological status”. The failure of transitional waters to achieve “good ecological status” is mainly attributable to (benthic) invertebrate status.

Figure 12

Status of individual quality elements for rivers and lakes.

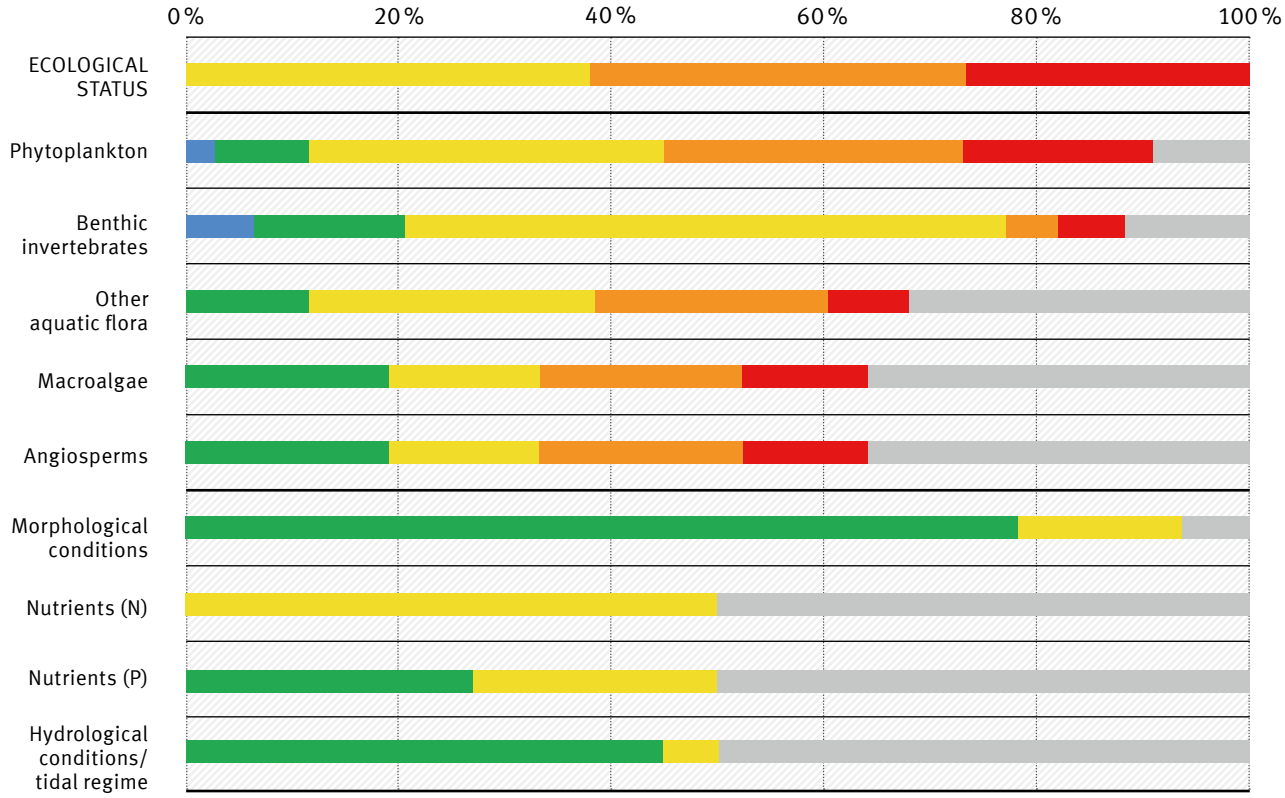


Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

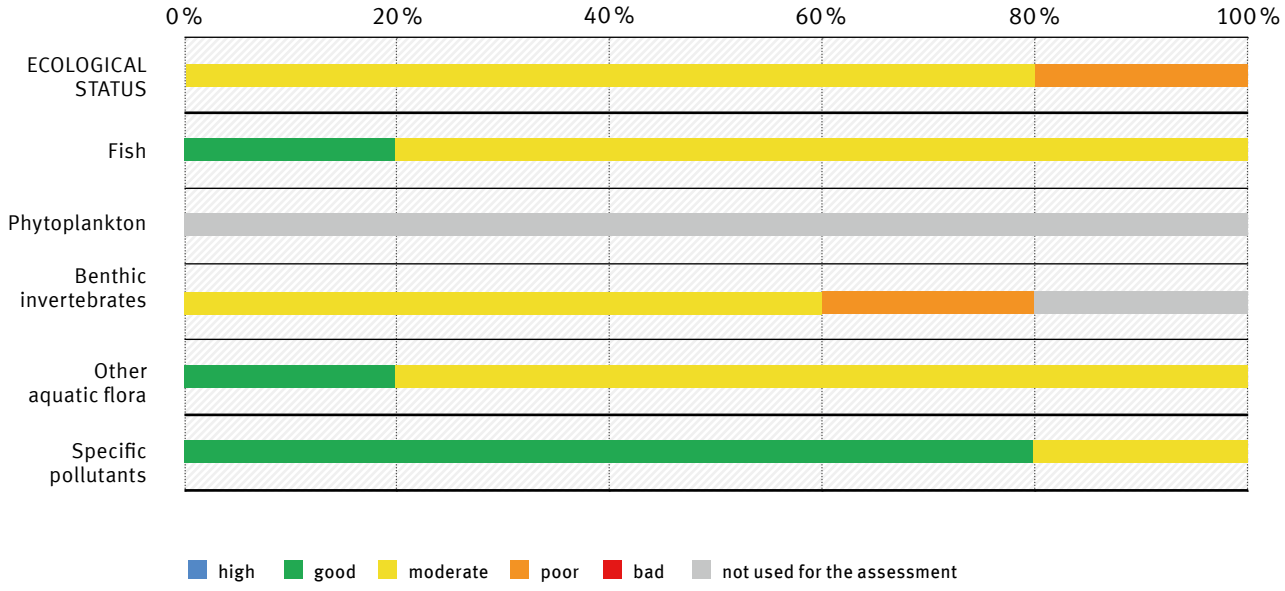
Figure 13

Status of individual quality elements for coastal and transitional waters.

Coastal waters



Transitional waters



Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Surface water chemical status

German water bodies contain numerous pollutants that stem from either point sources or diffuse sources. Keeping water bodies free of substances of concern and hazardous substances is a key goal of European water protection efforts.

In Germany, Water Framework Directive chemical status is assessed on the basis of the following uniform requirements that apply to all EU member states:

- Environmental quality standards for 33 (after 2015, 45) priority substances, as per Annex X, Water Framework Directive
- Environmental quality standards for certain other pollutants and for nitrate action value, as per Directive 91/676/EEC.

The chemical status of Germany's surface waters is assessed as either ● "good" or ● "failing to achieve good".

In Germany, given the fact that the environmental quality standard for mercury amounting to 20 µg/kg fresh weight is exceeded in all samples, findings of mercury saturation assays in fish are transposed to all surface water bodies. Consequently, chemical status is deemed to be "failing to achieve good" everywhere (Map 6).

For polycyclic aromatic hydrocarbons that are subject to modified environmental quality standards, assessments have yet to be carried out, particularly for the results of mussel assays. For mercury, as well as all other ubiquitous substances such as brominated diphenyl ether, polycyclic aromatic hydrocarbons and tributyltin, environmental quality standards are currently exceeded or are likely to be exceeded in a great many surface water bodies.

Completely different results are obtained, however, if chemical status assessments are based solely on non-ubiquitous substances (Map 7). 84 percent exhibit "good chemical status", 6 percent were assessed as "failing to achieve good" and 10 percent were not assessed, given that under the rule, that the assessment of chemical status without ubiquitous substances is optional. Table 2 indicates the substances that were factored into the assessment for Map 7, as well as which substances are responsible for chemical status "failing to achieve good".

New rules for hazardous substances

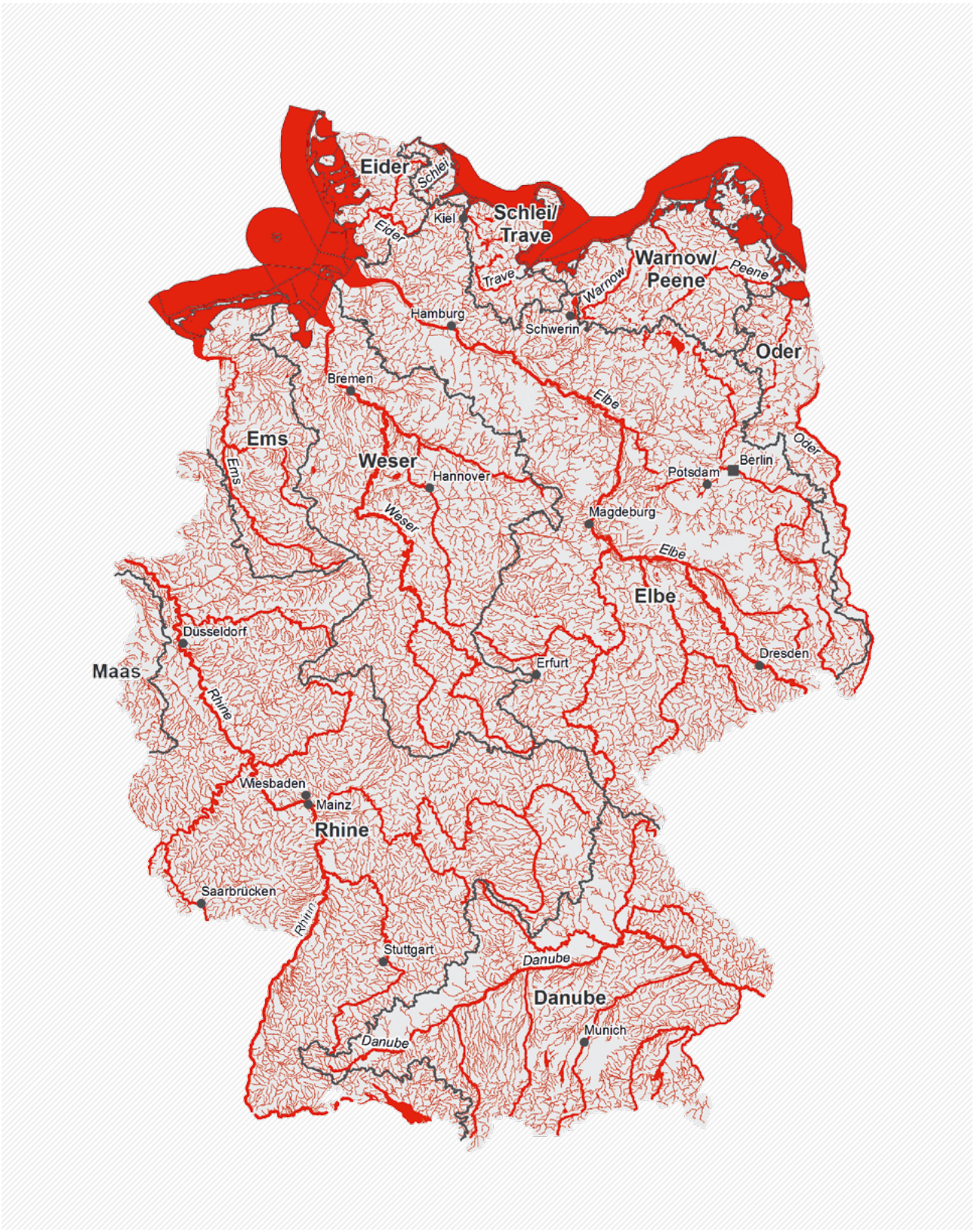
Until 2015, Annex X of the Water Framework Directive listed 33 priority substances, 15 of which are hazardous. As at 22 December 2015, 12 priority substances were added, six of which are priority hazardous substances. An investigation program and preliminary programmes of measures for these 12 new substances will only be elaborated within the second management cycle.

The substances listed in Annex X, which are subject to the environmental quality standards defined in the new daughter directive 2008/105/EC, comprise the benchmarks for good chemical status. Germany's management plans take into account the changes, relative to Directive 2008/105/EC, in environmental quality standards for brominated diphenyl ether (BDE), as well as for all polycyclic aromatic hydrocarbons that fall within the scope of Directive 2013/39/EU. Diphenyl ether is mainly used as a flame retardant in the electronics, construction, transportation and textile sectors. Polycyclic aromatic hydrocarbons are found in creosote, as well as in petroleum products, albeit in small amounts.

Owing to their poor biodegradability (persistence), certain substances are ubiquitous and are thus assessed as ubiquitous substances. The environmental standards for some of these substances are exceeded in many surface water bodies. This holds true for mercury everywhere.

Map 6

Chemical status of Germany’s surface water bodies.



failing to achieve good

Spatial base data: Geo-Basis-DE/BKG 2015

Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23.03.2016;
Adaptation/editing: Umweltbundesamt, Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

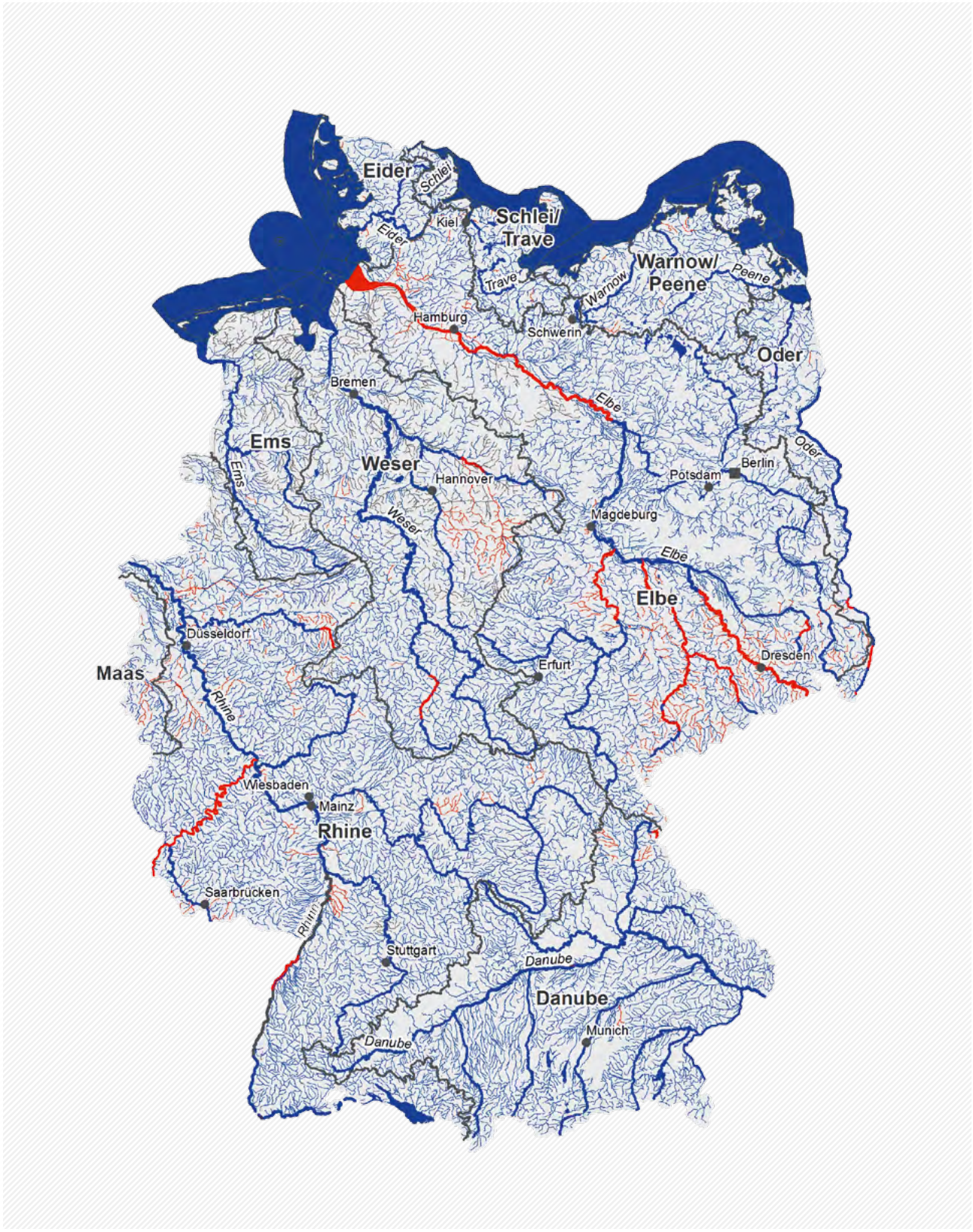
Fish investigations

Using the federal environmental specimen bank, since the 1990s the UBA has been regularly assaying the fish species known as bream (Abramis brama) in Germany's three major river basins, which are the Rhine (including the Saar), the Elbe (including the Mulde and Saale) and the Danube – as well as in two lakes (Belauer See, Stechlinsee). Mixed specimens comprising filets from eight to 12 year old fish are assayed. These assays show that mercury pressures in the aforementioned lakes are lower than in the Rhine, Elbe and Danube. No significant changes in fish mercury concentrations have been observed in Germany's river basins over the past 16 years or so, whereas significant drops in mercury concentrations in Elbe river fish were observed in the 1990s. Back then, the fish mercury levels were higher in the Elbe river than in other river basins. The mercury levels of fish specimens in both these northern German lakes nearly comply with the standard, whereas bream from Germany's major river districts fail the relevant environmental quality standard by a factor of 5 to 16.

The federal states carry out their own tests at selected monitoring sites, for purposes of monitoring compliance with biota environmental quality standards. Details concerning sampling (fish species, sizes, timing, number etc.), as well as selection of the tissue to be assayed are documented in a guideline. Given the fact that the fish that are tested are considerably younger (three to five years old) than those in the federal environmental specimen bank the contaminant concentrations that are observed are often somewhat lower. For example, mean mercury concentrations in 3 to 5 year old whitefish (bream, chub, roach) exceed the environmental standard by a factor of only 3 to 4.

Map 7

Chemical status of Germany's surface water bodies - without taking ubiquitous substances into account.



good failing to achieve good not assessed

Spatial base data: Geo-Basis-DE/BKG 2015

Technical data: WasserBLIcK/BfG & competent authorities of the federal states; last updated 30.09.2016
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Table 2

Substances used for chemical status assessments and their relevance for German river basin districts (excluding ubiquitous substances and those whose 2013 and 2008 standards differ).

Substance name	Danube	Eider	Elbe	Ems	Maas	Oder	Rhine	Schlei/ Trave	Warnow/ Peene	Weser
Heavy metals										
Lead	X		X				X			
Cadmium	X		X	X	X		X		X	X
Nickel	X		X	X	X		X		X	X
Industrial pollutants										
1,2-dichlorethane			X							
Di(2-ethyl-hexyl)phthalate (DEHP)			X				X			
Hexachlorinated benzene			X	X			X			
Hexachlorbutadiene			X				X			
Nonylphenol			X							
Octylphenol			X				X			
Pentachlorbenzene			X							
Tetrachlorethylene			X							
Trichlorbenzene			X							
Trichlorethylene			X							
Trichlormethane			X				X			
Others (no exceedance): benzene, C10-13 chloralkane, dichlormethane, pentachlorphenol, carbon tetrachloride										
Pesticides										
4,4-DDT, DDT (aggregate)			X							
Chlorpyrifos							X			
Diuron			X	X	X		X	X		X
Hexachlorcyclohexane (HCH)			X							
Isoproturon	X	X	X		X	X	X	X	X	X

"X" means that the relevant environmental quality standard was exceeded in at least one surface water body in the river basin district.

Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: UBA, based on data provided by the German states in 2016.

Some surface water bodies exhibit unduly high pesticide inputs (chlorpyrifos, diuron, isoproturon). Water bodies contaminated by heavy metals are mainly found in regions containing abandoned mines. Relatively few environmental standards for industrial pollutants are exceeded, and these occur mainly in the Rhine and Elbe river basin districts. Environmental standards were not exceeded in surface water bodies for 12 priority substances and certain other pollutants. Particle-bound pollutants (DDT, hexachlorbenzene, hexachlorcyclohexane, heavy metals, tributyltin com-pounds), which are of particular relevance in any given water body system, persist for lengthy periods in water bodies long after polluted discharges and inputs have come to an end. These pollutants affect the usability of the water bodies in question and their adjoining flood-plains and marshes in many different ways. Because such pollutants are discharged into seas, where the contaminated sediments are deposited, they also fall within the scope of the Marine Strategy Framework Directive.

Changes in surface water body ecological status since 2009

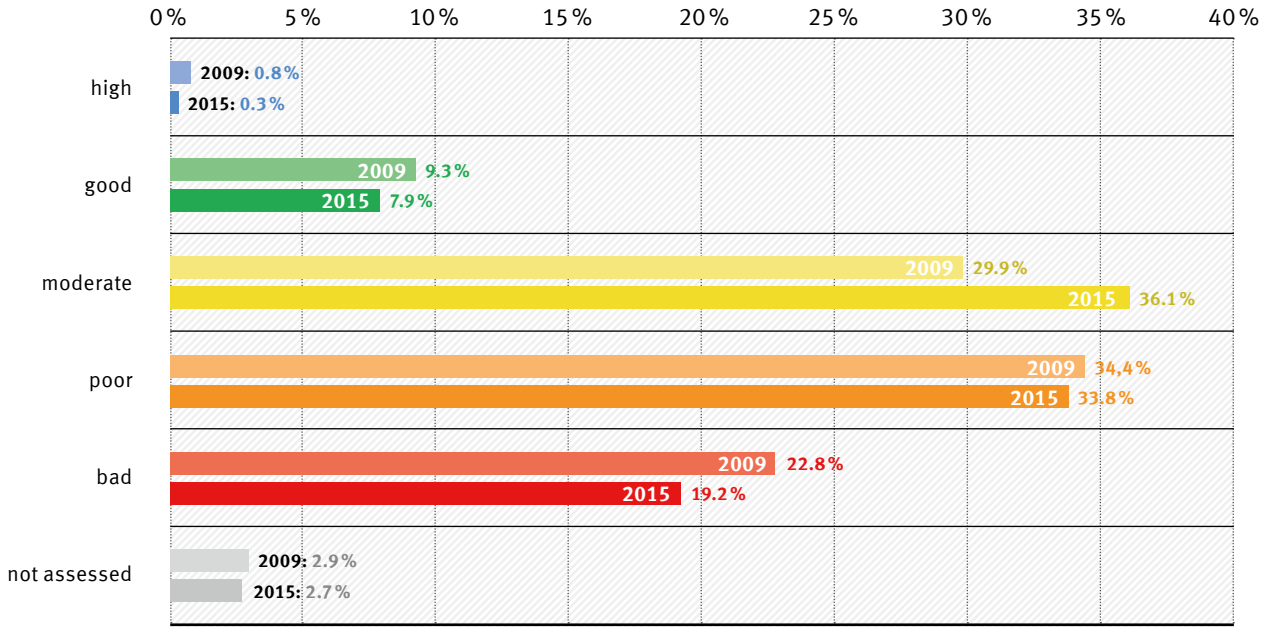
Experience has shown that there is no quick fix when it comes to German surface water bodies achieving "good ecological status". The key factor that comes into play here is this: assessment of the relevant biota takes time – for long term recovery and for recolonization of these biota. Both previously realized and envisaged measures set the stage for this process.

Failure to achieve "good ecological status" is mainly attributable to hydromorphological changes (and the accompanying lack of habitats) and excessive river nutrient pressures. These causal factors vary from one case to another; whereby multiple pressures often occur simultaneously in a given water body. Given that the recolonization potential afforded by the environs can also have an influence on biota recovery time and the achievement of "good ecological status", it is crucial – for fish fauna in particular – that river continuity is restored by removal of dams or weirs or by the installation of fishways. According to the evaluations of the programmes of measures, appreciable success has been achieved in this domain.

The positive tendency for water body status is reflected by the decrease in the number of water bodies that exhibited "bad ecological status" in 2009, and by a 29.1 to 36.1 percent increase (between 2009 and 2015) in the number of water bodies that exhibit "moderate ecological status" (Figure 14; Maps 8 and 9). However, these figures are not directly comparable with each other, owing to methodological changes such as in the method used for designating water bodies. Ecological status assessment methods have also evolved over the past six years. For example, there is now a special procedure for assessing the ecological status of heavily modified water bodies. Among the results of this methodological change is that water bodies that exhibited "high" or "good ecological status" in 2009 now have a lower status. But the results nonetheless point to a positive trend.

Figure 14

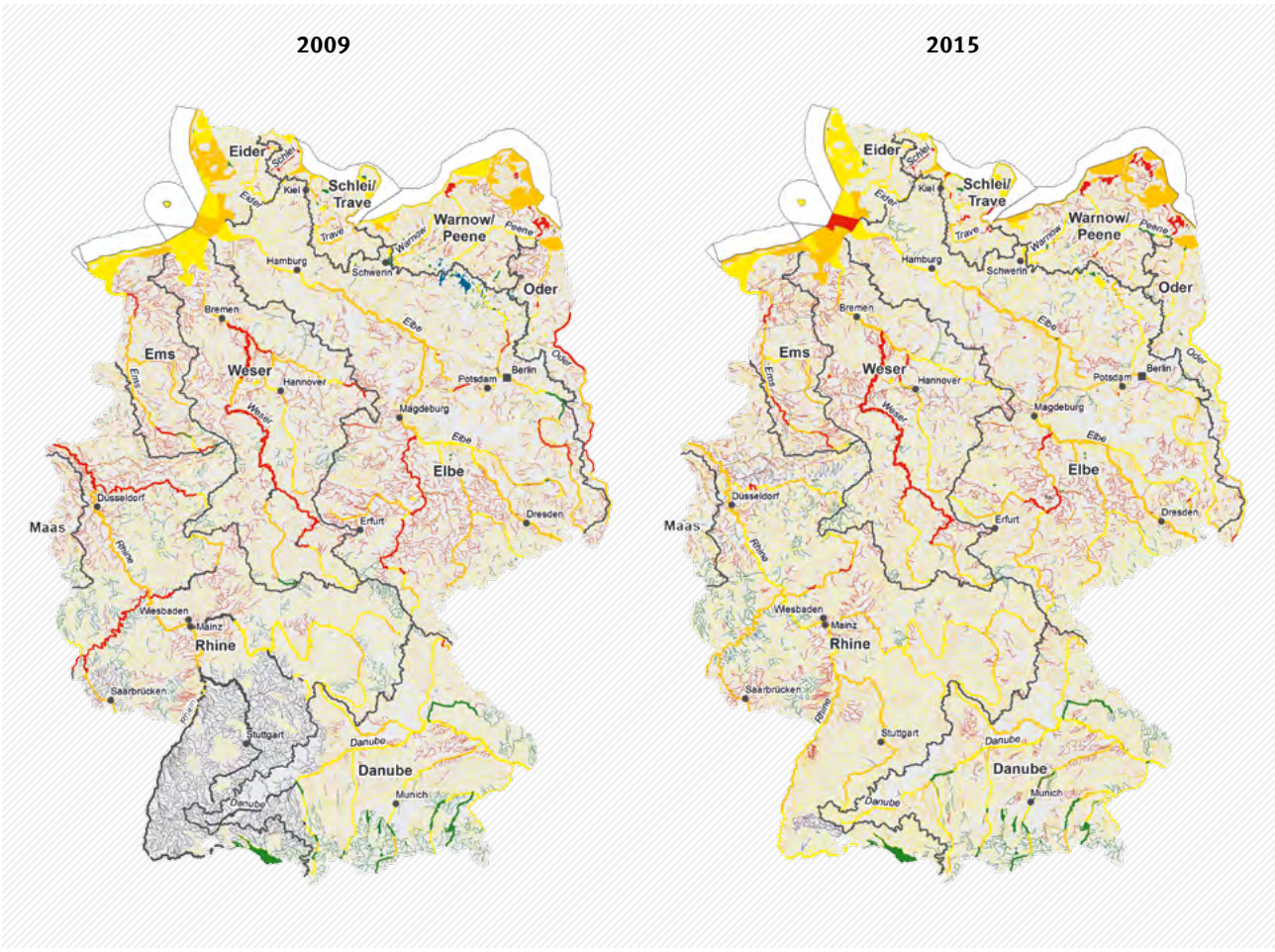
Comparison of the ecological status of German surface water bodies in 2009 and 2015.



Source: Berichtsportal WasserBLIcK/BfG; status as at 22 March 2010 and 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Map 8 and Map 9

Comparison of the ecological status of German surface water bodies in 2009 and 2015.



Source: Berichtsportal WasserBLIcK/BfG; status as at 22 March 2010 and 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Achieving the Water Framework Directive objectives will require additional funding in the coming years. Ecologically sustainable measures set the stage for lasting "good ecological status", and thus also allow for sustainable anthropogenic use of water bodies. Money invested in ecologically sustainable measures is money well spent, as such measures reduce long-term surface water body upkeep costs, and at the same time restore the ecological functionality of such water bodies for future generations.

Changes in surface water body chemical status since 2009

"Good chemical status" is failed everywhere, owing to exceedance of the standards for mercury and other ubiquitous substances; and thus the chemical status of Germany's water bodies has deteriorated considerably since 2009. This is the consequence not of any actual worsen-

ing of water quality, but rather of tightened rules arising from full implementation of Directive 2008/105/EC.

For certain substances, the situation has improved since 2009. The following list lists the substances for which, in at least one surface water body, pressures have lessened or substance use has been discontinued relative to the first management plan – and such that compliance with the environmental quality standards has now been achieved. According to information supplied by the German states, these substances are as follows:

Heavy metals:
Lead, cadmium and nickel
Ubiquitous substances (as per the former standard):
Brominated diphenyl ether (BDE), policyclic aromatic hydrocarbons (PAH) and tributyltin compounds (tributyl cation)
Other industrial pollutants:
Anthracene, di(2-ethyl-hexyl)phthalate (DEHP), nonylphenol, trichlormethane
Pesticides:
Atrazine, chlorpyrifos, 4,4-DDT, DDT in general, diuron, hexachlorcyclohexane (HCH), isoproturon, simazine

4.3 Groundwater status

Groundwater status is assessed in terms of groundwater bodies. A groundwater body is defined as a distinct volume of groundwater within one or more aquifers. Groundwater body status assessment is to be based on an assessment of both quantitative and chemical status. Germany has nearly 1,180 groundwater bodies, with an average size of around 320 square kilometres.

Quantitative groundwater status

The main criterion for the assessment of good quantitative status is groundwater level, whereby the following requirements apply:

- Long-term mean annual abstraction is not to exceed the available groundwater resources
- The groundwater level is not to be subject to anthropogenic changes that
  - result in failure of the ecological objectives laid out in the Water Framework Directive for the associated surface waters
  - significantly degrade the quality of these water bodies
  - significantly harm terrestrial ecosystems that are directly dependent on groundwater bodies
- No saltwater or other intrusions in groundwater are allowed

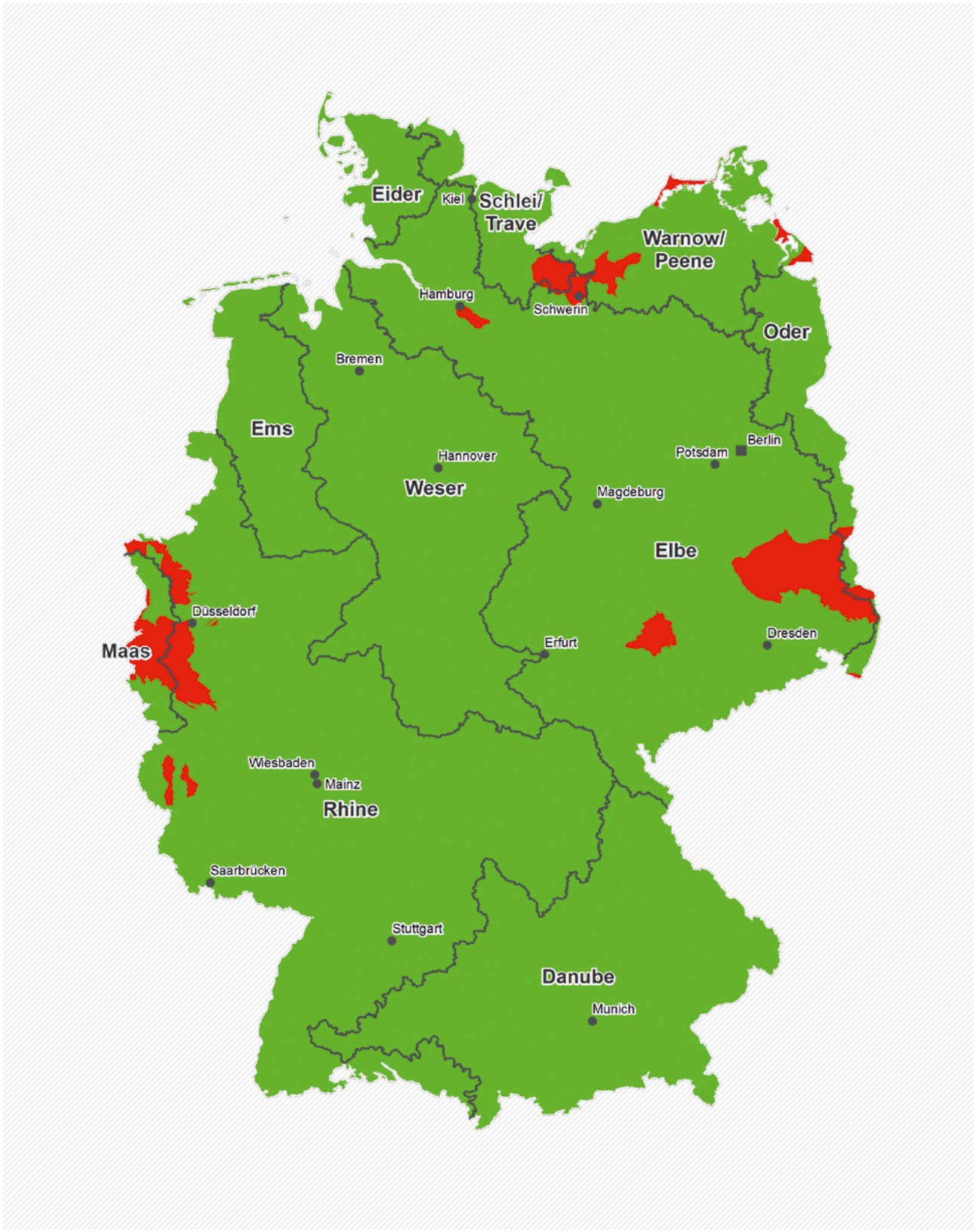
"Good quantitative status" can only be achieved for groundwater if the volumes of water abstracted and water recharged are balanced. The allowable groundwater abstraction rate should be substantially lower than the recharge rate. If the abstraction and recharge rates are the same, the unavoidable natural outflow will reduce the groundwater level and thus the volume of groundwater that flows into surface waters and wetlands. Only very few German groundwater bodies are overused, and only 4.3 percent of them fail "good quantitative status" (Map 10).

Sustainability means keeping abstraction of groundwater in balance with the replenished

Groundwater bodies with a "poor quantitative status" are located in the Rhine, Elbe, Oder, Maas, Schlei-Trave and Warnow-Peene river basins (Figure 15). Decreasing groundwater levels were detected in the Warnow-Peene river basin by means of comprehensive water balancing. "Poor quantitative status" in the Rhine, Maas and Oder river basins is often attributable to mining in general and lignite mining in particular, which has been (or was) actively pursued for decades in these regions, and whose groundwater levels have in many cases been extremely lowered for centuries. Moreover, even after mining comes to a halt, restoration of natural groundwater levels will take decades.

Map 10

Quantitative status of Germany's groundwater bodies.



good poor

Spatial base data: Geo-Basis-DE/BKG 2015

Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Figure 15

Quantitative groundwater body status in the ten river basins that are relevant for Germany.

Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Groundwater chemical status

Groundwater must meet the following requirements in order to exhibit "good chemical status":

- No sign of salt or other intrusions
- No exceedance of EU environmental quality standards or threshold values
- Pollutant concentrations do not exceed a threshold that would fail the management objectives for groundwater bodies that feed into surface waters, significantly reduce their ecological or chemical quality, or significantly damage terrestrial ecosystems that are dependent on groundwater.

Apart from the Ground Water Directive's environmental quality standards, which apply to all member states, the latter are required to set threshold values for other substances referred to in the Directive. These environmental quality standards and threshold values are the key assessment criteria for chemical groundwater status. Other criteria also come into play such as a size criterion, which factors in the size of the area affected by any given contamination. If the applicable environmental quality standards and threshold values are not exceeded at all monitoring sites of a groundwater body, its chemical status is assessed as "good". But if, on the other hand, such a standard or threshold is exceeded at one or

EU-wide standards ensure groundwater protection

The Groundwater Directive (2006/118/EC, as amended on 11 July 2014) lays down the following EU-wide environmental standards for nitrates, pesticides and biocides and the relevant metabolites thereof: for nitrate, 50 milligrams per litre; for pesticides, biocides and their relevant metabolites,[4] 0.1 micrograms per litre for each or an aggregate 0.5 micrograms per litre.

The EU Groundwater Directive was transposed into German law in 2010 via the Grundwasserverordnung (Groundwater Ordinance), which lays down criteria for description, assessment, classification and monitoring of groundwater status and implements the relevant trend reversal in German law. The Directive also calls for measures aimed at averting or limiting pollutant discharges into groundwater, the goal being to prevent groundwater status from deteriorating.

more monitoring sites, the size of the contaminated area and the environmental impact of the anthropogenic pressures in question must be determined. If the environmental impact is relevant or if the contaminated area exceeds a certain size, the water body as a whole is deemed to exhibit "poor chemical status" and measures aimed at reducing the relevant pressures are to be carried out.

Environmental quality standards and threshold values are an effective constellation of criteria when it comes to groundwater protection

In view of the fact that once an aquifer has been polluted, it often takes a long time, as well as extensive and cost intensive technical measures, to restore it to "good chemical status", the Groundwater Directive also requires that any "significant and sustained upward trend in the concentrations of any pollutant" is to be reversed. This key provision is intended to avert further accumulation of pollutants in groundwater, and to protect groundwater that has thus far been subject to little or no pollution.

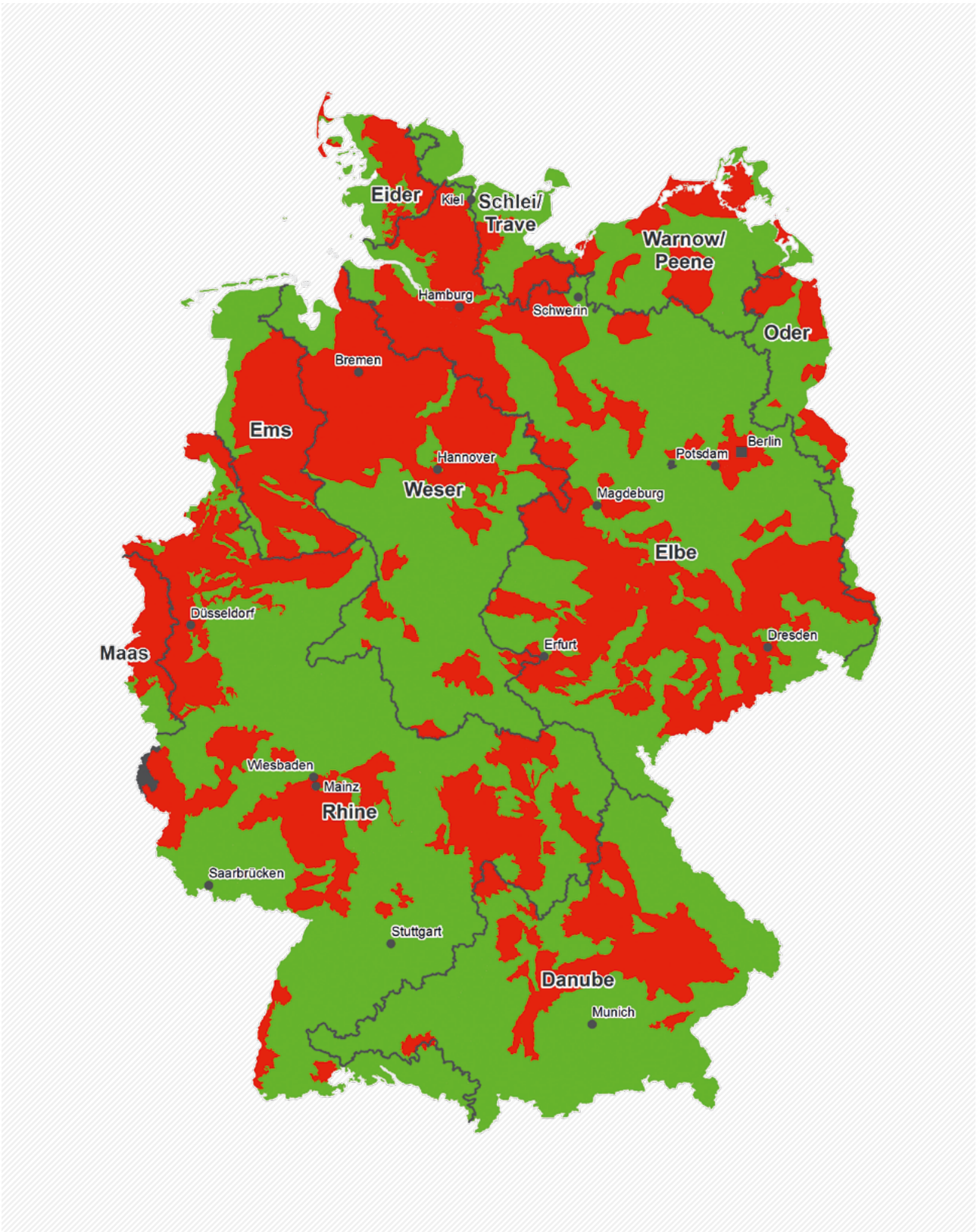
The long-term memory of groundwater is not easily erased

According to the current chemical status assessments of groundwater bodies by the various German states, nearly 64 percent of all groundwater bodies exhibit "good chemical status", whereas 36 percent have yet to achieve this status (Map 11, Figure 16).

4 Refers here to substances that are produced by the pesticide degradation products of pesticides and biocides. Relevant"means that these metabolites are toxic.

Map 11

Chemical status of Germany's groundwater bodies.

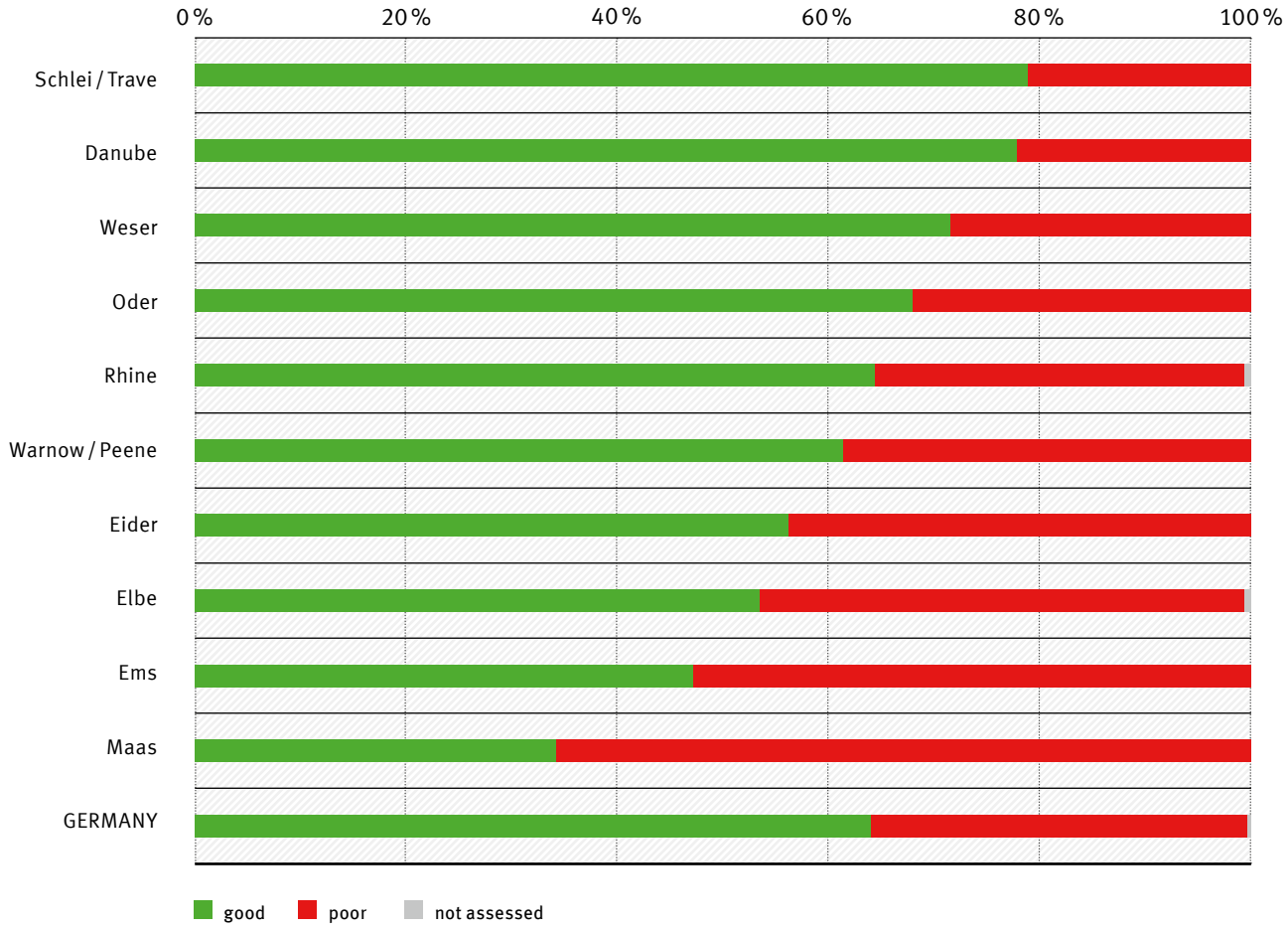


Spatial base data: Geo-Basis-DE/BKG 2015

Source: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Figure 16

Chemical groundwater body status in the ten river basins that are relevant for Germany.



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

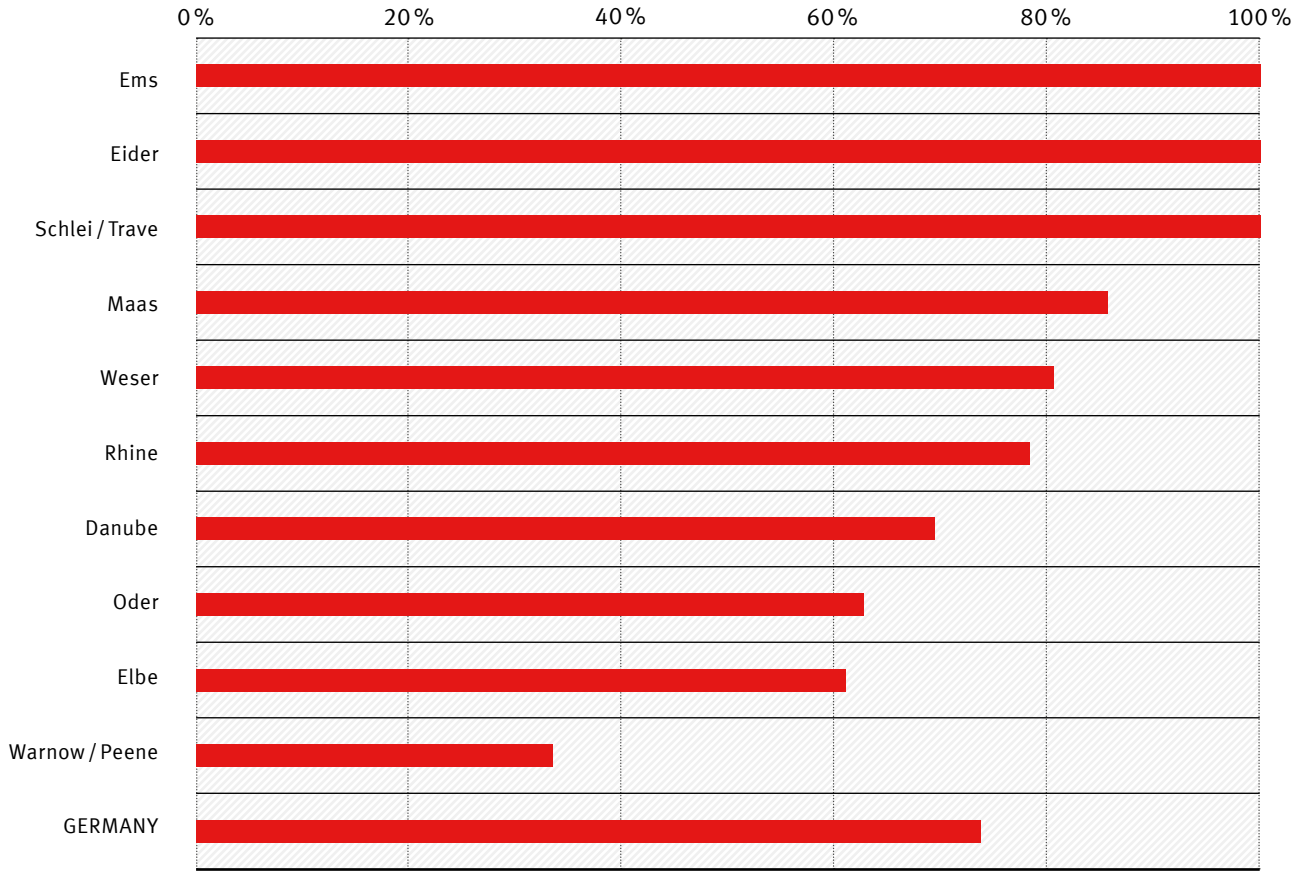
As Figure 16 shows, the groundwater bodies in the Maas and Ems river basin districts exhibit the greatest amount of contamination, in that more than 50 percent of their groundwater bodies exhibit "poor chemical status".

Groundwater pressures attributable to nitrogen compounds (usually nitrate) remain the main reason why German groundwater bodies exhibit "poor chemical status" (Figure 17). In Germany, 74 percent of these water bodies fail the management objectives owing to unduly high nitrate concentrations.

Pollutant concentrations are rising in 23 percent of the groundwater bodies that fail "good chemical status" (Figure 18), whereas pollutant concentrations are declining in 4 percent of these groundwater bodies – which are thus displaying a trend reversal. For 73 percent of the groundwater bodies that exhibit poor chemical status, only non-validated conclusions could be reached due to the fact that sufficiently long time series concerning nutrient and pollutant concentrations were not available for all of the groundwater bodies in question.

Figure 17

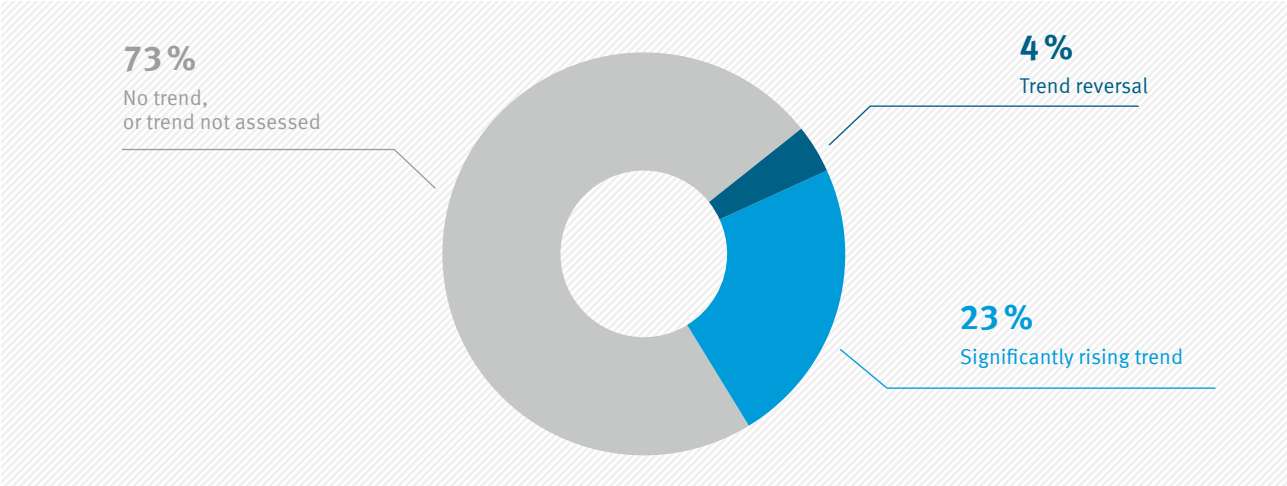
Groundwater bodies that exhibit „poor chemical status“ owing to nitrate in the ten river basins that are relevant for Germany.



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Figure 18

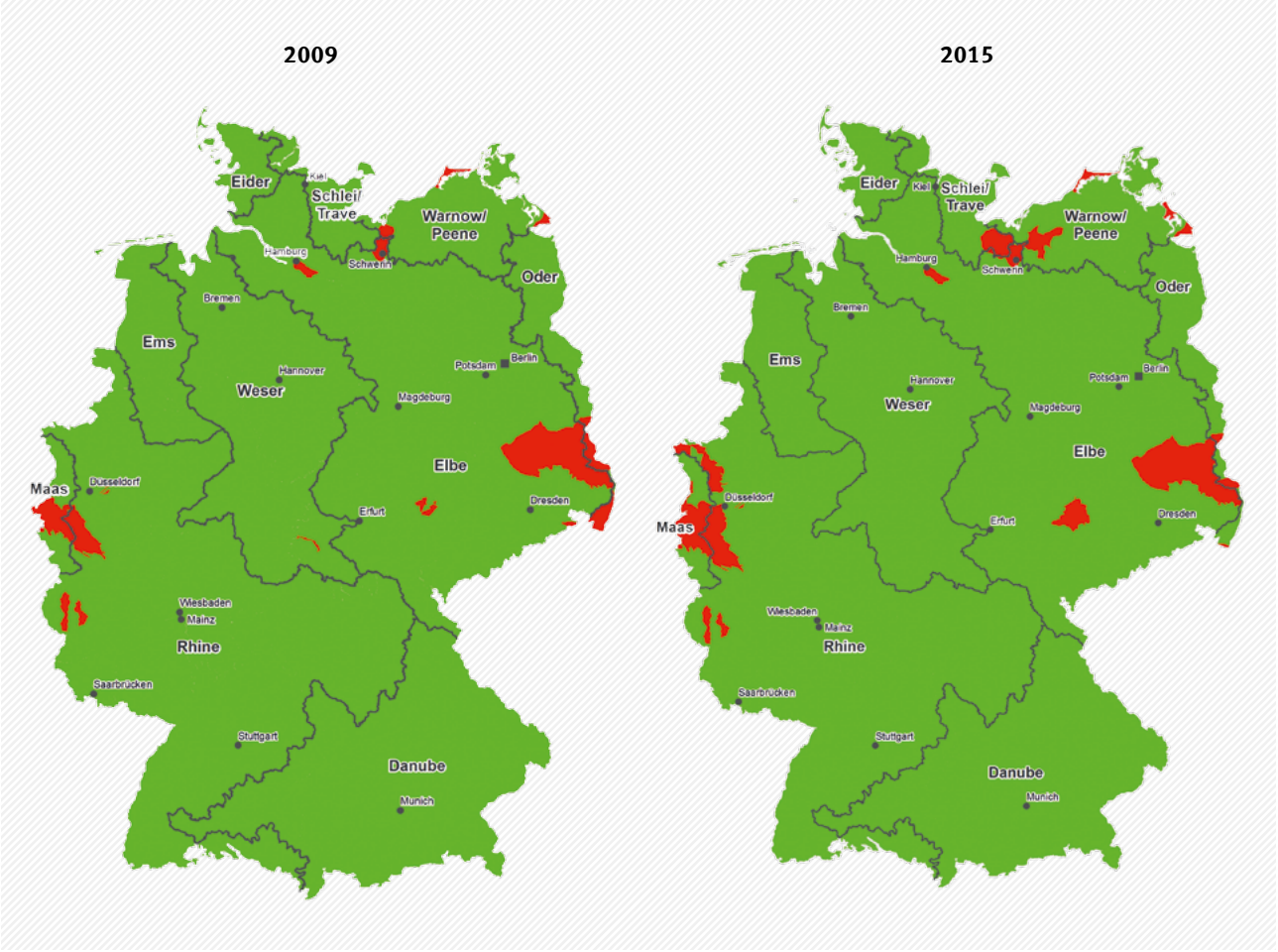
Pollutant trends for German groundwater bodies that exhibit „poor chemical status“.



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Map 12 and Map 13

Comparison of the quantitative status of German groundwater bodies in 2009 and 2015.



Source: Berichtsportal WasserBLIcK/BfG; status as at 22 March 2010 and 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Changes in groundwater body status since 2009

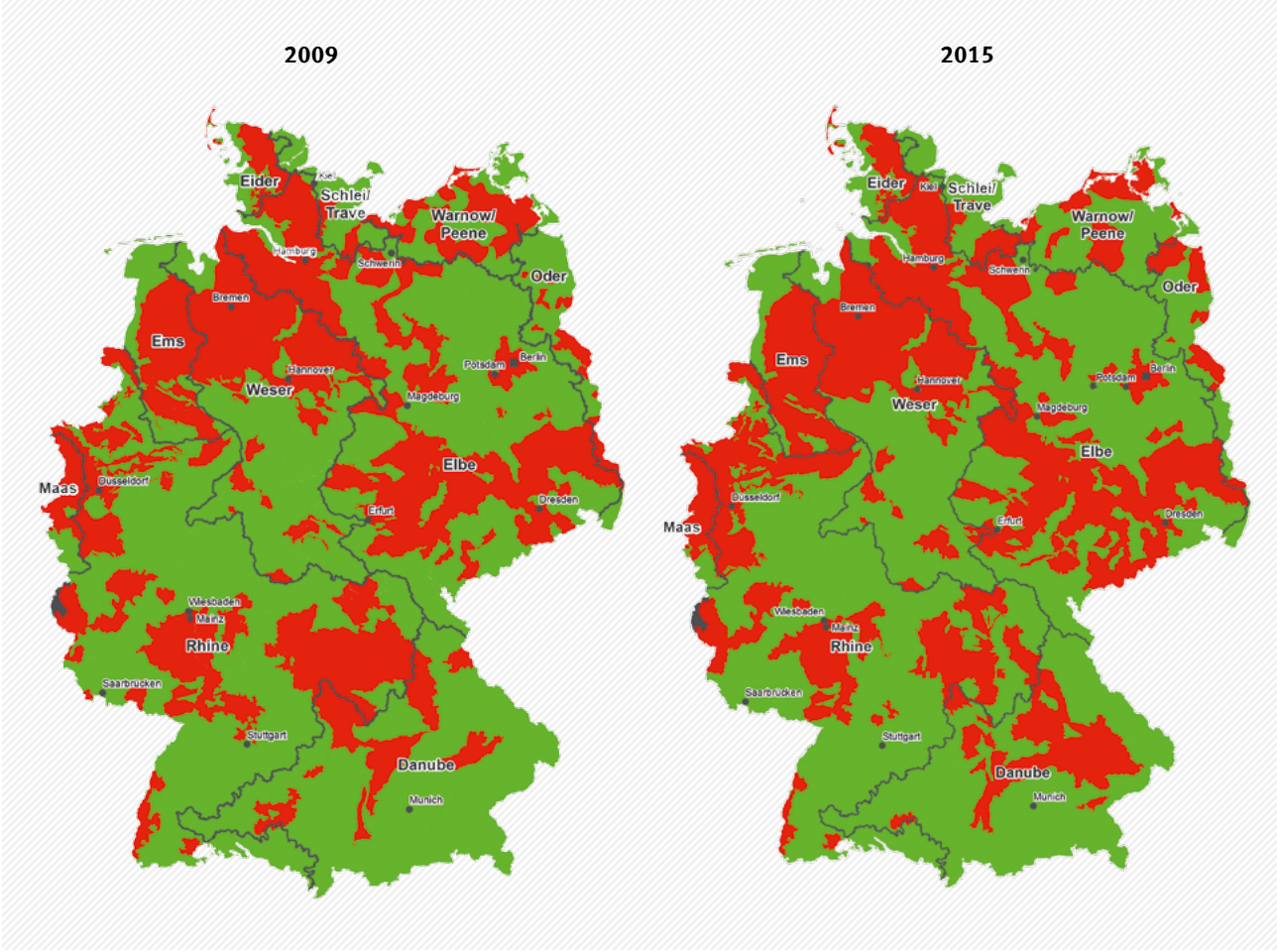
Programmes of measures have been devised and implemented with a view to achieving "good quantitative" and "good chemical status" for all groundwater bodies. Comparing groundwater status" at the beginning and end of the first management cycle sheds light on the degree to which Water Framework Directive objectives have been reached thus far. This assessment shows that, although neither the quantitative nor the chemical status of groundwater has improved significantly, it has also not significantly deteriorated.

As before, 4 percent of all groundwater bodies exhibit "poor quantitative status" (Maps 12 and 13). The status of most of the groundwater bodies that exhibited "poor quantitative status" at the beginning of the first management cycle remains unchanged. This holds true in particular for groundwater bodies whose recession is attributable to past coal mining or that is still ongoing to some extent. As was foreseeable at the beginning of the programmes of measures, it will take decades for these groundwater bodies to revert to "good quantitative status"

Maps 14 and 15 illustrate a comparison between groundwater body chemical status in 2009 and 2015, which are essentially the same. It should also be borne in mind that numerous groundwater bodies were designated after 2009, thus to all intents and purposes precluding a direct comparison of the relevant changes.

Map 14 und Map 15

Comparison of the chemical status of German groundwater bodies in 2009 and 2015.



Source: Berichtsportal WasserBLIcK/BfG; status as at 22 March 2010 and 23 March 2016.
Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

However, failing the Water Framework Directive objectives was and is mainly attributable to nitrate. In fact, according to current projections it is well within the realm of possibility that, owing to the growing size of livestock herds and the cultivation of sustainable raw materials on heretofore fallow farmland, groundwater nitrate concentrations will rise in certain regions.

The fact that groundwater body pressures did not change significantly between 2009 and 2015 is also attributable to (a) the lengthy retention time of water in the soil and its slow percolation rate into groundwater through the unsaturated zone; and (b) slow or lacking underground breakdown processes. As a result of these factors, the effects of groundwater quality improvement measures do not materialize for quite some time, and the pressures that come into play are not comparable with each other. In other words, under certain circumstances the causes of groundwater pollution date back decades.

Nitrates still pose a problem for groundwater

Programmes of measures

Given the fact that many water bodies still fail the Water Framework Directive management objectives, water status improvement measures need to be planned and implemented. Such measures are planned within the framework of programmes of measures, which are slated for implementation during the current management cycle, and to some degree in the subsequent cycle as well. A report on the implementation status of these measures will be submitted to the EU in 2018.

If it is found that the measures that have been taken are unlikely to allow for achievement of the Water Framework Directive management objectives, the programs will have to be updated for the next period. All planning and approval of water uses will henceforth need to take programmes of measures into account.

Measures or combinations thereof are usually planned by regional federal state water authorities in consultation with the relevant bodies. Implementation of the measures falls to municipalities, districts and counties, depending on the size of the water bodies in question. Continuity and water body maintenance for federal waterways fall to the Federal Waterway and Shipping Authority. In some cases, such tasks fall to third parties such as hydropower providers or water and soil associations. Planning, too, is affected by whether a given measure is technically and financially feasible. Here, the general principle applies that a given measure should achieve the greatest possible effect at the lowest possible cost (cost effectiveness).

A brief look back at the status of program of measure implementation in 2012

An initial interim assessment of the implementation status of the programmes of measures was undertaken in 2012, in accordance with the plan that was made in this regard in connection with the 2009 programmes of measures. It was found that 16 percent of the measures had been completed by 2012 and that around 70 percent of them had gotten underway; whereby plans for their implementation had been drawn up at a minimum.

But there was still uncertainty as to the actual implementation of these plans, a situation reflected by the fact that as of 2009, 30 percent of the planned measures had not yet commenced. The main causes indicated for this were a lack of human and financial resources, a lack of land area necessary for implementation, a lack of acceptance of measure implementation, and uncertainty as to whether the measures would have the desired effect.

The Water Framework Directive mainly distinguishes between two types of measures: basic measures and supplementary measures.

- Basic measures, which comprise the minimum water body protection and development requirements, are already defined in existing directives or serve to meet basic water management requirements (Article 11(3) of the Water Framework Directive) such as those laid out in the Urban Wastewater Treatment Directive (91/271/EEC) and the Nitrate Directive (91/676/EEC).
- Supplementary measures come into play in cases where Water Framework Directive objectives cannot be reached using basic measures alone. Such measures comprise construction and rehabilitation projects, as well as legal, administrative or management instruments and training measures.

Germany's programmes of measures were established on the basis of a list of measures that was drawn up by Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) with a view to ensuring nationwide uniformity in this regard. This list was updated and expanded for the current management cycle. Whereas the list of measures for the first management cycle contained 107 types of measures, the number has now increased to more than 170 – including, for example, measures promulgated by the Flood Risk Management Directive (2007/60/EC) and the Marine Strategy Framework Directive (2008/56/EC). Combining all measures into a single list allows for direct interconnections between the three directives – thus promoting optimized use of synergies and more efficient and comprehensive measure planning.

Improving riverbank habitats is only one of more than 170 types of measures

The analyses below show the pressures (see Section 5.1) and uses (see Section 5.2) that the programmes of measures focus on. To this end, the number of water bodies was determined that each type of measure is envisaged for and that is ascribable to a specific pressure or user. The actual number of individual measures is far greater than the aforementioned number, as it was possible to plan multiple measures of a give type for each water body.

5.1 Measures according to significant pressures

The pressures that are mainly responsible for surface water ecological and chemical status objectives being failed are diffuse sources, point sources, flow regulation and morphological changes and water abstraction. For each of these various focuses of pressures, measures are to be planned and implemented with a view to improving water body status. Groundwater pressures are mainly ascribable to diffuse sources.

The various measures are broken down by focus of pressure in the list of measures (Table 3).

Table 3

Representative excerpt from the LAWA list of measures, which formed the basis for planning the programmes of measures.

Measure designation	Focus of pressure
Building and expanding municipal sewage treatment plants	Point source
Installation of protective water buffer strips to reduce nutrient input	Diffuse source
Reduction of mining related water abstraction	Water abstraction
Improvement of river bank habitats	Flow regulation and morphological changes

Using this information as a basis, the various measures planned for the river basins can be broken down proportionally by focus of pressure (Figures 19 and 20).

As the graphic shows, 41.5 percent of all measures are planned in the focus-of-pressure category “flow regulation and morphological changes”. Of these, 19 percent relate to hydromorphology measures such as water-reach renaturation, 16.9 percent relate to continuity restoration measures, and 5.6 percent relate to hydrological regime measures such as achieving a minimum flow in a given water body.

38 percent of the envisaged measures relate to diffuse sources. They mainly centre around agricultural measures such as reducing soil erosion and rainwash (alternative tillage methods), as well as providing farmers with advice concerning water friendly cultivation meth-ods. Averting accident related inputs (6.5 percent) aims to reduce water body pollution ascribable to pollutants from industrial and agricultural activities, as well as populated areas. Diffuse-input reduction measures (3.7 percent) relate to mining, contaminated sites, abandoned industrial sites, built-up areas and so on.

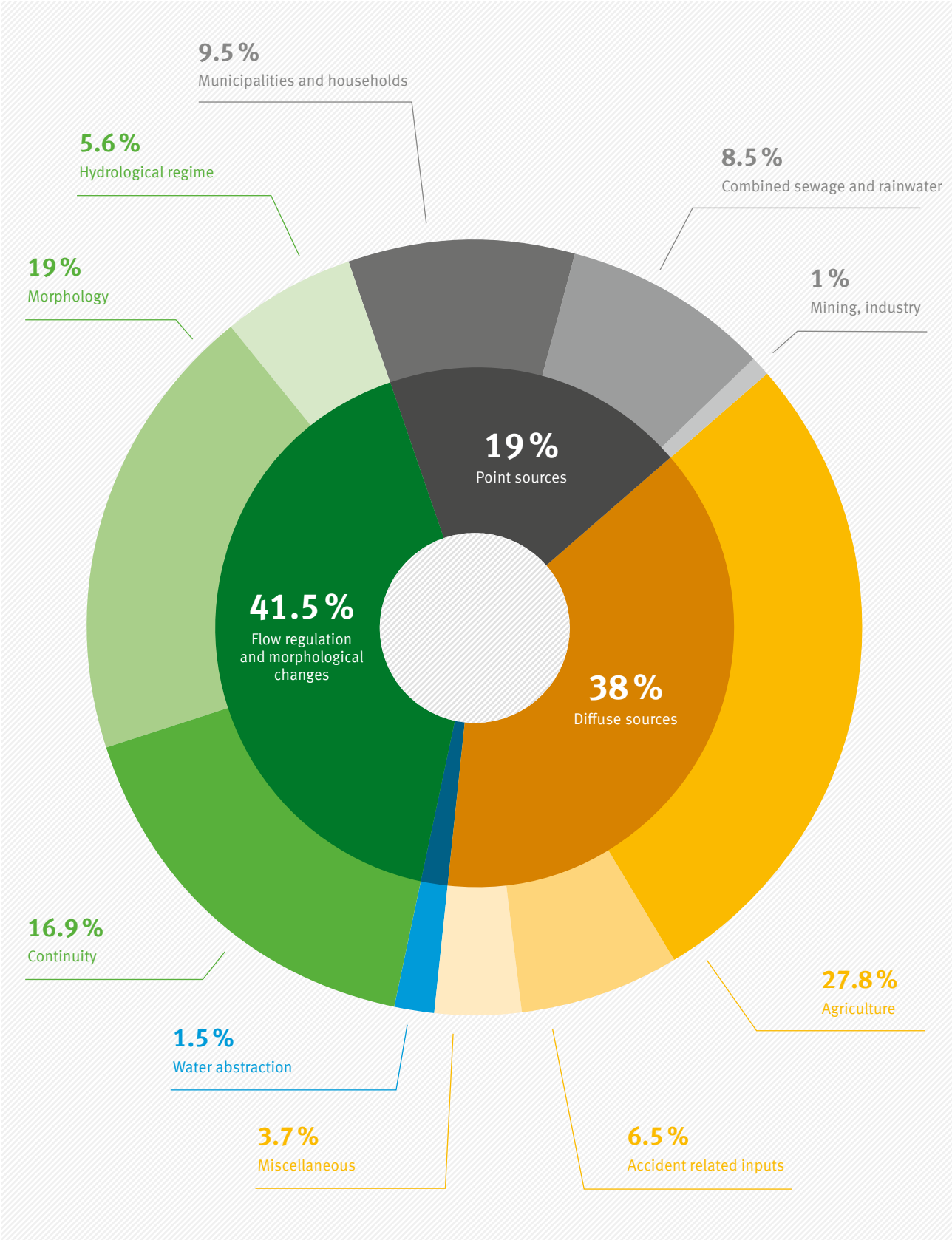
Point-source measures, which account for 19 percent of all envisaged measures, predominantly relate to municipalities and households (9.5 percent). Such measures mainly involve built-out and optimization of municipal sewage treatment plants. In the interest of reducing nutrient and pollutant input from combined sewage and rainwater discharges (8.5 percent), old piping will be replaced in many cases, or larger reservoirs will be built for purposes of improving rainwater retention. Mining and industry related measures are of negligible importance (1 percent) and play a role solely in regions affected by mining.

Measures relating to water abstraction (1.5 percent) are likewise of relatively minor importance. These measures mainly comprise technical measures aimed at improving water abstraction and irrigation-water use efficiency.

Apart from the aforementioned measures, numerous conceptual measures (as they are called) come into play that are often not ascribable to any particular focus of pressure. Such measures include research, in-depth investigations and testing and informational and in-service training events. These measures likewise relate to various

Figure 19

Proportion of planned measures for surface water body, broken down by focuses of pressures, for the current management cycle (2016-2021).



Technical data: BerichtsportalWasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

focuses of pressures, and are in many cases not ascribable to a particular water body, but instead encompass large areas. In Germany, such measures are planned for nearly half of all surface water bodies.

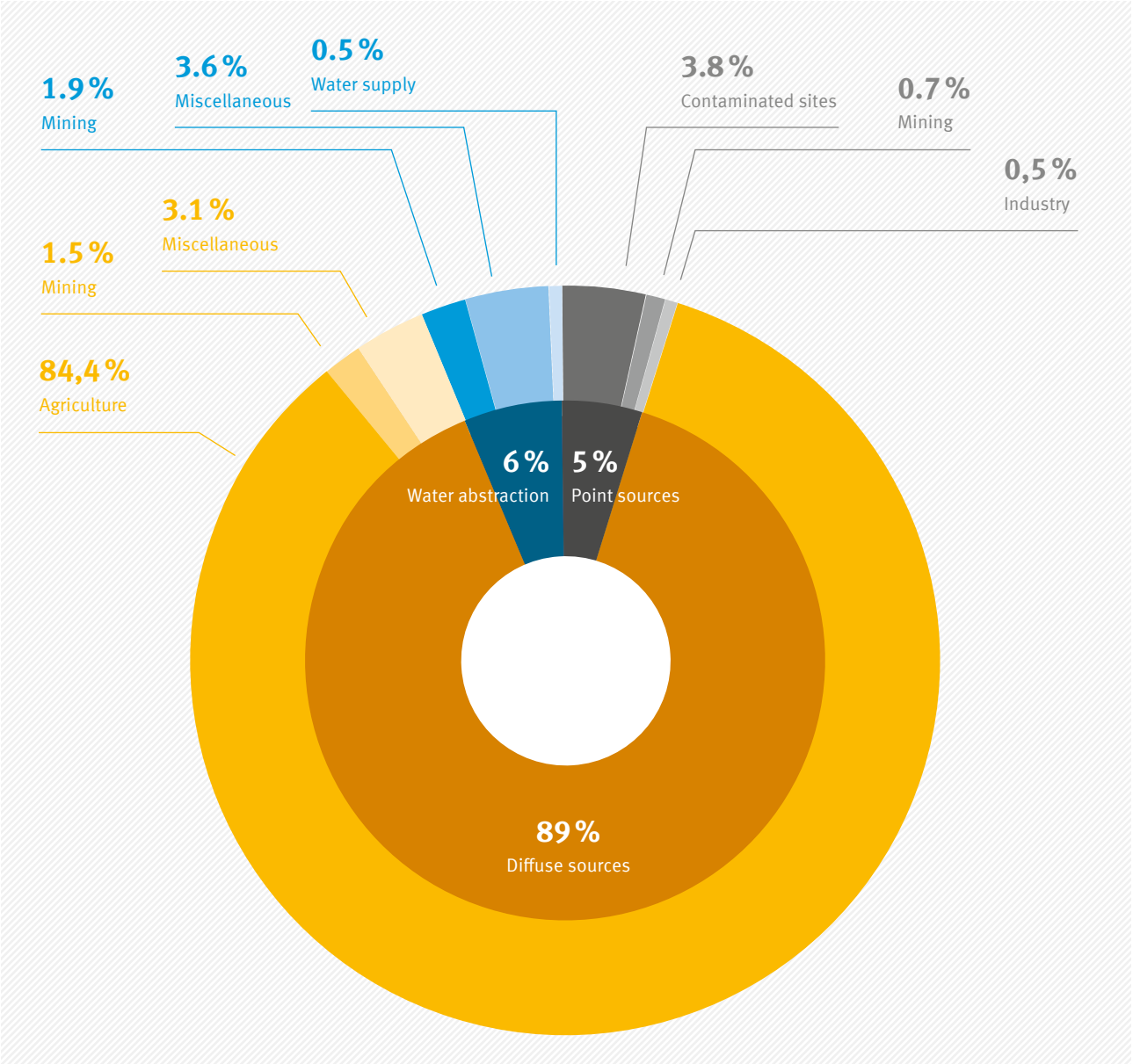
Most of the planned groundwater measures (89 percent) aim to reduce pressures from diffuse sources, which are predominately ascribable to agriculture (84.4 percent). Point sources account for a far smaller proportion (5 percent) of the planned measures. Sewage from contaminated sites, mining and industrial activities are relevant for groundwater.

The types of measures aimed at reducing groundwater abstraction are not specified in most cases (Miscellaneous: 3.6 percent). A minor proportion of the measures relates to mining and focuses on regions used for mining activities.

Conceptual measures, which also play a major role for groundwater, are slated to be carried out during the next management cycle for roughly half of all German groundwater bodies.

Figure 20

Proportion of planned measures for groundwater, broken down by focuses of pressures, for the current management cycle (2016-2021).



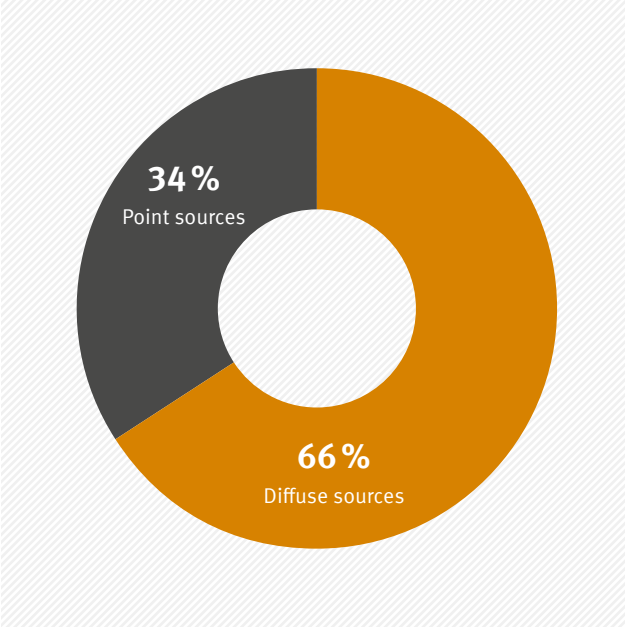
Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Eutrophication (nutrient oversupply)

Eutrophication is attributable to high concentrations of water body nutrients that come from point sources and diffuse sources. Numerous measures aimed at reducing water body nutrient content are planned. Of these measures, 34 percent target point-source loads, and 66 percent aim to reduce nutrient input from diffuse sources (Figure 21).

Figure 21

Proportion of planned eutrophication reduction measures for the current management cycle.

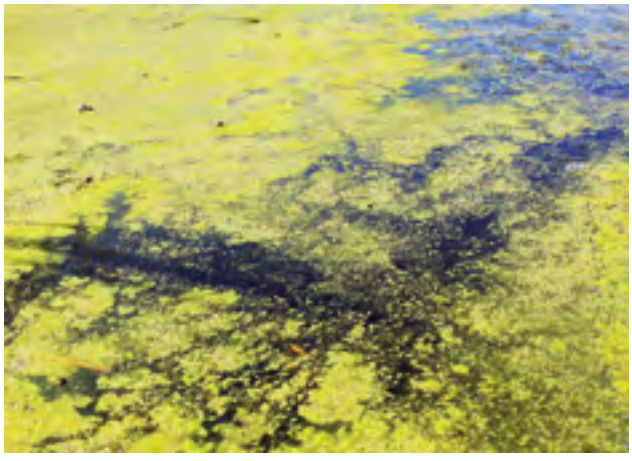


Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Diffuse-source related measures mainly concern agriculture, for purposes such as reducing farmland erosion through catch-cropping or modified tillage methods. In many cases, nutrient inputs are reduced by creating buffer strips alongside water bodies. By the same token, reduced fertilizer use and efficient crop rotation aim to reduce surplus soil nutrient loads and the risk of increased wash-out into groundwater or surface water.

Optimization of combined sewage and rainwater treatment reduces point-source pressures

Reducing nutrient inputs from point sources mainly relates to phosphorous. Improvement measures aimed at further reducing phosphorous inputs still remain to be carried out for water bodies subject to high sewage loads from municipal sewage treatment plants. In some cases, combined sewage and rainwater discharge improvement is needed; and in certain areas building new sewage treatment plants as well as increasing the proportion of areas that have yet to be connected to the public sewage grid.



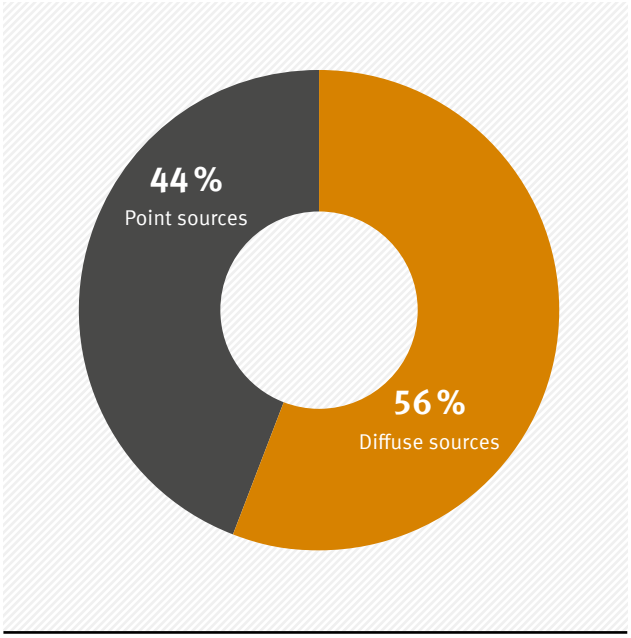
Pollutant inputs

Pollutant inputs will likewise be reduced via point and diffuse source measures (Figure 22) – although here, the proportion of measures targeting point-source pressure reduction is considerably higher (44 percent), relative to eutrophication reduction measures.

The pollutant input reduction measures planned for the current management cycle mainly target combined sewage overflows and rainwater management. Likewise of significance are measures aimed at reducing agricultural pesticide inputs into water bodies. Such inputs are currently unduly high, as was shown by the findings of the initial inventory of emissions in Germany. In this inventory, a total of ten pollutants was deemed relevant for Germany as a whole, including the pesticides diuron, isoproturon and trifluralin. The inventory revealed that these ten pollutants, as well as all other relevant substances, are mainly discharged into water bodies from diffuse sources. Equally important is the avoidance of pollutant inputs at their source (e.g. through proper disposal of pharmaceutical drugs) and reducing pollutant inputs from abandoned mining and industrial sites.

Figure 22

Proportion of planned pollutant input reduction measures for the current management cycle.



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/ editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Changes in and lack of habitats

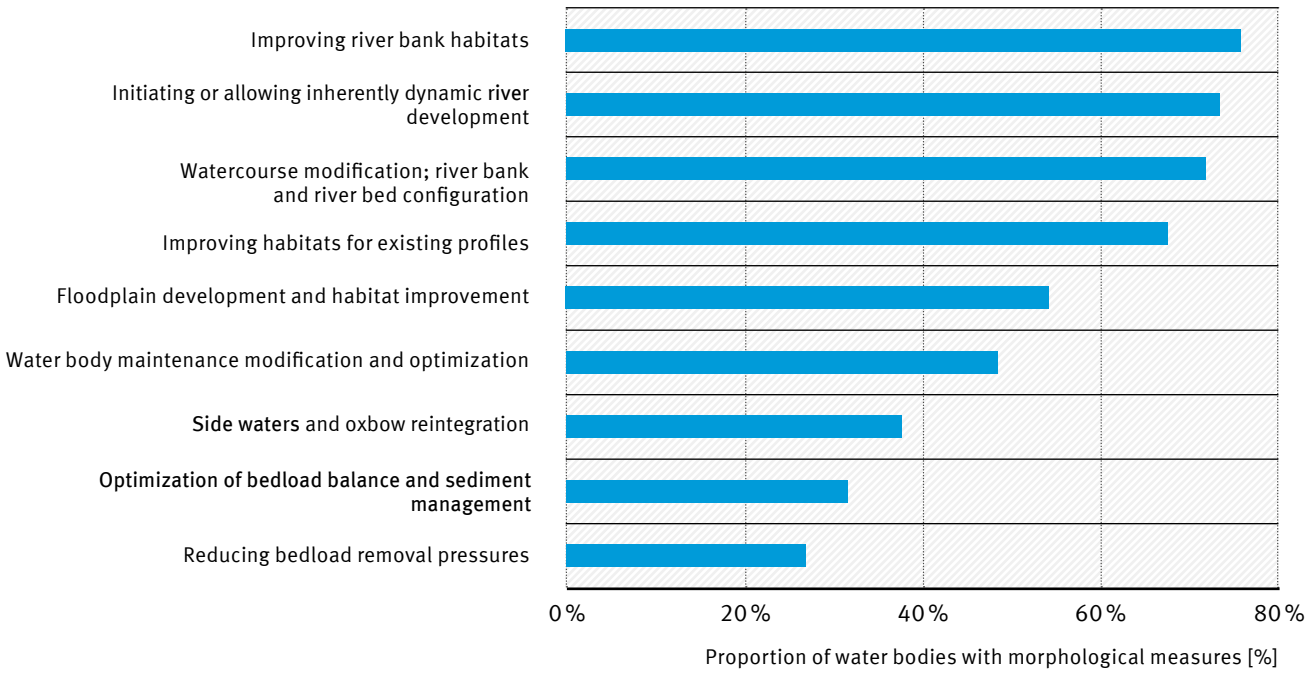
Given that hydromorphology has a considerable impact on the incidence and composition of biota that are characteristic of a particular location, when it comes to hydromorphological quality elements (hydrological regime, continuity and morphology), efforts should be made to achieve a state that allows for typical water body colonization. This state has yet to be achieved for the vast majority of water bodies.

Hence a great many hydromorphological measures are needed in all surface waters in order to meet Water Framework Directive objectives. The most prevalent type of measure in this regard centres around hydromorphology improvement. Such measures are planned for 60 percent of all surface water bodies for the 2015-2021 management cycle.
Watercourse habitat improvement – for riverbanks, in existing profiles, and in floodplains – is the most prevalent type of measure for these water bodies. Likewise prevalent are measures aimed at setting dynamic water body development in motion, as well as modification and optimization of water body maintenance. A considerable number of measures also targets floodplain development (Figure 23).

Good hydromorphology also means that rivers can make themselves at home again

Figure 23

Proportion of planned morphology improvement measures for the current management cycle (n = 5,800).



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Deficient continuity

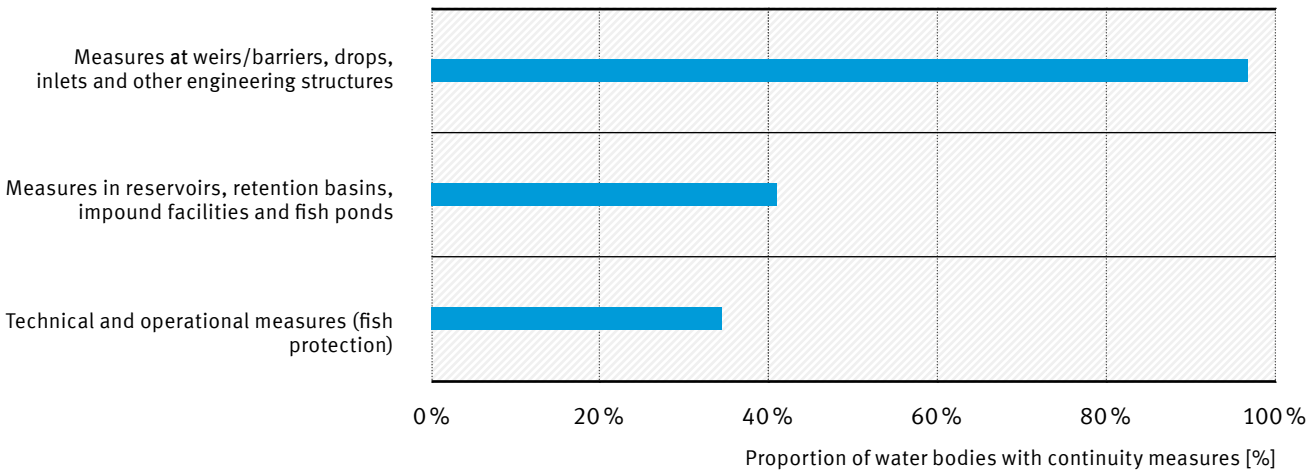
Water body continuity is currently disrupted in Germany by around 200,000 transverse structures, including extremely small structures such as sills and stream drops. The failure to meet the mandated management objectives is largely attributable to deficient water body continuity.

Owing to the presence of 200,000 transverse structures in German water bodies, continuity needs to be reestablished for more than half of them

Continuity restoration measures are planned for more than 50 percent of all surface water bodies – thus making such measures the second most prevalent type of measure in Germany. Many such measures will be implemented at river weirs and reservoirs and will entail, for example, the realization of bypass channels, or structures that enable fish to swim over or under engineering structures. Man-made abrupt drops in water bodies will be converted to structures such as river bottom slides – or if possible will simply be removed. Also planned are measures aiming at optimizing the management and control of lock and pumping station operations, as well as measures involving technical or operational optimization of engineering structures so as to prevent fish from being harmed (Figure 24).

Figure 24

Proportion of planned continuity improvement measures for the current management cycle (n = 5,150).



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Elevated water temperatures

Rises in water temperatures are attributable to, among other things, coolant water discharges from large power plants. In such settings, ambient temperature also plays a role of course, as does the impact of climate change on such temperatures and the variability of summer and winter temperatures. Nevertheless, during the 2016-2021 management cycle, heat-pressure reduction measures will be confined to power plants, and thus will focus on the largest such sites.

To this end, the measures planned in Germany mainly centre around major watercourses , with the goal of reducing or optimizing heat discharges – for example by building new cooling facilities or elaborating thermal load plans. Around half of these measures will be carried out at sites in North Rhine-Westphalia, for the Erft, Wupper, Lippe and Weser rivers. Such measures will also be carried relatively often in Saarland.

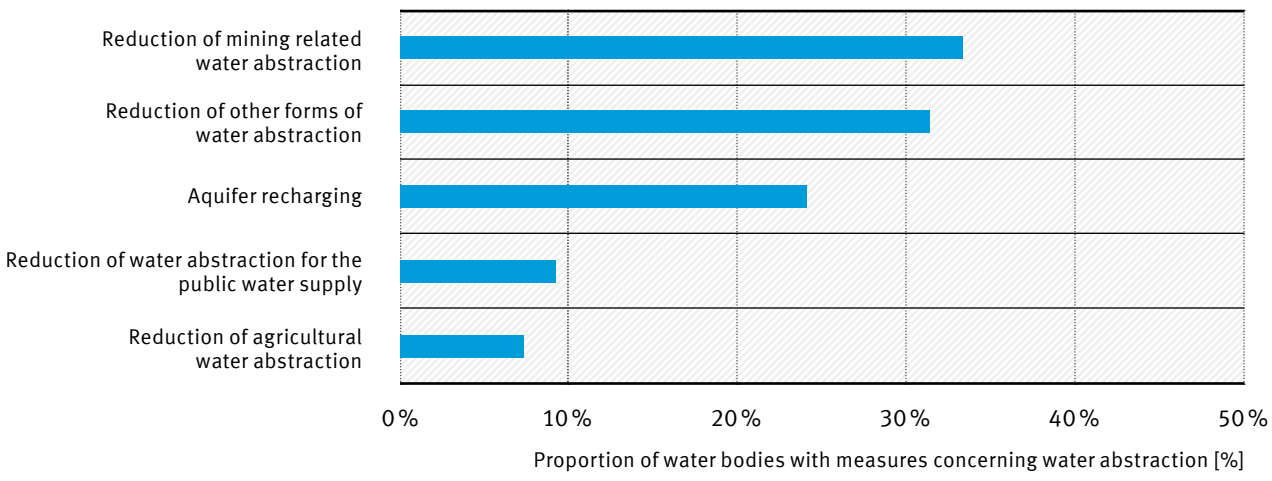
Falling groundwater levels

Although water abstraction-related measures represent a relatively minor proportion (1.5 percent) of all measures that are planned for this focus of pressures, water abstraction can have a major impact on water body status in both groundwater and surface waters.

Measures aimed at reducing water abstraction pressures are planned for nearly 54 (5 percent) of nearly 1,180 groundwater bodies. The most prevalent of these measures aim to reduce mining water abstraction and improve aquifer recharge rates. Of less relevance, on the other hand, are measures aimed at reducing water abstraction attributable to the public water supply and agriculture (Figure 24).

Figure 25

Proportion of planned water abstraction reduction measures for the current management cycle (n = 54).



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

5.2 Responsibility lies with the polluters

Agriculture

Measures

Measures aimed at reducing agriculture pressures are planned for two thirds of all surface water and groundwater bodies. As Figure 26 shows, mainly measures aimed at reducing nutrient inputs ascribable to factors such as wash-out and erosion are planned. Buffer strip creation is also frequently mentioned in the programmes of measures.

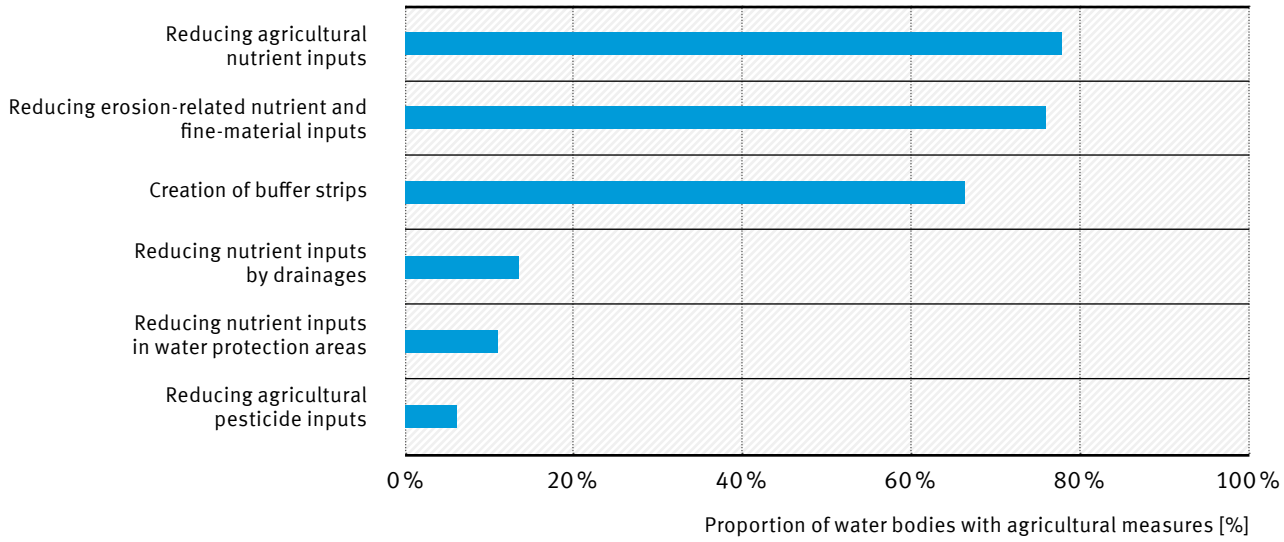
Most measures aimed at reducing agricultural nutrient loads target high levels of nitrogen wash-out for purposes of reducing agricultural inputs. Such measures involve, for example, providing farmers with advice on water protection; optimized methods for determining fertilizer needs; mulch seeding; undersowing; catch crops; reducing or modifying fertilizer use; technical measures aimed at drainage improvement; and switching to organic farming. Measures aimed at reducing pesticide pressures include the following: the use of modified application methods; banning pesticide use in particularly vulnerable areas; pest control using biotechnical and biological means.

Most measures planned for water protection areas involve agricultural usage restrictions, which in many German states are also prescribed by law or governed by contracts. Such usage restrictions often also result in economic losses for farmers, who under federal state laws are entitled to financial compensation for such losses. Such measures are usually carried out with the aid of adviso-ry support aimed at promoting water protection.
In addition to nutrient input reduction measures, numerous conceptual measures will be carried out – including, for example, agricultural advisory programs on managing farmland in a water body friendly fashion, or on efficient fertilizer use. Programs involving cooperation between farmers and water utility companies will also be available, with the goal of promoting water body-friendly farming practices – but mainly for the preservation of drinking water quality.

Some of these agricultural advisory programs do not pertain to water bodies per se. Instead, the federal states have envisaged such programs for implementation in entire planning units or federal state-wide, depending on which regional issues are being addressed.

Figure 26

Proportion of planned agriculture pressure reduction measures for the current management cycle (n = 6,300).

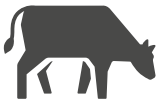


Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Measure implementation

The implementing units of agricultural measures are the farmers. Certain measures are mandatory under the EU agricultural reform, and are also a requirement for part of the direct payments effected to farmers in connection with the first pillar of the Common Agricultural Policy (see Section 3.1). That said, the German states have already included a major part of the aforementioned measures in their rural development subsidy programs; their aim is to implement Regulation (EU) No 1305/2013, which governs the European Agricultural Fund for Rural Development (EAFRD).

This regulation, which contains voluntary measures, constitutes the legal framework for the second pillar of the Common Agricultural Policy (i.e. the policy for Europe's rural areas) for the years 2014 to 2020. Of particular relevance for water body protection are the regulation's fourth and fifth priorities (Figure 27).

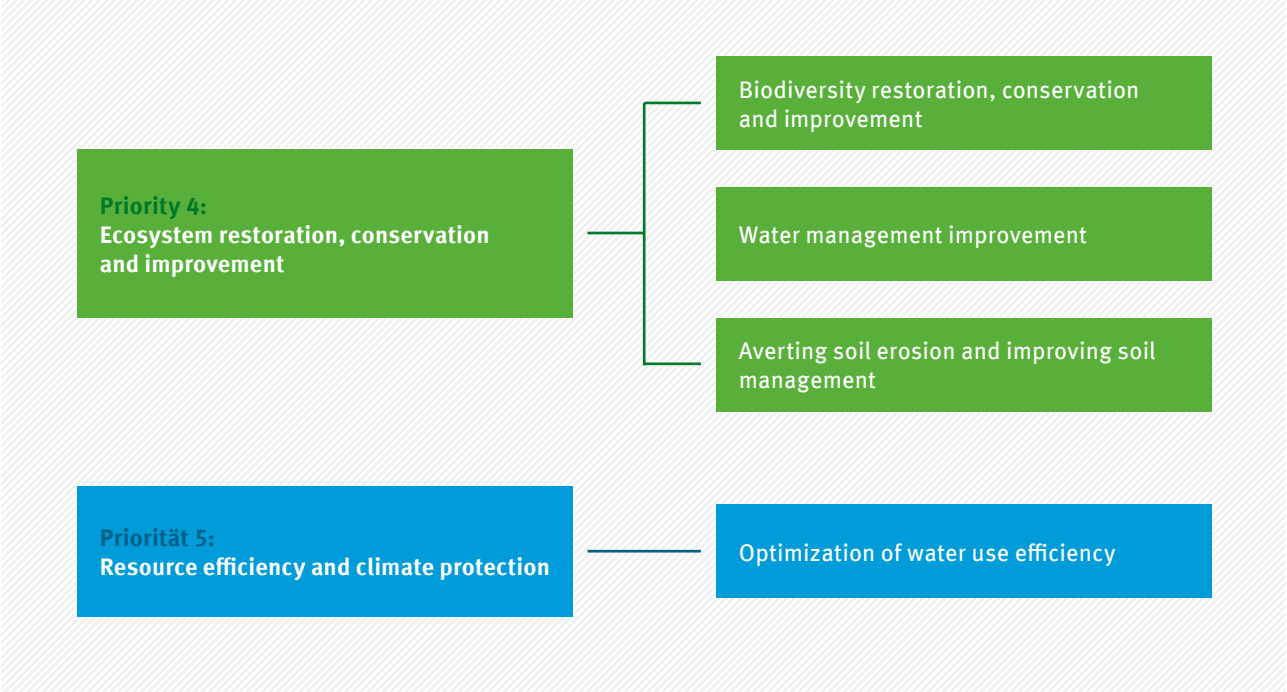


Supporting farmers in a meaningful fashion

The European Agricultural Fund for Rural Development (EAFRD) is the main subsidy program for the implementation of EU rural development objectives. Around €1.35 billion in annual subsidies has been allocated to Germany for the 2014-2020 period, subject to co-financing via federal, state and municipal funds. The federal government contributes around €600 million annually via the joint federal-state initiative known as Verbesserung der Agrarstruktur und des Küstenschutzes (GAK; Improvement of the agricultural infrastructure and of coastal protection). Thus a total of €16.9 billion will be available between 2014 and 2020 to subsidize agricultural measures and projects for all aspects of rural development that exceed the requirements prescribed

Figure 27

The key water protection related measures called for by the EAFRD Regulation.



by law. About one fifth to one third of these funds will be used for water protection measures, depending on the federal state concerned.

The rural development programs that implement the EAFRD Regulation have been variously named by the German states and are subject to differing regulations depending on regional needs. Table 4 provides an overview of these regulations and the scope of the subsidies available through them.

Table 4

Overview of water body related rural development subsidy programs in the German states.

	BW	BY	BB BE	HH	HE	MV	NI HB	NW	RP	SL	SN	ST	SH	TH	Subsidy range [€/ha]
Organic farming methods	x	x	x	x	x	x	x	x	x	x	x	x	x	x	200 – 1,200
Extensive pastureland and meadows	x	x	x	x	x	x	x	x	x	x	x	x	x	x	40 – 750
Ban on/avoidance of pesticide use; alternatives in connection with other agri-environmental measures	x	x	x	x	x	x	x	x	x	x	x	x	x	x	40 – 500
Ban on/avoidance of fertilizer use Maintenance fertilizing in connection with other agri-environmental measures	x	x	x	x	x	x	x	x	x	x	x	x	x	x	80 – 350
Limiting/reducing nitrate surplus	x		x	x	x	x	x	x	x	x	x				50 – 160

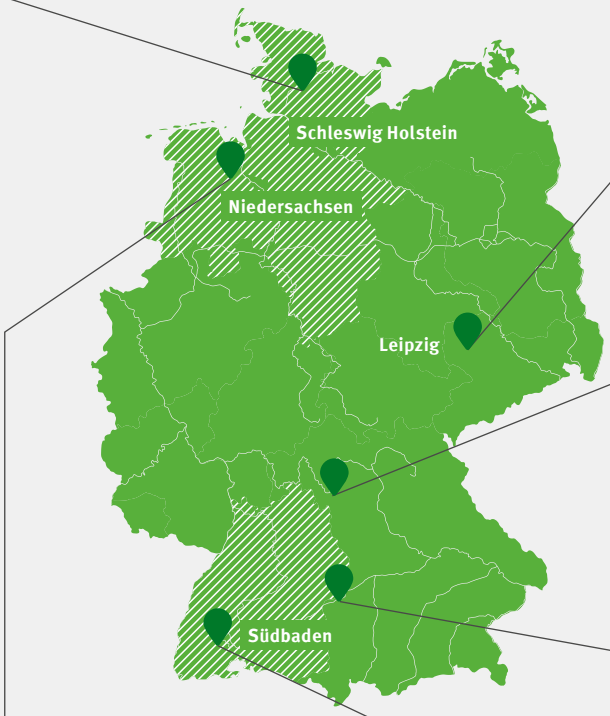
	BW	BY	BB BE	HH	HE	MV	NI HB	NW	RP	SL	SN	ST	SH	TH	Subsidy range [€/ha]
Low-emission and water body friendly application of farmyard manure (e.g. slurry)		x		x			x	x	x	x		x	x		25 – 80
Avoiding the use of sewage sludge and liquid manure on subsidized fields		x	x					x	x						–
Converting cropland to pastureland	x	x	x			x		x	x		x			x	40 – 1,300
Catch cropping, undersowing, and greening to prevent erosion and protect the soil and groundwater	x	x			x	x	x	x	x	x	x	x	x	x	40 – 150
Mulch seeding and/or direct seeding		x					x	x			x	x		x	65 – 300
Extensive crop rotation; crop diversity	x	x		x	x	x	x	x	x			x	x	x	40 – 120
Ecologically safe pasture use in vulnerable areas	x	x	x						x		x				125 – 700
Ban on plowing up in other agri-environmental measures	x	x	x	x			x	x	x		x		x		–
Setting aside arable land/ leaving it fallow	x	x									x				250 – 800
Farming set-aside land for groundwater resource conservation purposes			x		x										–
Development of near-natural water bodies	x	x	x			x	x		x			x	x		–
Buffer strips around fields and water bodies to prevent erosion	x	x		x	x	x	x	x	x	x	x	x	x	x	200 – 1,100
Marsh and fen protection and development; subsidies for marshes and wet meadows; greater water retention in wet areas	x	x	x			x	x		x	x	x	x	x	x	40 – 450
Extensive aquaculture	x	x									x				200 – 600
Restrictions on livestock herds on pastureland	x	x	x	x	x	x	x	x	x	x		x			–
Water management subsidies				x		x	x								–
Providing advice and training	x	x	x	x	x	x	x	x	x	x	x	x	x	x	–
Planning and conceptualization	x	x	x		x	x	x	x	x		x	x	x	x	–
Publications and PR	x	x	x		x	x	x	x	x	x	x	x	x	x	–
Financing pilot and model projects	x	x	x		x	x	x	x	x		x	x	x	x	–

In particular, rural development subsidies – the second pillar of the Common Agricultural Policy – are likely to make a key contribution. However, unlike the non-specific agricultural subsidies effected in connection with the first pillar of the Common Agricultural Policy, these rural development subsidies are subject to co-financing by the federal states. Hence the extent to which effective measures can actually be financed via the second pillar hinges on the amount of funding that is available and the political priorities that are defined.

A portion of the funding for implementation of the programs of measures in the various German states comes from water abstraction fees, which are levied in 13 states (i.e. not in Bavaria, Hesse or Thuringia) and amount to between 5 and 31 euro cents per cubic meter of abstracted water.

Examples of measures
Agriculture

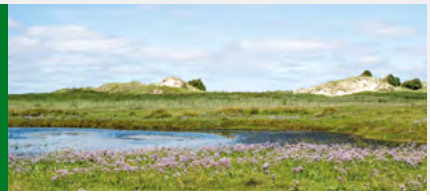
Agricultural advisory programs for endangered groundwater bodies in Schleswig Holstein



Water friendly agriculture in Leipzig's water protection areas

Aktion Backgetreide (Baking-grain initiative)

Statewide Donauried-Hürbe Projekt (DHP)



Water protection related agricultural advisory programs in Lower Saxony

Optimization of soil and nitrogen management for winegrowing in the Südbaden region

1) Agricultural advisory programs for endangered groundwater bodies in Schleswig Holstein

High groundwater nitrate concentrations from agricultural activities occur in around 50 percent of the surface area of Schleswig Holstein. Water Framework Directive good chemical status for groundwater bodies is failed for the most part, owing to these nitrate pressures.

In the interest of counteracting this problem, Schleswig Holstein offers agricultural advisory programs, as well as additional advice for farmers via a private consulting firm or the Chamber of Agriculture. In addition to providing advice on water friendly fertilizer use and management, groundwater friendly farming methods are tried out under real conditions and more farms are included in groundwater protection measures. In addition, in each agricultural advise area, a water protection forum has been established that provides proactive support for the implementation of agricultural advise. Among the accomplishments of these programs is that farmers have been reached who tended to be leery of extensive water body protection measures.

The degree to which nitrogen use has been reduced by agricultural advise concerning groundwater protection is not quantifiable as yet. However, at the level of individual farms, progress has clearly been made in terms of nitrogen balances – progress that in certain cases has translated into nitrogen use reductions from 120 to 60 kilograms per hectare. Moreover, considerable optimization potential has been uncovered at virtually all farms that received advise.

The around €5.4 million cost for agricultural advise between 2008 and 2014 was defrayed by the Schleswig Holstein government. Since 2015, water protection-related agricultural advise has also been subsidized by the European Agricultural Fund for Rural Development (EAFRD).

2) Water protection-related agricultural advise in Lower Saxony

Since 2010, the Lower Saxony Chamber of Agriculture and consulting engineers under contract to the Chamber have been offering farmers from high-vulnerability regions agricultural advise on groundwater friendly farming that are based on cooperation with the region's farmers. Participation in such programs is voluntary. In 2014, agricultural advise was introduced that also centres around surface waters – in this case the Große Aue, Hase, Fuhse and Wietze rivers. In these pilot regions, agricultural advise on reducing nutrient inputs, with a focus on nitrate and phosphorous pressures, is offered as a state of Lower Saxony model project. In 2016, these goals were extended to include particularly vulnerable or sensitive areas in Ems-Nordradde – to which end agricultural advise was offered for the first time in the watersheds of two lakes (Steinhuder Meer and Bederkesaer See). Agricultural advise concerning groundwater protection are being offered in seven other areas. In these areas, farmers are offered specific water protection measures as per the ELER-NAU/BAU-Finanzierungsrichtlinie funding program.

3) Optimization of soil and nitrogen management for winegrowing in the Südbaden region

Given that, owing to high nitrate concentrations, good groundwater chemical status has not been reached in winegrowing regions, measures aimed at reducing nitrogen wash-out were developed at existing and new vineyards. This project, which ran from 2010 to 2013 and was carried out by Weinbauinstitut Freiburg, entailed the following milestones:

- Determination of potential nitrate discharges engendered by the current soil, greening and nitrogen management practices of various winegrowers.
- Investigating and shedding light on options for improved soil management, in collaboration with vineyard managers and winegrowing and water protection area consultants.
- Elaboration of recommended courses of action for fertilizer use and soil management in recently established vineyards, in conjunction with analyses of possibly conflicting objectives.

The cost of the project, which was subsidized by the state of Baden-Württemberg, was €342,000. It will be a few years before positive outcomes come to light, owing to the significant time lags for groundwater.

4) Water friendly farming in Leipzig's water protection areas

The drinking water supply for Leipzig and environs comes from groundwater that exhibits high nitrate content owing to intensive farming in the watershed. If these nitrate pressures rise, cost intensive water treatment would be necessary. This situation prompted Leipzig's municipal water utility company (Kommunale Wasserwerke Leipzig (KWL)) to elaborate, in collaboration with officials and farmers, new objectives aimed at reducing

nitrate concentrations to 25 milligrams per litre. These objectives were reached via the following measures:

- Wassergut Canitz switching to organic farming.
- Area related agricultural protection concepts for Leipziger Wasserwerke (Leipzig's municipal water utility company) water protection areas – namely hydrological measures, and protection requirements and compensatory payments, differentiated in accordance with location and farming activities.

As a result of these measures, groundwater nitrate concentrations declined from 40 to 20 milligrams per litre.

5) Aktion Backgetreide (Baking-grain initiative)

The Backgetreide model project has adopted a novel approach to reducing elevated nitrate pressures on groundwater. Following a successful test phase in 2014, since 2015 three farmers in the Unterfranken communities of Werntal, Würzburg and Sulzfeld/Marktsteft have been omitting the final application of nitrogen fertilizer for the cultivation of wheat used for baking. This measure reduces nitrate wash-out and is beneficial for the quality of local drinking water – which in turn obviates the need for cost intensive drinking water purification. The farmers in question receive compensatory payments from local water utility companies. After being milled separately, their grain is sold to participating bakeries, whose customers are thus afforded the opportunity to support local, groundwater-friendly grains and traditional artisan bakeries.

6) The Donauried-Hürbe Projekt (DHP)

The Donauried-Hürbe Projekt (DHP) centres around collaboration with the state of Baden-Württemberg, represented by the ministries known as Ministerium für Ländlichen Raum und Verbraucherschutz (MLR) and Ministerium für Umwelt Klima und Energiewirtschaft Baden-Württemberg (UM), along with the state water supply association known as Zweckverband Landeswasserversorgung. Their avowed goal, formulated in 2015, is to substantially improve the groundwater status of Donauried, representing major state-wide groundwater resources. Specifically, the initiative aims to reduce untreated-water nitrate concentrations in the Donauried-Hürbe water protection area to 30 milligrams per litre, within the next 15 years.

To this end, the federal state launched a project known as the Donauried-Hürbe Projekt, via a working group whose members are farmers, district administrators and regional councils. The groundwater-friendly farming measures that have been elaborated (referred to as DHP-Maßnah-men, or DHP measures) comprise voluntary environmental measures that mainly centre around fertilizer use (e.g. multi-farm area-specific nitrate sensor fertilizing) and soil tillage (e.g. refraining from any tillage following the winter-rape harvest).

Municipalities, households, and the industrial sector

Measures

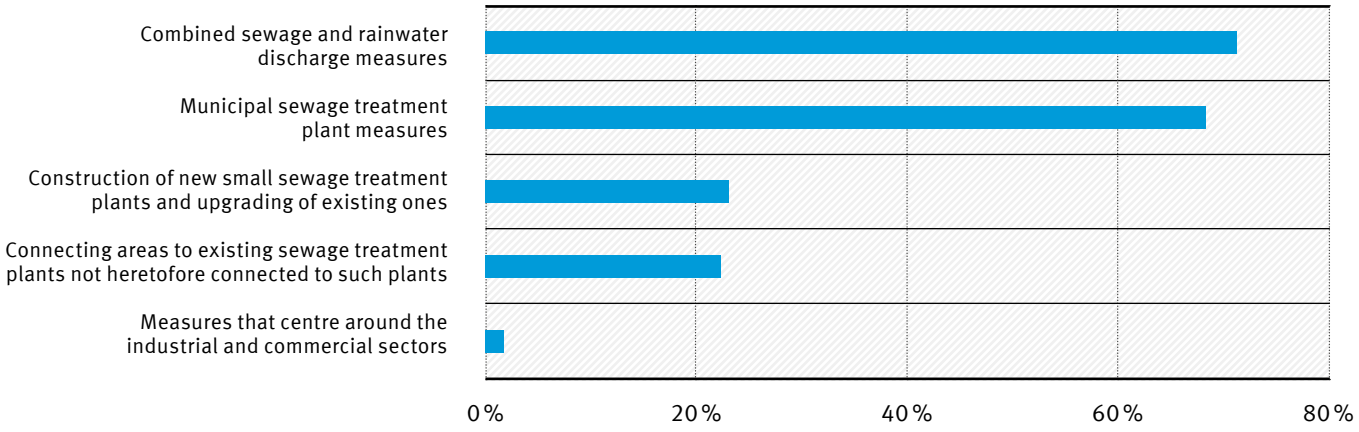
More than 3,000 surface water and groundwater measures are planned for the municipalities, households and the industrial sector.

One of the focuses of these measures is avoidance of or protection against pollution from populated areas, such as combined sewage and rainwater management, or measures realized in municipal sewage treatment plants (Figure 28).

Another cluster of planned measures involves the construction of small sewage treatment plants or the overhaul of existing plants, and connecting areas (mainly in eastern Germany) to existing sewage treatment plants not heretofore connected to such plants. Newly built small sewage treatment plants are integrated into non-connected regions. Small sewage treatment plants are mainly planned for less densely populated areas where the cost of connecting them to large sewage treatment plants would be prohibitive because, for example, the areas in question are very far away from the relevant plants. Measures aimed at reducing industrial and commercial pressures are less prevalent.

Figure 28

Proportion of planned measures aimed at reducing municipal, household and industrial pressures, for the current management cycle (n = 3,020).

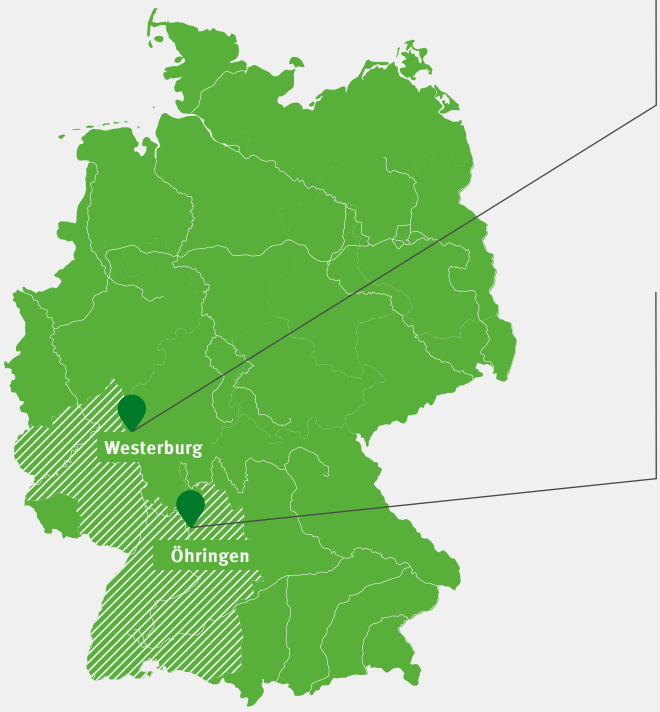


Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Measure implementation

Inasmuch as responsibility for sewage treatment falls to municipalities in Germany, local and regional waste disposal companies are responsible for financing sewage treatment plant construction and operation. Public sewage treatment costs are passed on to connected residential, industrial and commercial users, via fees and charges. The costs of operating small private sewage treatment plants, and the related measures, can be defrayed by the relevant municipalities, or in some cases by property owners. Such actors may also be eligible for government subsidies in this regard. Industrial sewage treatment plants are financed and measures are carried out by the company involved.

Examples of measures
Municipalities, households, and the industrial sector



Newly built Westerburg sewage treatment plant

Öhringen sewage treatment plant in Baden-Württemberg

1) Newly built Westerburg sewage treatment plant in the state of Rhineland-Palatinate

A new sewage treatment plant was built with the following objectives in mind: reduce pollutant loads in the Elbbach river; a more cost-efficient sewage treatment plant; reduce energy consumption; achieve low cost sewage sludge treatment that nonetheless complies with increasingly stringent quality standards.

Owing in particular to decommissioning, as well as the consolidation of seven pond treatment plants and smaller, older municipal treatment plants into a central sewage treatment plant, water quality improved considerably, particularly as regards nutrients. It is anticipated that construction of the plant will result in restoration of the Elbach's good ecological status. Additional energy benefits are being achieved through an innovative compact anaerobic digestion system that reclaims the gas generated at sewage treatment plants where sewage sludge is treated.

Construction began in 2008 and the plant went into operation in 2012. The remaining currently non-connected pond treatment plants are slated for connection in 2016. The cost of constructing the sewage treatment plant and the related sewage lines amounts to €25.6 million.

2) Build-out of the Öhringen sewage treatment plant in Baden-Württemberg

In 2012, the city of Öhringen (population 50,000), which is located in the state of Baden-Württemberg, built out its sewage treatment plant with the goal of minimizing nutrient pressures on water bodies. To this end, an additional trickling filter was installed in order to improve water quality, and an additional secondary settler was built in order to ramp up storage capacity – and thus sewage residence time at the plant. In the interest of optimizing the sewage treatment plant still further, a flocculation filtering system was installed in the third purification phase, mainly in order to further reduce phosphorous concentrations. The cost of building out the plant and optimizing its operations amounted to €5.5 million, which were defrayed by the state of Baden-Württemberg and the plant operator.

Shipping

Measures

The numerous measures that have been and are being carried out for federal waterways do not reduce shipping capacity. These measures are as follows: hydromorphology improvement; continuity restoration; conceptual measures.

Hydromorphological measures include the following, among others: reconnecting oxbows; dike relocation; dismantling large scale bank revetments; ecologically oriented restructuring of stream and regulating structures. A federal program known as Blaues Band, a system of ecologically re-shaped waterways, which involves the implementation of hydromorphological measures, is a joint initiative of the federal environmental and transportation ministries. During the 18th legislative period (as per the coalition agreement), the ruling parties agreed to implement a subsidy program for river and floodplain renaturation – the goal being for a biotope network of national scope to be established in federal waterways.

At the regional level, a joint concept is being elaborated for the Elbe that allows for harmonization of the many usage needs that come into play. In the LIFE-IP project known as LiLa – Living Lahn, environmental protection, nature conservation, flood protection and tourism are handled on an equal footing; whereby the future of the Lahn federal waterway is being shaped in collaboration with land and water body users, associations and local citizens.

River continuity is also a major focus in the waterways domain; measures in this regard mainly entail the installation of facilities (fishways) that enable fish to bypass engineering structures. In this regard, the Bundesministerium für Verkehr und digitale Infrastruktur (Federal Ministry of Transport and Digital Infrastructure) is currently implementing, in consultation with the relevant federal states, a concept aimed at establishing continuity in waterway impoundments.

The “Blaue Band” program interconnects habitats

A key conceptual measure aimed at limiting traffic-related waterway development involves using the available transportation potential and thus the related infrastructure. These measures include the following: nautical optimization via modern traffic management; the use of satellite and terrestrial radio navigation systems; fleet modernization; and a logistical network of means of transport through the establishment of intermodal interfaces at the relevant harbours. This would also be environmentally beneficial, given the currently high levels of air pollution resulting from the use of outmoded ship engine technology.

Other direct effects of shipping traffic on water body status resulting from pressures such as load residues or sewage are governed by international treaties such as Convention on the Collection, Discharge and Reception of Waste arising from Navigation on the Rhine and Inland Navigation (CDNI).

Measure implementation

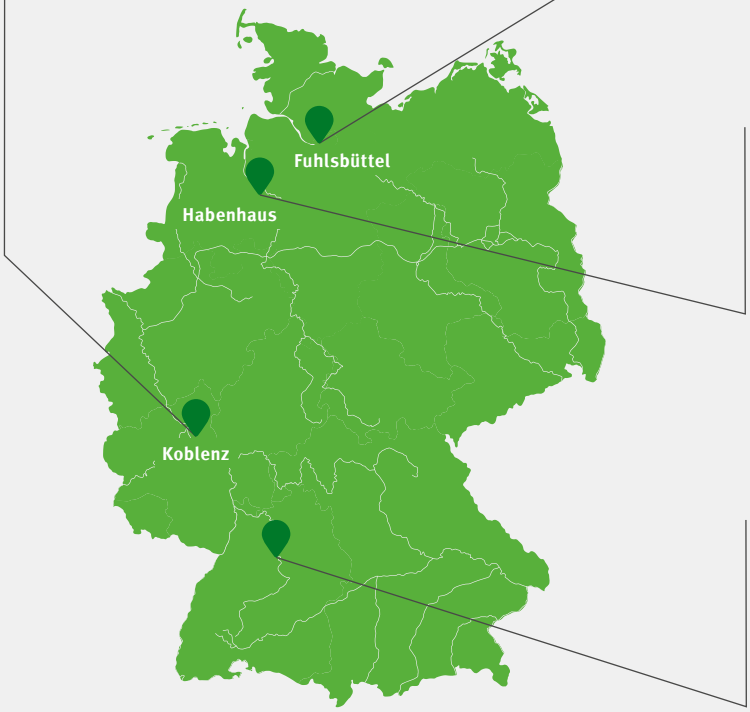
Large scale measures aimed at ameliorating water body status and floodplains, as well as for water body maintenance purposes, have been and are being successfully carried out via collaboration between the federal government, state governments and associations. However, support for measures whose purpose is to achieve Water Framework Directive objectives for federal waterways is somewhat hampered by the fact that the responsibility for these measures is divided between the states and the federal government. The Federal Waterways and Shipping Administration (Wasserstraßen- und Schifffahrtsverwaltung des Bundes (WSV)) is in charge of water flow and ensuring that German waterways are kept open; since 2010 its sphere of responsibility has included establishment of river continuity and water resource management.

The federal states are responsible for water quality, flood protection, and water-management and ecologically oriented development measures for Germany's waterways. The Blaues Band program aims to greatly simplify this situation. Through this program, renaturation of federal waterways and their floodplains will be funded – which will in turn break new ground in the nature conservation and water body protection domains. The program addresses the necessary organizational and legal changes and streamlining of the rules governing spheres of responsibility.

Examples of measures
shipping

Mosellum Koblenz –
experiencing fish passages

Meander fish bypass at Fuhlsbüttel lock



Renaturation of Weser river banks between Fuldahafen and Atlas-See; Weser floodplain revitalization in Habenhausen

Neckar biotope Zugwiesen area

1) Mosellum Koblenz – experiencing fish passage

As per an agreement between the state of Rhineland-Palatinate and waterway and shipping authorities, in 2011 the federal state inaugurated a visitor and information centre known as the Tor zur Mosel ("Gateway to the Mosel"). Thanks to this project, a fishway for upstream passage was constructed at the Koblenz barrage weir, on the right bank of the Mosel, at a cost of €5.6 million. The three accesses that were built now make it easier for migratory fish to find the passage. In order to enable the fish to negotiate the six meter high weir, it was necessary to build 39 staircase-shaped basins.

Scientists keep track of which species actually use the fishway for upstream passage and how well they are able to negotiate it. This tracking is accomplished by means of an automatic fish counter and a monitoring station that are installed at the fishway. The underwater world at the fishway for upstream passage is rendered visible by the specially created Mosellum visitors centre. Built at a cost of around €3 million, it enables visitors to watch migratory fish in action. The centre also features informative exhibits on water body ecology, shipping and electricity generation.

2) Neckar biotope Zugwiesen area

Between 2011 and 2013, the Neckar shoreline was renaturated at the Poppenweiler barrage weir (near Ludwigsburg) for ecological upgrading and to open up

the area for recreational use. The existing Neckar dam was removed over a stretch of 800 meters, and the 17 hectares of the Zugwiesen area were completely restructured. Creating 40,000 square meters of new water body surface area rounded out the project. The existing embankments were removed and were replaced by near-natural landscaped copses.

An additional goal of the project was to show that the relevant transportation and ecological dimensions can be jointly addressed and coordinated – in this case via a successful partnership between the federal government and municipalities. The project was carried out by Stuttgart's Office of Waterways and Shipping (Wasser- und Schifffahrtsamt (WSA)) and by the city of Ludwigsburg, which also financed the project along with Verband Region Stuttgart, the state of Baden-Württemberg and the federal government. Additional funding was provided by the EU subsidy program known as Live+, as part of the My Favourite River project. Environmental foundations and private companies also participated in various components of the project.

3) Renaturation of the Weser riverbanks between Fuldahafen and Atlas-See; Weser floodplain revitalization in Habenhausen

This measure aimed for the following: reinstatement of links between floodplains and the Weser federal waterway; hydromorphological improvement; making the area conducive to tourism and municipal recreation. To this end, 650 meters of Weser riverbank were renatured in the Bremen Hemelingen area and a link was established between the Weser and its floodplain. The Lake Hemelinger peninsula was planed down and watercourses were created that run through it.

A large natural beach and large areas of water with flat sandbanks were created between Fuldahafen and the Hemelingen marina. The Weser floodplain revitalization measures in Habenhausen increased the diversity of the river's hydromorphology. To this end, a 500 meter long and structurally varied river landscape was created that is nearly 74,000 square meters in size. The flood channel in the northern portion of the area was made up to 1.1 meters shallower so as to foster the development of near-natural shallow water zones, sand habitats, reed beds and ruderal herbaceous plant areas. All of the foregoing serve as key habitats and spawning grounds, and will be largely off limits for human use.

The measures in Hemelingen were carried out in February and March of 2012; the restructuring in Habenhausen was implemented in 2014. Half of the costs were defrayed via funding from the European Regional Development Fund (ERDF), and the remainder from sewage fees.

4) Meander fish bypass at Fuhlsbüttler lock

In Hamburg, the ecological continuity of Alster water body systems in particular is slated for restoration, including the river's tributaries. The Alster and many of its tributaries extend to Schleswig-Holstein, thus making them relevant for multiple states.

Like other Hamburg watercourses, Alster continuity is disrupted by a number of locks and weirs. During the reconfiguration of the Fuhlsbüttler lock (2010-2012), a fish bypass was built so as to enable fish to migrate past the lock. The success of this measure has been confirmed by means of fish population observations. In the wake of this measure, work was begun on five other Alster water body system locks; the vertical slot pass at Mühlenschleuse lock has already been completed.

Hydropower

Measures

The 2015 programmes of measures call for numerous measures aimed at reducing the impact of hydropower on the relevant water bodies. The lion's share (66 percent) of these measures aims to improve water body continuity (see Section 5.1). The programmes also call for measures aimed at improving hydromorphology and water flow.

Other hydropower plant hydromorphology measures include measures aimed at improving bed-load balance through sediment management. Water flow measures are envisaged that are intended to achieve ecologically viable minimum flows and flows that are characteristic for the water body in question.

There are many ways to establish upstream and downstream continuity

In terms of continuity restoration measures, it should be borne in mind that certain fish species cover long distances, and in so doing need to bypass not only one but many upstream and downstream hydropower plants. Hydropower plant operators can contribute to the achievement of the mandated management objectives by implementing fishways for upstream passage, for which a very broad spectrum of proven forms and sizes – and thus a recognized state of the art – is now available. It is essential that characteristic water body fish species fish be readily available to find and negotiate all such fish ladders.

Technical solutions are also available for fish that migrate downstream. In smaller rivers, for example, fish screens outfitted with closely spaced slats prevent fish from swimming into turbines.

On large rivers, migrating eels on their way to the Sargossa Sea can be detected at an early stage and can be provided with alternative routes in the environs of hydropower plants so as to enable the fish to safely bypass turbines. Such measures protect eels, and may also protect other fish species in the future.

Another cluster of measures aims to improve channel flow in hydropower plant diversion stretches. Channel flow rates should (a) foster favourable living conditions for characteristic water body biota; and (b) ensure that the reaches in question do not become an impasse for migratory fish.

In the zones affected by hydropower plants, measures entailing the following could also be implemented that improve reproductive conditions for fish and other biota: habitat improvement via removal of riverbank and bed structures at reservoir heads; the use of deadwood, groynes and flow-diverting large rocks for purposes of tailwater structuring and controlled bed-load input. Alternative habitats also provide fish with large shallow-water and bypass zones.

Measure implementation

The larger a given hydropower plant and the greater its output, the more fully and effectively its impact on watercourse ecology can be mitigated. But because more than 85 percent of Germany's hydropower plants are in fact small installations, oftentimes the necessary measures can only be implemented to a limited degree, or in certain cases only if the installation's water rights are withdrawn and the installation is dismantled. Various instruments and subsidies are available that make it easier to reconcile water body protection and hydropower plant use. Particularly when it comes to the modernization of larger power plants, good opportunities are available that allow usage and ecology to be reconciled with each other.

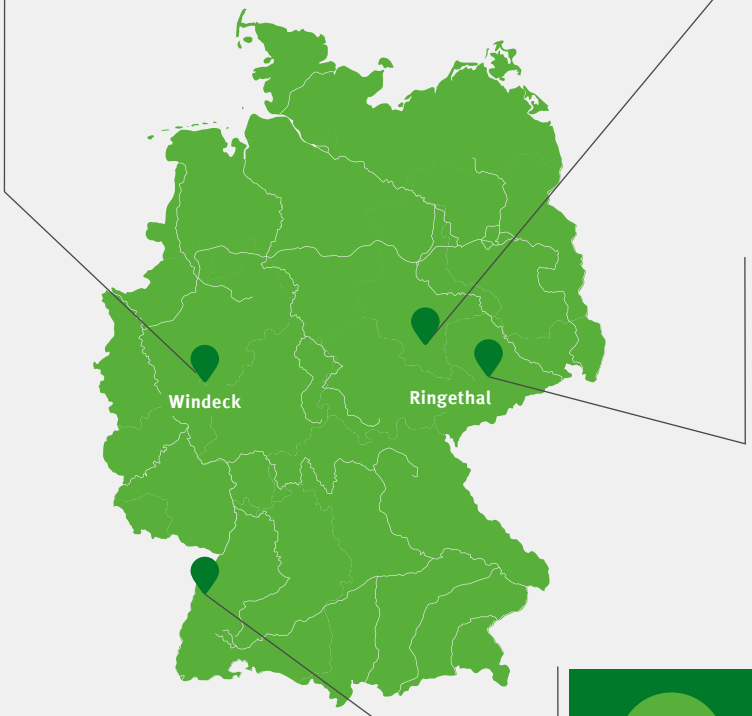
The technology that allows electricity to be generated via hydropower plants has been in use for more than a century. Accordingly, more than 80 percent of Germany's technically and ecologically usable hydropower potential has already been tapped. Any potential in terms of output

increases should only be tapped by replacing old power plants with new ones, or by modernizing existing hydropower plants. When it comes to efforts to improve water body system ecology and avoid ecological deterioration, water body use for energy generation purposes should be based on strategic concepts which, for example, allow for the identification of suitable hydropower plant sites and the elaboration of continuity strategies. All such actions should seek to minimize conflicts between climate protection and water protection, by virtue of ecologically sustainable power plant designs and operating modalities.

Examples of measures
Hydropower

Fish protection at the Unkelmühle hydropower plant

Fish screens at Saale river hydropower plants



Ecological continuity at the Mühle Ringethal hydropower plant on the Zschopau

Relocation of the Alte Kinzig river hydropower plant to the Kinzig river, and optimization of the plant

1) Fish protection at the Unkelmühle hydropower plant

With installed power amounting to 420 kilowatts, RWE's Sieg river Unkelmühle hydropower plant generates around 2 million kilowatt hours of electricity annually. In partnership with the North Rhine-Westphalia Ministry or Climate Protection, the environment, agriculture, nature conservation and consumer protection, various fish bypass solutions have been tested at this power plant and have undergone scientific monitoring. These measures centre around fish protection appurtenances such as fish screens with slats spaced 10 millimetres apart that prevents fish from swimming into hydropower turbines. In addition, surface and river bottom bypasses that enable fish to bypass turbines and hydropower plants without being harmed are also being investigated. To this end, fish are outfitted with transmitters that can be tracked using antennas, with a view to finding out exactly how underwater fish migration unfolds. More than 16,000 migratory fish across nearly 30

species have been studied, including more than 5,000 migrating smolts (young salmon that migrate toward the open sea).

The findings of this research will also help the operators of other hydropower plants to select suitable measures aimed at reducing fish loss and making their plants more water body friendly.

2) Relocation of a hydropower plant from the Alte Kinzig to the Kinzig river, and optimization of the plant

In optimizing their hydropower plant after relocating it from the Alte Kinzig river to the Kinzig river, the plant operator, SÜWAG, had a fishway for upstream passage installed in the Kinzig. This measure restored the continuity of the Kinzig and of the Alte Kinzig in Willstätt. In addition, the Alte Kinzig underwent an ecological transformation, which involved extensive participation by the general public. For example, the relevant citizens' association made a film documenting the progress of the measure.

The purpose of the project, which was commissioned by the Freiburg regional administrative government, was to ecologically transform and structurally optimize the river and to restore its continuity without any change in groundwater levels. To this end, the following measures were carried out: flow reduction; dismantling the existing hydropower plant; filling in the riverbed; construction of a riverbed ramp. The Alte Kinzing constitutes the original watercourse, which now runs parallel to the newly created riverbed. Fish migration in this area is crucially important for the entire Kinzig river system; it thus plays a key role in implementation of both the Water Framework Directive and the international Salmon 2020 program.

3) Fish screens at Saale river hydropower plants

The Saale, a high-flow river and major tributary of the Elbe, is of trans-regional importance for various fish populations. Accordingly, the Elbe river basin district has designated the Saale as a trans-regional priority water body, and has set concrete objectives for it aimed at improving its continuity. Fishways for fish swimming both upstream and downstream are needed at hydropower plants. Fish screens combined with bypasses at many hydropower plants on the Saale have resulted in considerable progress for the protection of fish migrating downstream, and have reduced cumulative losses. For example, the Halle-Planena protective system featuring more than 30 meter long screens diverts fish and flotsam highly effectively. A check revealed that all of the water-course's fish species use the pathway, and that the lengths of these fish range from 5 centimetre long juvenile fish to a 1.3 meter long catfish.

4) Ecological continuity at the Mühle Ringethal hydropower plant on the Zschopau

This measure aimed to restore ecological continuity at the Zschopau's weir site, along with an adequate minimum water flow rate, and to install a fish ladder upstream and two pathways downstream.
For purposes of continuity restoration, two downstream pathways were installed at the turbine inlet in the channel, one near the river bottom and one near its surface. Migratory fish are guided to a downstream opening (via guidance elements) and around the turbine enclosure via a bypass channel, into the tailwater area. From there, the fish can continue on their way. Hence this hydropower plant not only generates renewable energy, but has also restored river continuity.

Of the €200,000 cost of installing this upstream and downstream fishway, €121,000 was financed as per the subsidy guidelines titled Sächsische Förderrichtlinie Gewässer/Hochwasserschutz.

Mining

Measures

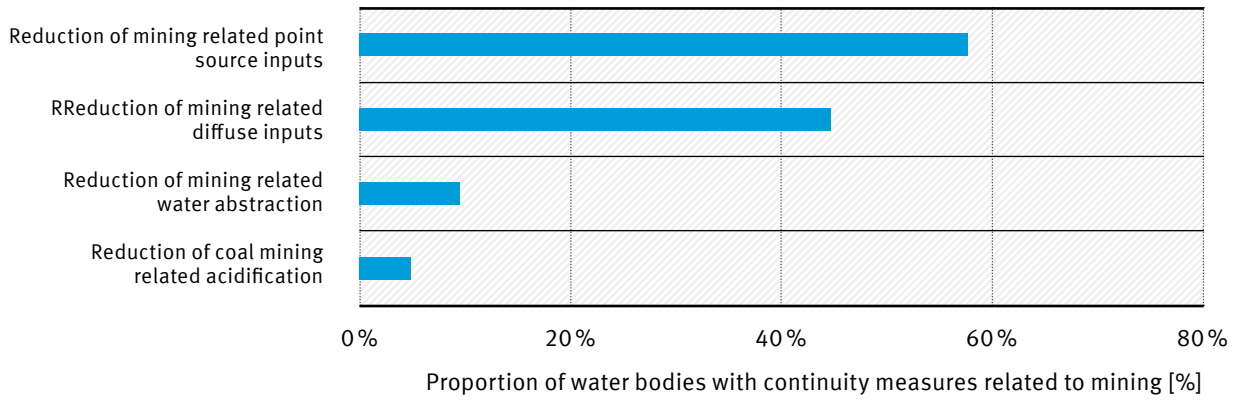
Of 191 water bodies for which measures have been planned, the measures for 35 of them fall within the scope of mining. These measures mainly aim to reduce pressures resulting from mining point sources and diffuse sources, as well as measures aimed at reducing mining-related water abstraction and acidification (Figure 29). The measures aimed at reducing mining-related point source inputs include special treatment of mining pit water, management of mining pit and mine discharges into receiving waters and the realization of feasibility studies. The main type of measure for mining-related diffuse inputs entails special monitoring programs aimed at obtaining conclusive findings concerning the nature and amount of the relevant discharges. In the interest of reducing mining-related water abstraction so as to prevent decreases in groundwater volumes, permits concerning the allowable amounts of water abstraction will be modified, among other measures. The measures aimed at reducing mining-related acidification include interim landscaping of dump sites and liming excessively acidified soil and water bodies.

The most effective measures for reducing mining-related pollutant inputs are measures that are implemented right at the sites affected – for example, reducing sewage, treating sewage on site, or properly dumping mine waste in empty mine pits. Minimizing diffuse water body inputs that in some cases occur decades after a mine has been shut down is a daunting task. In such cases, since diffuse sources cannot be measured reliably, the scope and origin of the load must first be clearly ascertained in order to ensure that effective counter-measures can be defined.

Oftentimes the hydrological regime is severely disrupted by mining to the point where timely improvement of quantitative status and chemical status appears to be virtually impossible; plus the cost of some measures is prohibitive. Moreover, potentially risky measures such as mine lake flooding or mine waste removal may complicate the task of rehabilitation.

Figure 29

Proportion of planned measures aimed at reducing mining pressures for the current management cycle (n = 191).



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

Measure implementation

Mine operators are required by law to defray the costs of measures aimed at minimizing the impact of mining activities on water bodies. Mining companies normally establish provisions to cover the costs of site cleanups that are necessary even decades after the mines in question have been closed. However, these funds oftentimes do not cover the actual costs that are incurred, in which case other financing instruments must be sought.

5.3 Integrated measure planning include ...

Protected areas, nature conservation and biodiversity

Water bodies have a major impact on the surrounding natural environment. Many endangered animal and plant species depend for their survival on habitats that cannot thrive without water. Hence water body protection can make a major contribution to flora and fauna protection. One example of this is large scale renaturation of rivers in conjunction with dike relocation, which promotes the development of natural structures and habitats. They in turn allow for recolonization by characteristic floodplain species.

Implementation of the Water Framework Directive involves 20,000 protected areas

The Water Framework Directive stipulates that protected areas are to be folded into planning processes. Germany has around 20,000 protected areas that fall into various categories and that must be taken into account in Water Framework Directive implementation:

- 13,245 drinking water protection areas, which are used for drinking water abstraction pursuant to Article 7 of the Water Framework Directive
- 638 bird protection areas and 3,516 flora-fauna habitat areas that are subject to aquatic protection objectives.
- 294 areas designated for the protection of economically significant aquatic species (shellfish waters and fisheries)
- 2,178 lakes and coastal waters that are used for swimming and other recreational purposes
- Nutrient-sensitive areas and vulnerable zones, to both of which Germany applies the relevant EU directives (the Municipal Wastewater and Nitrate Directives) across the whole country.

These requirements are adhered to in a number of different ways in the ten river basin districts. A key example of this relates to the part nature conservation plays in water body status assessments. The Groundwater Ordinance (Grundwasserverordnung) stipulates that in order for groundwater to achieve good status, the “terrestrial ecosystems that are directly dependent on the ground water shall not be significantly damaged.” Such terrestrial ecosystems include, for example, nature conservation habitats, flora-fauna habitats, bird sanctuaries and national parks areas

Flora, fauna and water are interrelated

The programmes of measures aim to achieve a broad range of objectives, including the following: restoration of river continuity; improvement of water body and floodplain habitats; limiting water body pressures from

diffuse sources. Most of these measures tie in with more comprehensive and long term strategies and programs such as the federal government's national biodiversity strategy, the Federal Ministry for the Environment's 2020 nature conservation program, and the state of Bavaria's floodplain program, which is part of its biodiversity program. The aim of the latter program, for example, is to achieve long term protection of intact floodplains and to develop them. Both the biodiversity program and the floodplain program are slated to continue in operation until 2030. Not only do these programs benefit introduced species; they also promote the achievement of other objectives such as flood and climate protection.

Water protection also entails floodplain protection

Near-natural rivers and their floodplains, with their impressive diversity of habitats, are the lifeblood of our country. Here one finds in close proximity to each other river arms and oxbows, pools, ancient floodplain forests, wetlands, dry sandbanks and gravel islands. Wetness and dryness, the extremes entailed by the rhythm of river high and low tide, provide a habitat for countless plants and animals that have adapted to these conditions.

When river valley pastures and moors are re-hydrated, water landscapes help to reduce green-house gas emissions and mitigate the effects of climate change. Another key function of intact water bodies and floodplains is water purification, from which we all benefit on a daily basis.

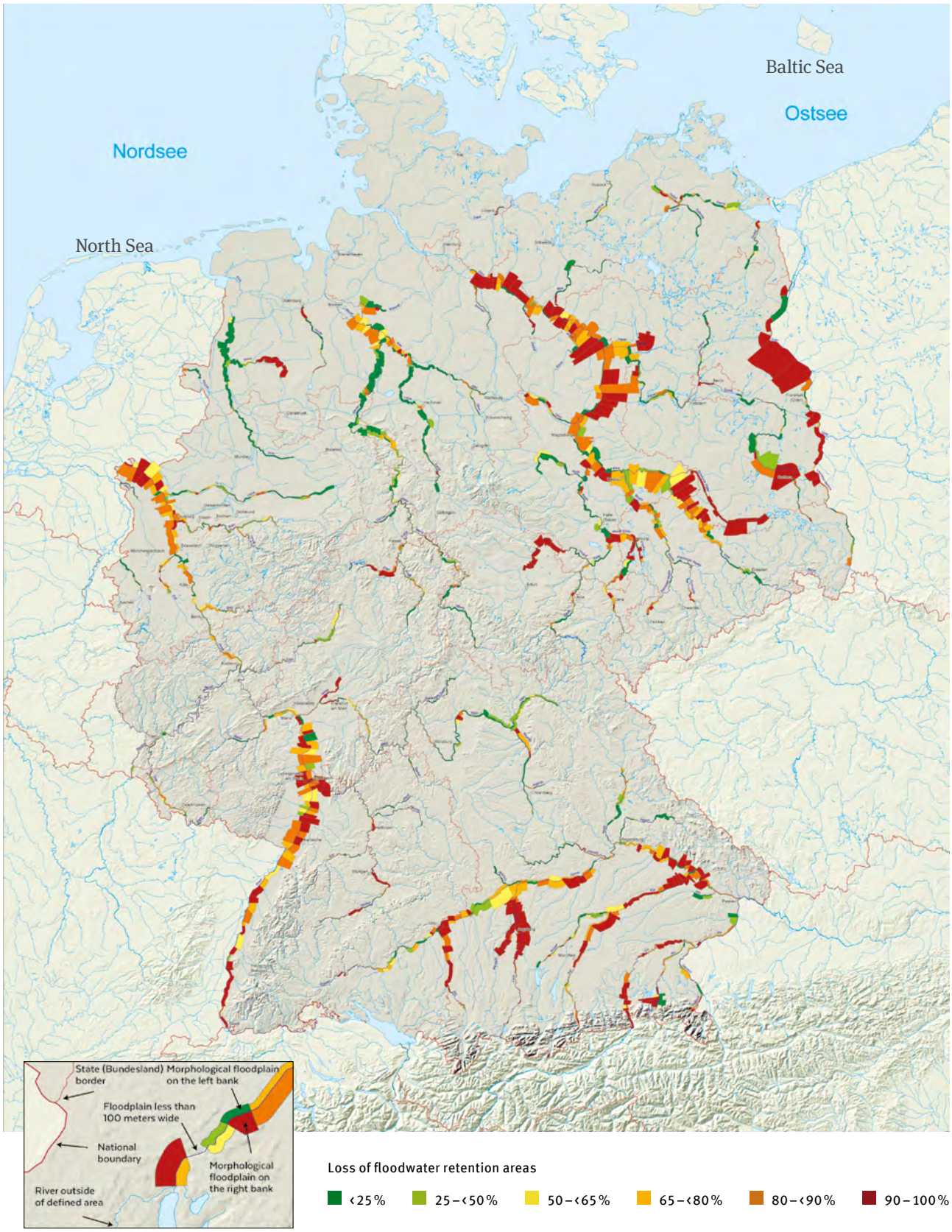
Over the years, the Federal Agency for Nature Conservation has commissioned studies aimed at determining the current capacity of river flood plains to carry out these functions. These studies show that two thirds of what once amounted to around 15,000 square kilometres of flood plains have been cut off from their respective rivers and thus are no longer available for floodwater retention purposes. Of the remaining floodplains that are still viable floodwater retention areas, only 10 percent are near-natural, whereas more than half have been modified or heavily modified (Map 16). In the majority of rivers, extensive floodplain use, levee construction, waterway development, and water impoundment regulation have resulted in substantial losses of natural floodwater retention areas and to major changes in the ecological status of floodplains.

Many different measures have already been undertaken in all of Germany's regions with a view to renaturating flood retention landscapes and reactivating natural floodplains for nature conservation and flood protection. Efforts in this regard on the part of water management and nature conservation authorities have been stepped up since the 1980s. Since the 1990s, efforts have been underway to restore natural water retention zones. Professional planning promotes the achievement of both flood and floodplain protection.

Around 170 large scale river floodplain renaturation projects were carried out in Germany from 1979 to 2014. Many of these projects concurrently promoted both nature conservation and water resource management objectives. In order for the Water Framework Directive objective of achieving good surface water status by 2027 to be reached, in addition to the restoration of near-natural hydromorphology, sufficient room for near-natural floodplain development is needed. This would in turn allow these areas to function as migration corridors and biotope networks for multiple German states; it would also help to reestablish habitat networks. In this context, renaturated federal waterways play an important role in their capacity as network of elements known as "Blaues Band".

Map 16

Floodplain loss in German rivers whose watersheds are upwards of 1,000 square kilometres in size.



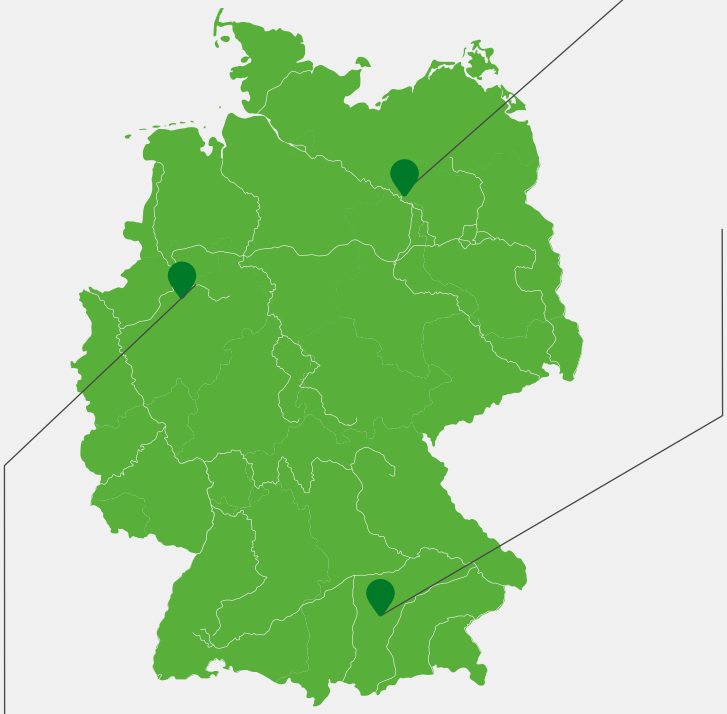
Source: EuroGlobalMap © EuroGeoGraphics, VG1000, GN250, DLM1000 © GeoBasis-DE/BKG (2014), SRTM 90m Digital Elevation Data © CGIAR Consortium for Spatial Information, Bundesamt für Naturschutz (BfN), (2009) (Brunotte et al 2009).

Financing for these measures comes from various sources, whereby many German states also used water abstraction fee funds to finance the measures. These funds are usually earmarked for water protection purposes, and are available for purposes such as protecting and improving groundwater dependent terrestrial river floodplains and terrestrial ecosystems. Another key source of financing is statutory compensatory payments. Such payments are effected, for example, in connection with interventions in natural areas, and are used to fund measures that are carried out in collaboration with nature conservation authorities and that relate to both nature conservation and water body protection.

The federal government funds exemplary projects of national importance that promote long term conservation of nationally significant natural and cultural landscapes. For example, from 1979 to 2014 under the federal subsidy program known as “Chance Natur”, numerous river and floodplain projects were funded throughout Germany by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and by the Federal Agency for Nature Conservation (BfN). These projects involved the removal of embankments and dikes, re-linking oxbows and flood channels to their respective rivers, floodplain foresting, and building out and re-hydrating floodplain pastureland.

Examples of measures

Protected areas, nature conservation and biodiversity



Dike relocation in the Lenzener Elbe valley floodplain

Ampermoos rewetting

LIFE-Project Ems

1) LIFE-Project Ems

As part of the LIFE-Project, which is funded by the European Union and the state of North Rhine-Westphalia, a 4.5 kilometre stretch of the Ems and its tributary, the Hessel (near Einen), was transformed into a near-natural watercourse. The goal of this project was to achieve inherently dynamic development of the watercourse and its adjoining floodplains, and the consequent increase in water body and floodplain habitat diversity and biodiversity.

To this end, more than 30 measures were carried out, including the following:

- River lengthening
- Freeing up the riverbanks and extending the river bed
- Linkage with oxbows and continuity creation
- Flood plain extensification and floodplain forest development

The public was also extensively involved in the project. LIFE is an EU financing instrument whose purpose

is to implement environmental protection and nature conservation measures. The costs of these measures are shared 50/50 by the EU and the North Rhine-Westphalia Ministry of the Environment. Water body and floodplain development has been highly successful and promising, since the project's inception.

2) Dike relocation in the Lenzener Elbtalaue (Lenzener Elbe valley floodplain)

The largest-scale dike relocation project to have been completed in Germany to date is located on the Elbe, in northwest Brandenburg, in the Prignitz district. This nature conservation project, which was carried out from 2002 to 2011, was funded by the BMUB/BfN (chance natur), the state of Brandenburg and by Trägerverbund Burg Lenzen e. V.

Relocation of the dike over a 6,100 meter stretch resulted in the creation of 420 hectares of new inundation area. This reclaimed floodplain exhibits a multi-faceted spectrum of newly planted floodplain forest, periodically wet river valley grassland and flood channels. Some parts of the area are used as horse grazing land for purposes of conserving the open space. Migratory birds such as cranes use the area as a roosting place. In the winter, many Arctic avian species such as Bewick's swans and whooper swans are spotted here. Following completion of the dike re-siting project, in 2009, the flood waters that occurred in the area in 2011 and 2013 were up to 49 centimetres lower than for the equivalent flooding prior to relocating the dikes. These lower floodwaters were documented up to around 30 kilometres upstream of the measures.

3) Ampermoos rewetting

The Ampermoos, which is a riverine fen that was formed by lake silting during the last ice age, is Germany's largest fen, by virtue of its 600 hectare size. It was thus designated as a nature conservation area in 1982, with the goal of preserving this internationally significant wetland and its biodiversity and characteristic moor flora and fauna. Increasing use and a decrease in groundwater levels were resulting in the moor becoming ever drier. For this reason, in the winter of 2012/2013, a sill was installed in the Amper river, with a view to increasing surface-water depth and allowing for re-wetting of the moor. Damming the Amper by up to 40 centimetres also resulted in an increase of watercourse depths and groundwater levels in the Ampermoos's streams and drainage ditches. A monitoring program allows for documentation of ecosystem response in the years following installation of the stream threshold.

The Ampermoos rewetting project was financed by the Bavaria's Ministry of the Environment, whereby nearly half of the costs were co-financed by the European Union. The total cost of the project amounted to nearly €1.2 million.

Climate change

Unlike the first management cycle, because the initial effects of climate change are now being felt, climate change is now being discussed in connection with many river basins. It is presumed that climate change will increase the pressures on many river basins, and that this in turn will increase the number and severity of management issues. In some river basins, climate change is for the first time being seen as a key water resource management issue. Climate change can lead to the following discernible changes, both seasonally and regionally:

- Further increases in mean air temperature.
- An increase in winter precipitation
- Decreased rainfall during the summer months
- An increase in the frequency and intensity of heavy rainfalls and heavy snowfalls
- Longer and more frequent dry spells

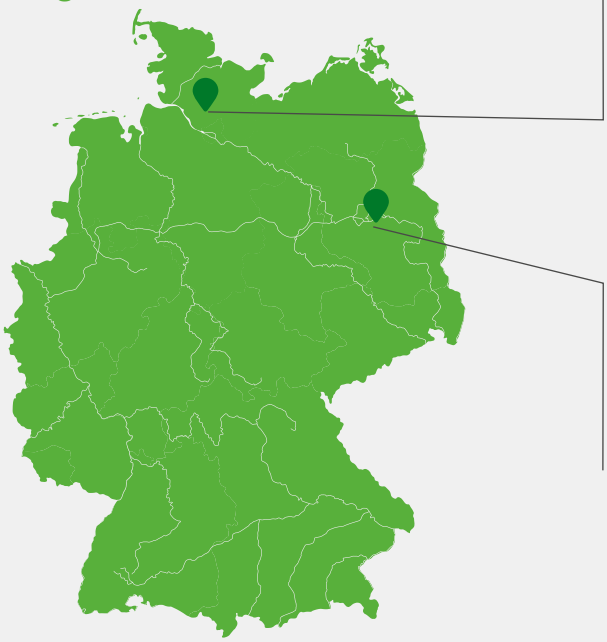
Climate checks and adaptive measures for water temperatures and drought

In the interest of determining the impact of climate change on water body protection efficiency, a “climate check” was carried out for all measures that are included in a list of measures. Climate change can have negative effects owing to factors such as combined sewage and rainwater discharge installations. The more frequently such installations are used in response to heavy rainfall, the more nutrients and pollutants are discharged into water bodies.

For some river basins, recommendations for specific adaptive measures exceeding the scope of the climate checks have been incorporated into management plans. Depending on regional river district conditions, these measures aim, in particular, to reduce water temperature through measures such as creating buffer strips planted with copse or by elaborating thermal load plans. Drought management and natural water retention are also mentioned as possible adaptive measures. Irrigation recommendations for river basins with a high level of agricultural activities include, among other things, computer aided irrigation management and building out local and regional networked systems for interim handling of peak-demand periods or periods where water resources are limited. In addition, the climate surcharge is mentioned in connection with coastal protection dikes. Studies on the impact of climate change on certain river basins are mentioned as conceptual measures for the next management cycle. In addition, a series of ongoing research projects is studying the possible regional effects of these measures on water resources and groundwater recharge.

In summary, it can be said that the effects of climate change are comprehensively covered in the management plans for the second management cycle. The ramifications for water management planning and incorporation into actual plans vary from one river basin to another. As an instrument that aims to promote the effectiveness of water body protection measures, the climate check is taken into account in an overarching fashion.

Examples of measures
Climate Change



KLEE – Klimaanpassung Einzugsgebiet Este (Adapting to climate change for the Este watershed

INKA BB – climate change and innovation

1) KLEE – Klimaanpassung Einzugsgebiet Este (Adapting to climate change for the Este watershed)

The KLEE project (German acronym for adapting to climate change for the Este watershed) aims to develop a detailed and integrated concept for adapting to climate change in the Este watershed. This project was prompted by the fact that climate change is poised to exacerbate the already problematic sediment influx/transport and flood protection situation on the Elbe's 45 kilometre long tributary.

The concept that was developed to address this situation involves (a) the identification of integrated adaptive measures for the watershed as a whole (rather than separate measures); (b) compiling these measures into an overarching concept; and (c) establishing a durable network comprising the relevant stakeholders. To this end, a new federation of municipalities was founded as part of the KLEE project, which was divided into the following seven work packages:

- Establishment and operation of a measurement and monitoring program
- Carrying out a climate change impact assessment
- Planning and quantifying adaptive measures
- Extensive networking with all stakeholders
- Elaboration of an integrative overall concept
- Implementing the relevant measures as pilot measures
- Coordination and outreach

The project, which began in 2013 and will end in 2016, is being funded by the Federal Ministry for the Environment (BMUB).

2) INKA BB – climate change and innovation

The INKA BB network consists of stakeholders from the scientific, business, political and government communities. These stakeholders comprise private companies from the agricultural, forestry, tourism and water management sectors, as well as interest groups and officials from the states of Brandenburg and Berlin, and beyond. INKA BB has nearly 100 members.

The Brandenburg/Berlin region has a relatively large number of water bodies, but relatively low annual precipitation. INKA BB conducts research into various aspects of sustainable water management and possible adaptive water management solutions in light of climate change, and develops recommendations concerning the following:

- Sustainable water management methods and instruments for smaller watersheds
- Water management instruments and strategies for large wetlands
- Instruments for sustainable regional water management planning and development
- Sustainable climate change management strategies for the state of Brandenburg's glacial lakes
- Technologies for urban water management in the face of climate change
- Planning instruments and pilot solutions for sustainable water management in populated areas

INKA BB is one of seven project federations that are funded by the Federal Ministry of Education and Research (BMBF) under the KLIMZUG (German acronym for "shaping regional climate change management for the future") subsidy program.

Marine environmental protection

The world's marine waters are key ecosystems that perform vital functions for our planet such as climate regulation. The North Sea and Baltic Sea contain a great many flora and fauna habitats, some of which are in need of protection, and provide us with food, energy and raw materials. Apart from the multiplicity and rising levels of human use, nutrient and pollutant inputs from rivers and plastic waste pollute the world's marine waters and are a threat to biodiversity. In particular, nitrogen inputs into marine waters via rivers and the atmosphere resulting from factors such as marine-shipping emissions lead to eutrophication, which remains one of the most severe ecological problems facing Germany's marine waters.

These issues are addressed by current legislation in many different ways. Most important in this regard are, in addition to the EU Water Framework Directive, the EU Marine Strategy Framework Directive. It requires the EU member states to take all steps necessary to achieve or maintain "good marine environmental status" by 2020 and encompasses all marine species and habitats, and all pressures on marine waters. Hence its implementation also involves taking into account the relevant Water Framework Directive pressures and quality elements – which in turn means that implementation of these two directives is thematically intertwined. For example, under established national standards concerning "good environmental status", coastal waters are deemed to have achieved "good ecological status" in terms of eutrophication insofar as "good ecological status" as defined by the Water Framework Directive has been reached. Measure selection is likewise thematically intertwined, by virtue of the fact that the Water Framework Directive list of measures also contains measures aimed at implementing the EU Marine Strategy Framework Directive.

Over the past decades, nutrient inputs from rivers have been substantially reduced, mainly thanks to sewage treatment plant development. In order to achieve "good coastal-water status" for eutrophication pursuant to the Water Framework Directive and reach EU Marine Strategy Framework Directive objectives, much remains to be done, however – mainly in terms of the nutrient nitrogen. Concerning the interface zone between fresh

water and salt water, the nitrogen concentrations have been determined that will allow for the achievement of good status for marine waters. For North Sea tributaries, 2.8 milligrams total nitrogen per litre has been set as a target level, and 2.6 milligrams per litre has been set as a mean target level for Baltic Sea tributaries. These targets, which have been adopted as coastal protection reduction objectives, now form the basis for determining actual nitrogen loads in inland river basin districts. This is a complex task, in that it is necessary to factor in both surface water and groundwater inputs that reach rivers and streams. What's more, a given input cannot itself be equated with marine pressure. Nitrogen compounds break down into atmospheric nitrogen primarily in lakes (denitrification) – by virtue of which only a portion of nitrogen inputs reach the Baltic Sea and North Sea.

If these reduction objectives values are exceeded, nitrogen input reduction measures will be needed. For this, a whole series of measures from the combined national list of measures that is maintained by Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) is available; its implementation takes into account the needs of marine waters and is geared to the EU Marine Strategy Framework Directive programme of measures. Key here are all point and diffuse source nutrient reduction measures – although the focus is on diffuse nitrogen inputs of agricultural origin.

The various river basin districts will be carrying out a series of measures that are expected to have a positive impact on the ecological status of marine waters. These measures constitute the basic measures aimed at implementing the Nitrate and Urban Wastewater Directives, which have already yielded nitrogen input reductions. But apart from these basic measures, additional river basin district measures are in the works that are based on various preparatory measures such as improved data management for the coastal and marine domains, as well as sediment management concepts.

Flood risk management

The management plans called for by the Water Framework Directive and flood risk management plans, which are mandated by the EU flood risk management directive, constitute elements of integrated management for an identical defined area – namely the river basin. When it comes to flood risk management, Water Framework Directive management objectives should be taken into account, potential synergies should be used, and application of the two directives should be coordinated. These synergies mainly occur in connection with planning, prioritization and implementation of programmes of measures and their impact on objectives related to data management and providing the public with information.

In particular in connection with measure planning, synergies, as well as possible conflicts, have been identified and categorized as regards the objectives of both directives. To this end, the following categories have been defined:

Category 1:

Measures that promote implementation of the objectives of the other directive. For instance, hydromorphological measures (e.g. floodplain development or oxbow reintegration) that increase water retention and promote the achievement of EU flood risk management directive objectives (i.e. reducing the risk of flooding). Flood risk management measures such as keeping floodplains free of built structures through legally mandated inundation areas, or measures that strengthen natural water retention in a given zone, such as dike relocation, in turn contribute to reaching Water Framework Directive objectives.

Category 2:

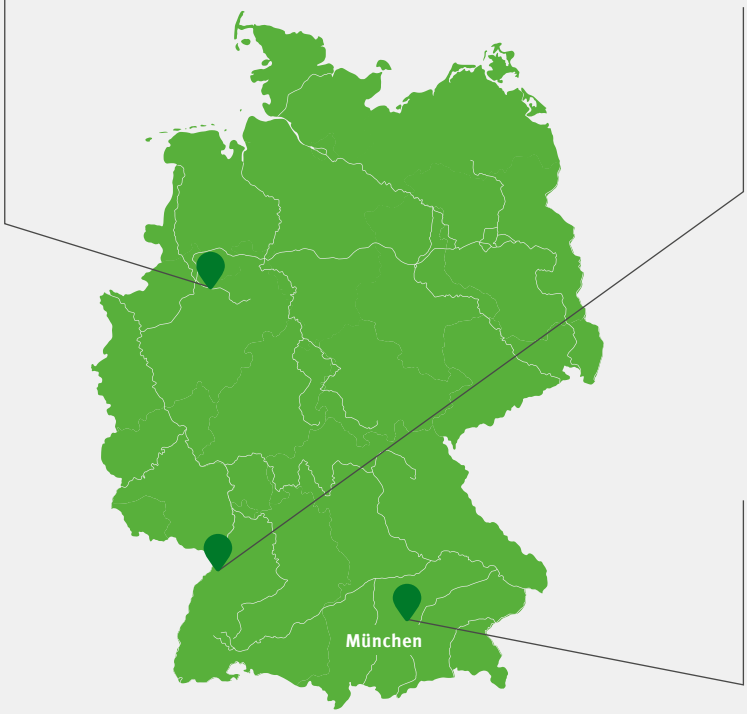
Measures that could potentially result in a conflict between two or more objectives and that need to be assessed on a case by case basis. Such measures include location-specific natural water body development that increases the risk of flooding, and land reclamation measures that help to reduce water body pressures, but that subsequently conflict with coastal protection measures. In terms of flood risk management measures, it is mainly technical-infrastructure flood protection measures such as dikes and floodwater retention basins, and engineering structures in rivers that can potentially hinder natural water body development and thus make it more difficult for a given water body to achieve good ecological status.

Category 3:

Measures that are not relevant to the objectives of the other directive. Such measure usually have neither a positive nor a negative effect on the objectives of the other directive. Examples of this from the programmes of measures include concept studies, monitoring programs, administrative measures and diffuse-input reduction measures. Examples from the sphere of flood risk management include warning/alert services, disaster preparedness planning and preparatory measures aimed at averting danger, and cleanup and regeneration concepts.

Synergies with Water Framework Directive objectives were also evaluated in preparing Germany's national flood protection program (Nationales Hochwasserschutzprogramm (NHWSP)). The NHWSP was elaborated by the conference of environmental ministers in the wake of the catastrophic flooding in the Elbe and Danube regions in 2013, as a series of priority trans-regional flood preparedness measures. The NHWSP, which contains more than 100 trans-regional measures, represents a prominent component of flood risk management planning. As a result of the decision, in the spring of 2016, to continue the program, it now contains 30 trans-regional dike-resiting measures that will promote the achievement of Water Framework Directive objectives.

Werse river development plan: flood protection and ecological development



Hochwasserschutz- und Ökologieprojekt (HÖP; flood protection and ecology project) for the district of Rastatt

Renaturation of the Isar in Munich

1) Werse development planning

In the wake of catastrophic flooding of the Werse river in 2001, a joint inter-municipal initiative was established in which the cities of Ahlen and Beckum and the Warendorf district participate, among others. A near-natural landscape featuring floodplains and integrated flood protection was created along an around 10 kilometre stretch of the Werse, between Beckum and Ahlen; and river straightening and regulation from the 1960s and 1970s were corrected. The reactivation of the Werse floodplain that was accomplished and the extensive near-natural inundation areas that were established also create sufficient room for inundation, even during heavy rains. A 240,000 cubic meter flood retention basin can also hold back water during heavy rains, and the water can be discharged into the upper reaches of the Werse in a controlled fashion.

These measures proved their worth during the 2010 flooding, at which time the water level in Ahlen was far lower than in the past. A comparison of the projected monetary amounts of the flood damage showed that the protective measures reduce potential flood damage. The measures also resulted in a permanent reduction in maintenance costs for the water and soil management association.

The multi-year, €10 million project was funded by the state of North Rhine-Westphalia. Project participants comprised farmers, land owners, tenants, the water and soil management association, suppliers, nature conservation organizations and the general public.

2) Hochwasserschutz- und Ökologieprojekt (HÖP; flood protection and ecology project) for the district of Rastatt

The Murg river was straightened and endowed with dikes decades ago, in the interest of protecting local residents against flooding. This resulted in a very rapid water flow rate – which, however, also increased the risk of flooding further downstream. Moreover, formerly inundated floodplains dried out and their habitats deteriorated.

In the interest of revitalizing these floodplains while still providing adequate flood protection, in 2012 a dike re-siting project was initiated on the Murg. On an up to 500 and up to 100 meter wide strip on the left and right banks respectively, around 50 hectares of land were reclaimed. The additional measures involved creation of a forked watercourse and embankment flattening. The Murg was restored to a near-natural state along its urban stretch as well (Rastatt).

This measure improved flood protection in the city of Rastatt. As a result of the dike re-siting, the water level decreased by 55 centimetres for a one-hundred-year flood and by 30 centimetres at Franzbrücke bridge. In addition, near-natural water and riverbank vegetation developed – as did, most notably, floodplain forests. Since the project was completed, four two-year floods have inundated the urban stretch, resulting in substrate relocation and sorting and the formation of potholes and flat riverbanks. Pebble and even sand beaches have appeared in many locations.

This extensive measure is part of the Rheinauen (Rhine floodplain at Rastatt) LIFE project. The €9.2 million cost of considerably improving flood protection on the Murg were shared by the state of Baden-Württemberg, which contributed 70 percent, and the city of Rastatt and the European Union, which jointly contributed 30 percent. An additional €2 million in funding was provided by the LIFE subsidy program.

3) Renaturation of the Isar in Munich

Development of the Isar in Munich for flood protection and hydropower purposes had a highly detrimental effect on the river's hydromorphology.
[Foto]
Beginning in 2000/2001, under the motto "A new life for the Isar," comprehensive renaturation of the river was carried out by the state of Bavaria and the city of Munich, with the following aims:

- Improved flood protection
- Transformation into a near-natural river landscape
- Restoration of river continuity
- Water quality improvement
- Quality improvement for recreational uses

The measures involved, among other things, modifying riverbed ramps, enabling the river to develop on its own, and establishment of near-natural alluvial dynamics within a development corridor demarcated by "dormant" bank revetments.

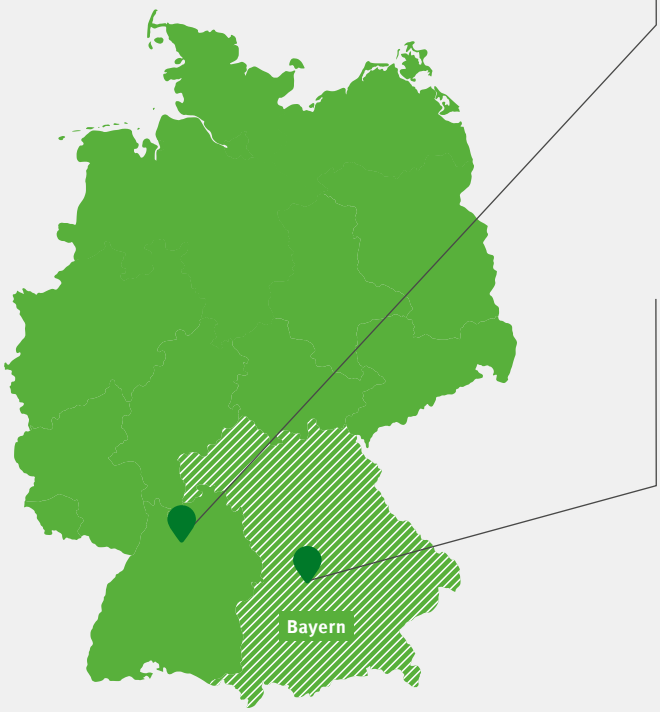
The success of these measures was not long in coming. Despite the Isar having reached a record level of 5.6 meters in 2005, Munich was spared catastrophic flooding. As early as one week following completion of the measures, the Munich stretch of the Isar began a process of substantially reconfiguring its riverbed. The existing stands of trees on the dike slopes remained largely intact. Modifying riverbed characteristics not only improved Isar flood protection, but also made the river look more natural and facilitated access to it for swimming. This in turn has restored the river's accessibility and has transformed it into an area that people can enjoy.

The Isar Plan project (as it was called) cost around €28.1 million, which was jointly defrayed by the Bavaria (55 percent) and the city of Munich (45 percent). Bavaria's Ministry of the Environment provided an additional €8.3 million for water quality improvement.

Research

Given the fact that many water body cause and effect relationships have yet to be adequately researched, measures involving research and improving the state of knowledge in this regard have been planned. These measures include the following: research conceptualization; studies and expert reports; in-depth studies and assessments. Most of these measures revolve around more specific topics of lesser scope such as detailed identification of the sources of pressures in a given river reach, or specialized studies aimed at determining the effectiveness of the measures that have been implemented.

Larger scale research and demonstration projects are mainly be carried out in cases where the following is to be achieved: quantification of nutrient inputs for an entire river basin; application of new assessment procedures; development of effective Water Framework/ Marine Framework Directive implementation measures or flood protection measures. In the interest of gaining greater insight into the effects of climate change on water bodies, and acquiring the ability to make more accurate projections concerning these effects in the future, a great many studies and research projects have been carried out since 1999 (e.g. the collaborative KLIWA project by the states of Baden-Württemberg, Bavaria and Rhineland-Palatinate and the Deutscher Wetterdienst (German Weather Service)), which today enable us to predict the regional effects of climate change.



Feasibility study concerning the potential for reducing sewage treatment plant phosphorous inputs into rivers in the Neckar watershed

Fish ecology monitoring in Bavaria

1) Feasbility study concerning the potential for reducing sewage treatment plant phosphorous inputs into rivers in the Neckar watershed

This project, which was carried out from 2009 to 2010, involved a feasibility study aimed at estimating the potential for improvement resulting from increased phosphorous elimination by sewage treatment plants in the Neckar watershed as a whole.

Possible strategies and measures were recommended aimed at reducing phosphate loads from municipal sewage treatment plants in the Neckar watershed, with a view to complying with the maximum mandated target concentrations amounting to 0.1 milligrams of orthophospate in the regulated Neckar, and 0.2 milligrams in the remaining water bodies.

The study results showed that sewage treatment plants can potentially be instrumental in reducing water body phosphorous concentrations. However, the study also found that other input sources also need to make a significant contribution to reaching the mandated objective.

The entirety of the around €140,000 cost of the study was financed by the Baden-Württemberg Ministry of the Environment, Climate and Energy Management.

2) Fish ecology monitoring in Bavaria

Between mid 2014 and the end of 2016, the impact of eight types of installations and technical systems on fish fauna is being investigated statewide at eight existing and new pilot hydropower plants. This involves studying habitat changes as well as direct harm incurred by fish as they negotiate their way past hydropower plant screens and turbines. The project aims to shed light on technical and ecological options that would allow for hydropower plant use without endangering fish populations and in a manner that has the least possible impact on water body ecology. These findings are intended to be helpful to hydropower plant operators and authorizing bodies.

The project was carried out by Technische Universität München for the Bayerisches Landesamt für Umwelt, and within the framework of the Bayerische Strategie zur Wasserkraft, which is a 10-point roadmap for ecologically sustainable hydropower plant operation.

Objectives for 2021-2027

6.1 Deadline extensions and exemptions

The aim of German water protection policy is to achieve "good status" for all surface waters and groundwater. The deadlines for reaching these management objectives are geared to the six year management cycles – thus making the deadline either 2021 or 2027, after the end of the first cycle.

The Water Framework Directive allow member states to extend the deadlines for achieving its objectives, so as to allow a more realistic timeline and less stringent objectives to be set. Invocation of such deviations from these objectives (whose achievement was originally set for 2015) is subject to stringent requirements, and may only be effected after all implementable measures have been planned. They must also be clearly documented in the management plans.
The Water Framework Directive allows for the following options:

- Deadline extensions (achievement of management objectives by 2027)
- Setting less stringent management objectives
- Temporary deterioration resulting from natural causes or force majeure (e.g. flooding or draught)
- Failing to achieve "good status" or failure to forestall status deterioration owing to changes in physical properties or new sustainable development activities.

Achievement of management objectives in another water body are not to be jeopardized, and the applicable EU regulations will remain in force.

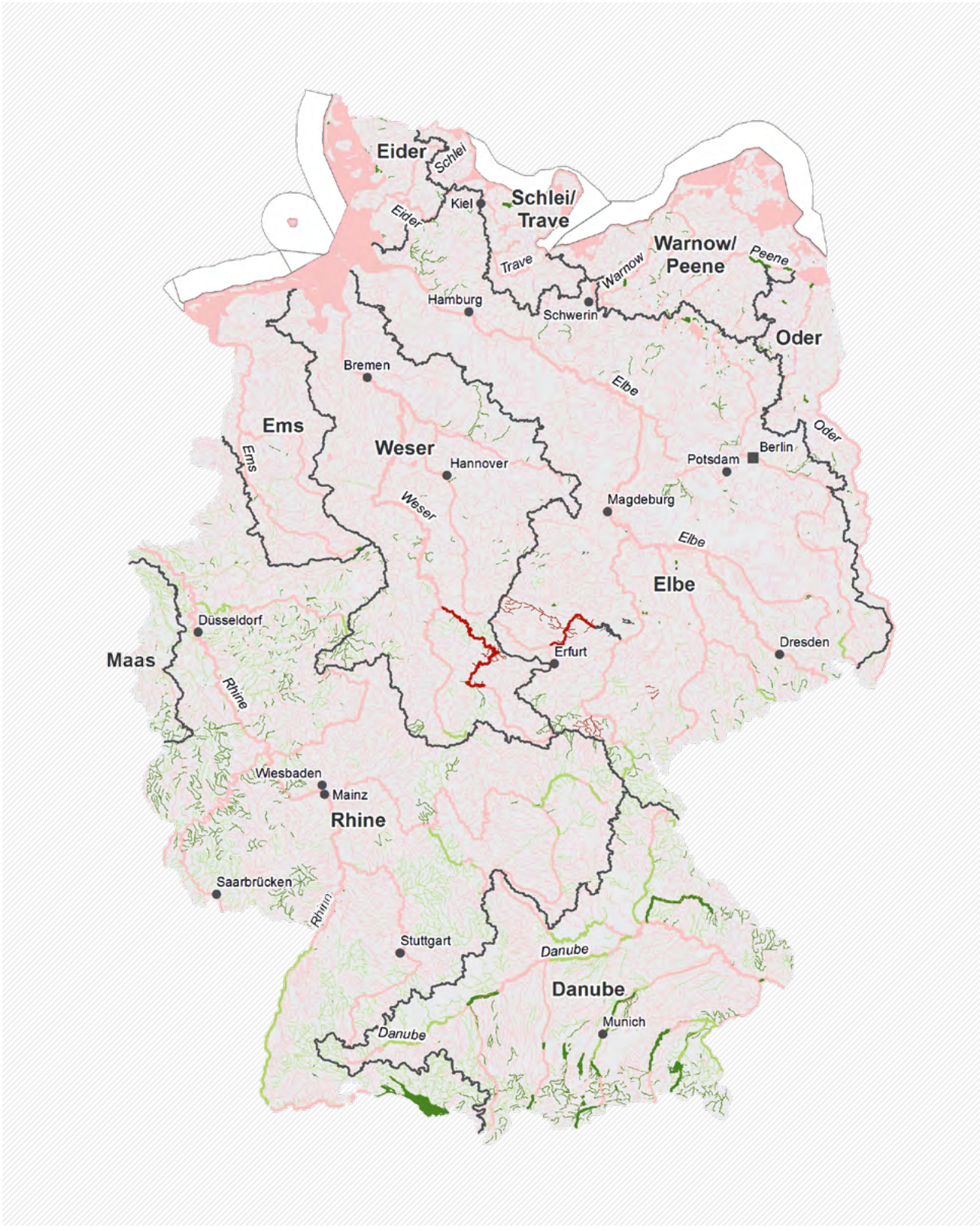
Deadline extensions and exemptions in Germany

Currently, 8.2 percent of Germany's surface water bodies have reached the desired ecological status. This means that for the current management cycle, deadline extensions and exemptions are being invoked for nearly 92 percent of all surface water bodies (Map 17, Figure 30).
Setting less stringent management objectives for certain surface water bodies on the Werra river in the Weser river basin district is necessitated by the fact that, as the result of geogenic and diffuse input saltwater intrusion pressures, the guide values mandated for the relevant salt ions in the Weser River Basin Community cannot be reached. Discontinuation of salt water injection during the 2015-2021 management cycle will reduce diffuse saltwater inputs – although the mandated guide values will only be reached in the post-2027 period. There is currently no known additional (and suitable) measure that would allow good status to be reached for these water bodies.

Inasmuch as the desired chemical status has yet to be achieved for all surface water bodies, deadline extensions have been invoked for them.

Map 17

Objectives, deadline extension and exemptions invoked for the ecological status of German surface water bodies.



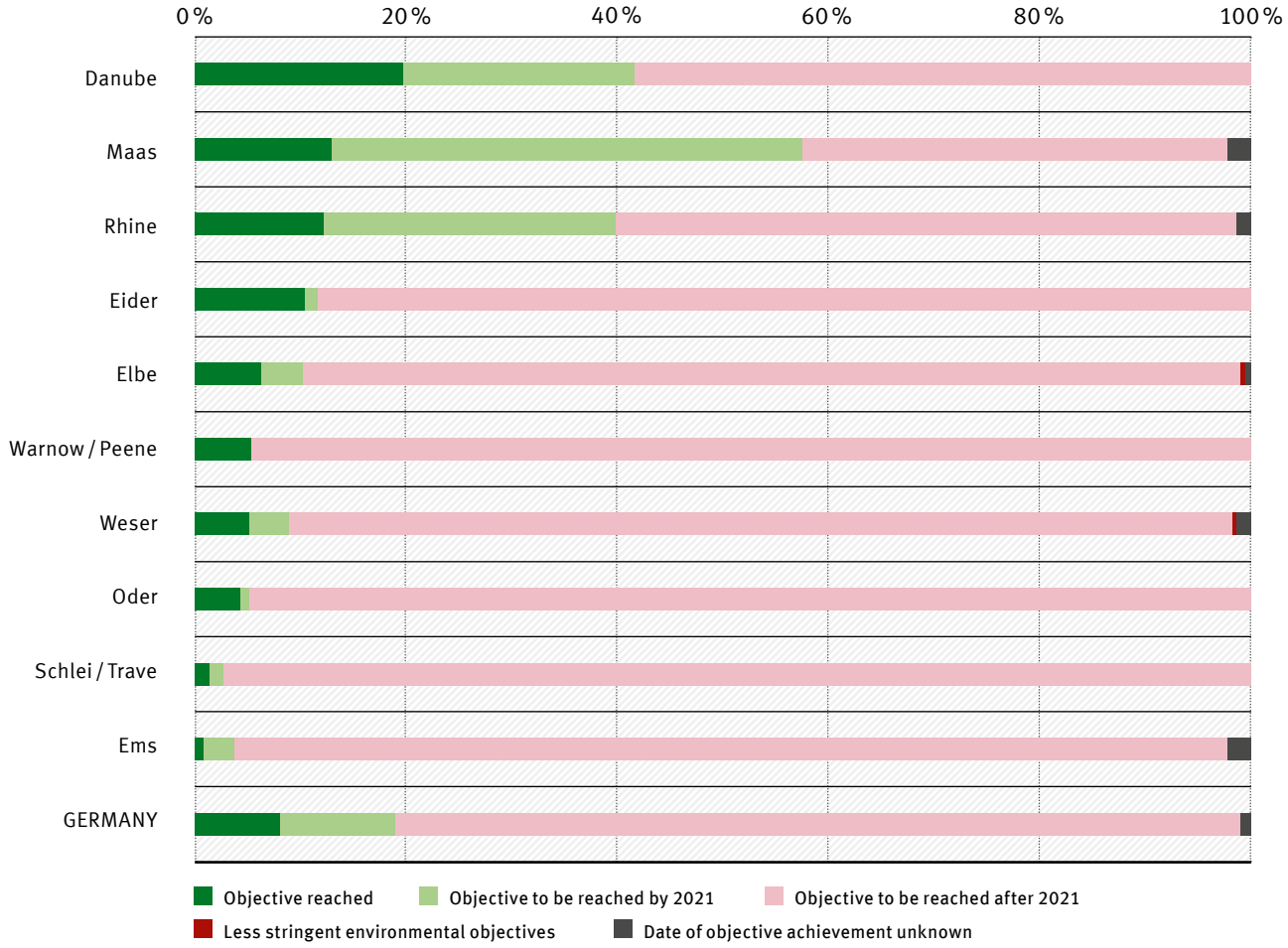
Objective reached | Objective to be reached by 2021 | Objective to be reached after 2021 | Less stringent environmental objectives | Date of objective achievement unknown | No ecological status assessment necessary

Spatial base data: Geo-Basis-DE/BKG 2015

Technical data: Berichtsportal WasserBLIcK/BfG; llast updated 30.09.2016; amended
Adaptation/editing: Umweltbundesamt based on information of LAWA and competent authorities of the federal states

Figure 30

Objectives, deadline extension and exemptions invoked for the ecological status of surface water bodies in the ten river basins that are relevant for Germany.



Technical data: Berichtsportal WasserBLIcK/BfG; llast updated 30.09.2016; amended
Adaptation/editing: Umweltbundesamt based on information of LAWA and competent authorities of the federal states

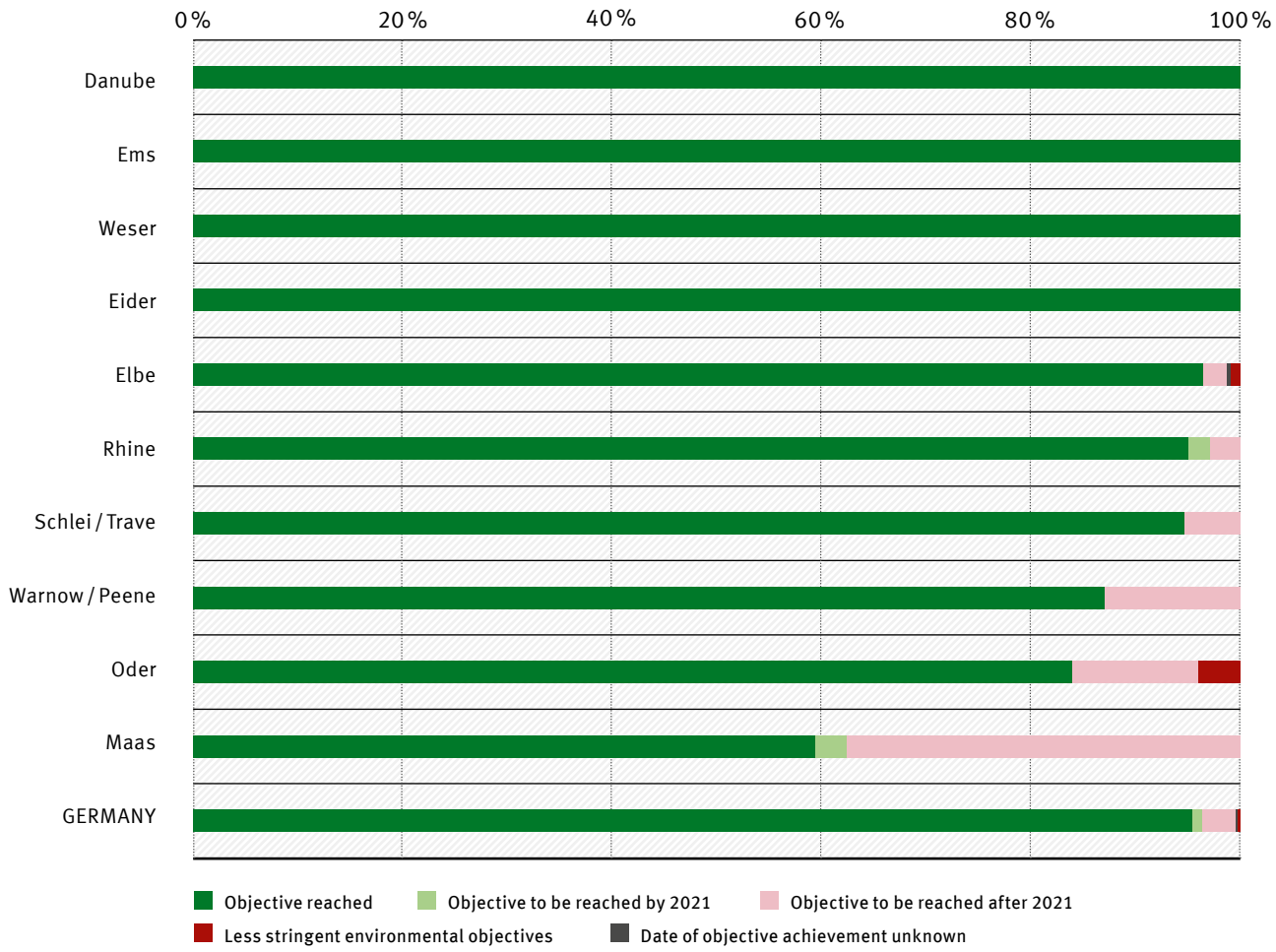
For 51 groundwater bodies (4.3 percent), deadline extensions and exemptions have been invoked for quantitative water body status. The measures planned for a total of ten groundwater bodies in the run-up to 2021 in the Rhine and Maas river basins aim to achieve good quantitative status. For all remaining groundwater bodies, deadline extensions until 2027 have been invoked, and in a few cases less stringent management objectives have been invoked owing to mining-related pressures.

For a very small number of groundwater bodies, the date by which the mandated objectives will be reached remains indeterminable (Figure 31, Map 18).

64 percent of Germany's groundwater bodies currently exhibit "good chemical status", a figure that is set to increase by 1.5 percent in the run-up to 2021 (i.e. for 18 groundwater bodies). The deadlines for the remaining groundwater bodies have been extended until

Figure 31

Objectives, deadline extension and exemptions invoked for the quantitative status of groundwater bodies in the ten river basins that are relevant for Germany.



Technical data: Berichtsportal WasserBLIcK/BfG; llast updated 30.09.2016; amended
Adaptation/editing: Umweltbundesamt based on information of LAWA and competent authorities of the federal states

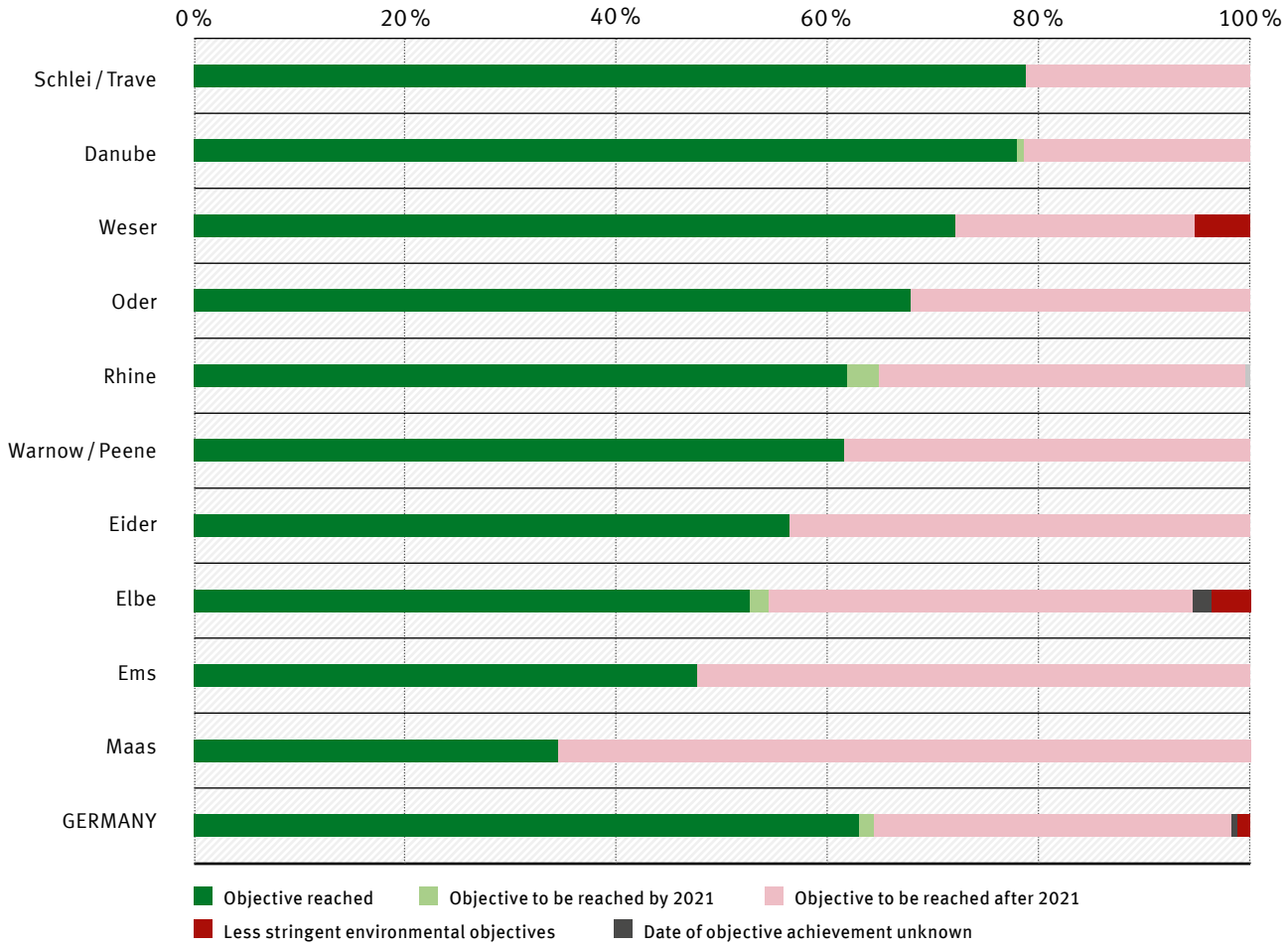
2027, except for a few Elbe or Weser river basin district groundwater bodies whose desired chemical status is unreachable owing to salt mining activities and intrusions occasioned by the potash industry's long-standing practice of saltwater injection. Thus less stringent management objectives have been invoked for these groundwater bodies (Figure 32, Map 19).

No exemptions such as temporary water-body deterioration, failure to achieve good status, or non-forestalling of status deterioration owing to changes in physical properties or new sustainable development activities were not invoked in the run-up to 2015.

Such extensions are particularly necessary for groundwater bodies in many cases since it takes a long time for the chemical status of these water bodies to improve – as is also the case for groundwater quantity status.

Figure 32

Objectives, deadline extension and exemptions invoked for the chemical status of groundwater bodies in the ten river basins that are relevant for Germany.



Technical data: Berichtsportal WasserBLIcK/BfG; llast updated 30.09.2016; amended
Adaptation/editing: Umweltbundesamt based on information of LAWA and competent authorities of the federal states

What are the valid justifications for deadline extensions and exemptions?

Exemptions, which are subject to review at six year intervals in the management plans, can be invoked for the following reasons:

- The objectives cannot be met on the grounds that they are unfeasible from a technical standpoint, or can only be met in stages
- Implementation of the objectives by 2021 would entail disproportionate costs
- The existing natural conditions would not allow for timely improvement of the relevant status

"Technically unfeasible" means, for example, that the process in question is lengthy due to a series of mandatory measures, among other things; or additional research and development are needed.

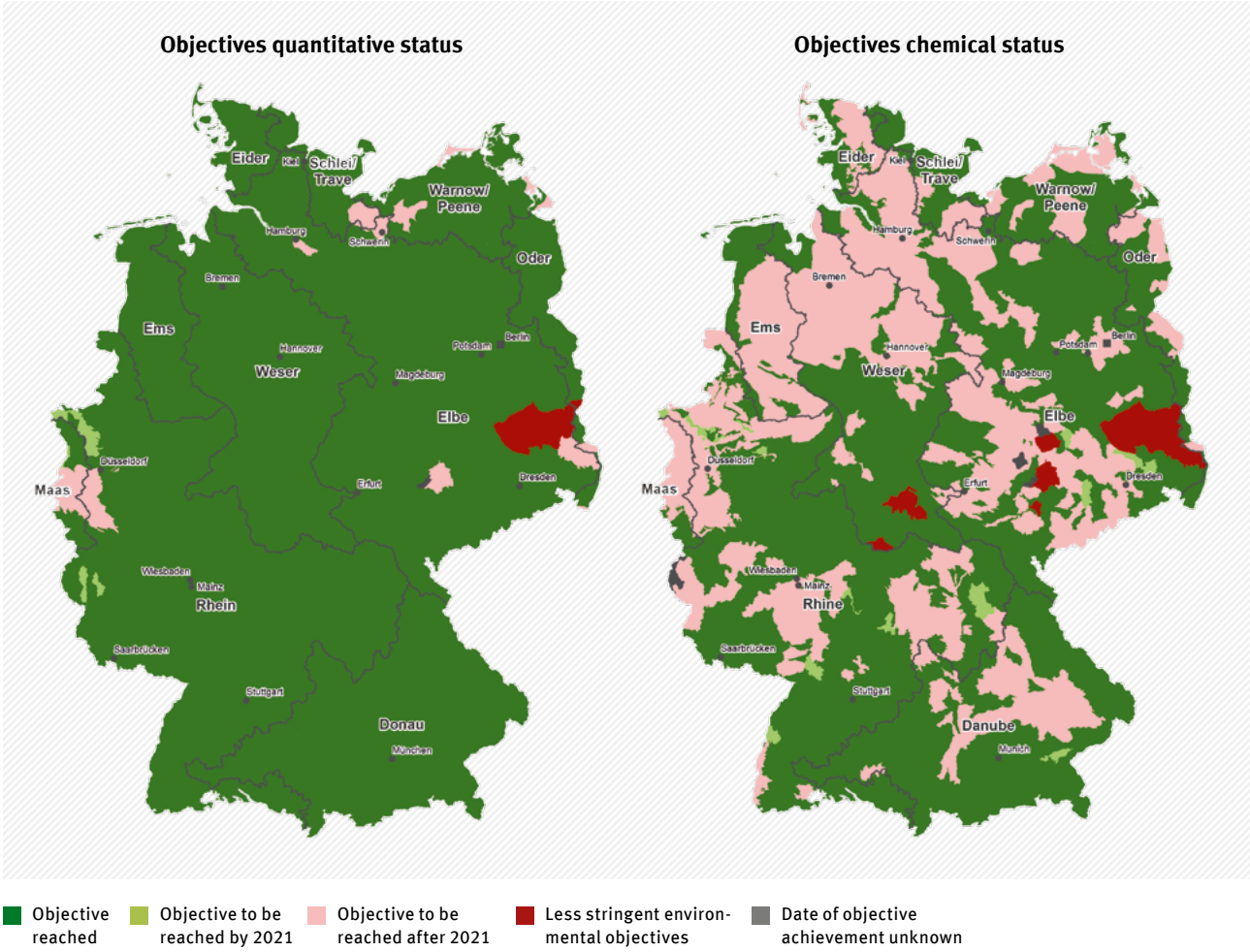
"Disproportionate costs" refer to costs that would impose an unduly heavy financial burden on the party concerned, or costs that would entail a negative cost benefit ratio.

"Natural conditions" refers to measures for which a lengthy period would elapse between implementation and the point at which the positive impact of the measure concerned on water bodies and their biota would take effect and become measurable.

Exemptions and deadline extensions are often justified for surface waters on the grounds of insufficient technical feasibility (62 percent), or existing natural conditions (31 percent). Existing natural conditions is the justification the most frequently invoked for groundwater deadline extensions and exemptions (Figure 33). However, most deadline extensions and exemptions are invoked on multiple grounds.

Map 18 und Map 19

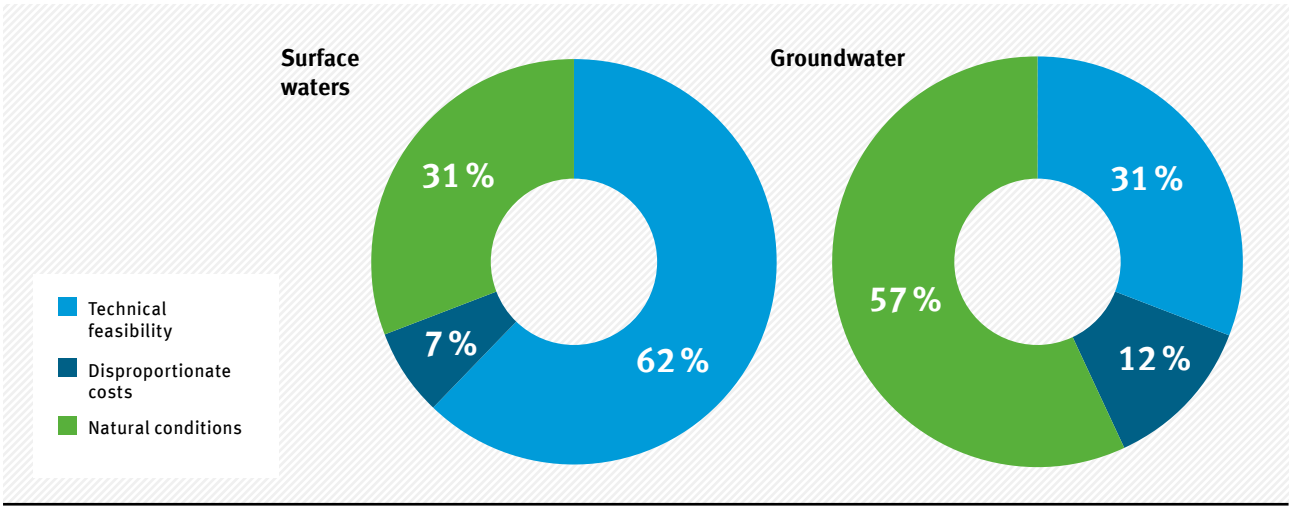
Objectives, deadline extension and exemptions invoked for the chemical and quantitative status of German groundwater bodies.



Technical data: Berichtsportal WasserBLIcK/BfG; llast updated 30.09.2016; amended
Adaptation/editing: Umweltbundesamt based on information of LAWA and competent authorities of the federal states

Figure 33

Grounds for invoking deadline extensions and exemptions for surface waters and groundwater.



Technical data: Berichtsportal WasserBLIcK/BfG; last updated 23 March 2016. Adaptation/editing: Umweltbundesamt, based on Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) data.

6.2 Measure financing

Measures can only be carried out if sufficient funding is available for them; and this in turn is a precondition for achieving the mandated management objectives. Adequate financing of Water Framework Directive measures is therefore essential for achievement of the Directive's management objectives.

Sources of financing

Implementation of the polluter pays principle also generates considerable funding for Water Framework Directive measures. This principle holds that water users must defray the costs of mitigating or eliminating the water-use related ecological damage incurred by water bodies. This also promotes cost transparency. The general public is only called upon to pay in cases where the polluter is unavailable or unknown, or if the transaction costs for individual instances of cost recovery are prohibitive. The polluter pays principle, which is a rationale of EU environmental policy, essentially says: If you pollute the environment, you have to pay.

The polluter pays principle and the consequent allocation of environmental and resource costs are mainly implemented in Germany via regulatory instruments comprising restrictions and requirements that relate to products, manufacturing processes and methods. Manufacturers are required to limit their emissions or other water body pressures to a specific level. This applies, for example, to emission limits for the following: the industrial sector; minimum standards that apply to hydropower plants; or the tenets of good professional practice in the agricultural sector.

Costs of measures

Management plans in the EU are based on river basin districts. Since all management plans are elaborated by the river basin associations, and in some cases also by the German states, some of the available data also relates to the federal states. As can be seen from the current management plans, the methods that were used to calculate the costs of the relevant measures lack uniformity. For example, river basin district Elbe mentions total costs of 1.2 to 1.4 billion Euros for implementing current management cycle measures.

Sewage fees and water abstraction charges

In the interest of protecting Germany's waters from pressures, all German companies and municipal treatment plants that discharge sewage into waters are required to pay sewage fees, which apply nationwide. Municipalities pass on to users the sewage fee costs for discharges from municipal sewage treatment plants, via sewage treatment fees.

Water abstraction charges are currently levied in 13 German states. The purpose of such charges is to reduce water abstraction so as to protect the water bodies whose water is abstracted. Parties that abstract water are subject to water abstraction charges – and in the case of the public water supply, this means water utilities. As is the case with sewage fees, it is consumers who ultimately bear the costs that companies incur from water abstraction charges.

By law (Article 13 Abwasserabgabengesetz (AbwAG)), sewage fee revenues must be earmarked for sewage management measures. In most federal states, revenue from water abstraction charges is likewise used for water resource management measures.

Recovery of the costs of water services

The Water Framework Directive stipulates that the water prices charged by the member states must cover the relevant costs. This means a number of things. First, revenue from a given invoicing period must cover the construction, operating and maintenance costs for water supply and sewage treatment facilities. But at the same time, the member states are barred from incurring cost overruns.

Secondly, the prices charged must include environmental and resource costs. Moreover, in accordance with the polluter pays principle, the principle user groups – industry, agriculture and households – are required to make a reasonable contribution to the costs incurred by water utility operators. And finally, water-pricing policies are to provide adequate incentives for efficient and sustainable water resource use.

The cost-recovery principle is prescribed by federal state law throughout Germany and is documented in the German state management plans.

In Germany, external costs are also partly apportioned to polluters, via the following:

- nationwide sewage fees;
- the water abstraction charges that are levied in 13 German states;
- mandatory precautionary and compensatory measures as established in permit and approval decisions.

End user price trends

For many years now in Germany, increases in drinking water and sewage fees are lower than the overall inflation rate. Thus according to a 2015 Bundesverband der Energie- und Wasserwirtschaft study entitled Branchenbild der deutschen Wasserwirtschaft 2015, between 2005 and 2013 prices and fees for drinking water and sewage rose by 12.2 and 10.9 percent respectively. These price increases thus are lower than the 14.3 percent overall inflation rate during this period.

The way forward

The current state of things

Germany's river basin district management plans were adopted in late 2015 following extensive consultation with water users, various interest groups, and interested members of the general public and were submitted to the European Commission on 22 March 2016. In conjunction with the programmes of measures, these plans constitute a water body management framework for the coming years. The plans also provide a metric for the relevant authorities in the 16 German states, and serve an orientation function for the general public and water protection and user interest groups. Numerous measures are either in their planning or in their implementation phases. The member states are required to report on the progress of measure implementation at the end of 2018.

The third and final management plans and programmes of measures as per the Water Framework Directive will come into effect in 2021. This directive's ambitious system of environmental goals and measures was not fully established in the member states and in the EU as a whole during the first management cycle. For instance, it was not until this latter period that comparisons of the biological assessment procedures applied by the various member states were completed. Because the priority-substances directive was not amended until 2013, it was not possible to take the amended version into account for planning purposes until late in the planning phase of the current management cycle. Hence, an additional interim programme of measures for the current period will have to be elaborated in 2018.

Both major and minor progress toward implementation has been achieved in recent years

Continuity in a great many stretches of water has been restored, an achievement exemplified by the return of salmon and vegetation to a growing number of water bodies. The government has begun to establish continuity at transverse structures for migratory fish on federal waterways, and is laying the groundwork for implementation of the Blaues Band program – which aims to improve nature conservation and water protection in selected stretches of federal waterways. Progress has been made in terms of protecting fish as they make their way past hydropower-plant turbines – for example, thanks to a forum established by the UBA, and the fish protection and fish passage pilot installations that have been im-

plemented by a number of federal states. The forum formulates requirements and solutions that reflect the current state of knowledge and the state of the art concerning fish protection and fish passage that can lay the ground-work for fish population establishment and preservation.

Progress has likewise been made in terms of water protection in the agricultural sphere – although nitrogen surpluses still remain unchanged. Diffuse pollutant inputs from intensive farming and increased levels of biomass cultivation are likely to remain a threat to groundwater purity. The trend toward lower nitrate levels in groundwater that was observed in the 1990s has faded in recent years. A rising level of eutrophication is occurring in coastal waters as well.

Flooding is a natural phenomenon that results in the establishment of near-natural habitats in river valleys. A sufficiently wide water body corridor affords rivers and streams the room they need to develop near-natural habitats on their own. Such corridors also do a better job of retaining nutrients and promoting the development of biodiversity networks. In light of these phenomena, land should be purchased expressly for natural floodplain development, with a view to achieving Water Framework Directive objectives and at the same time promoting effective flood protection.

Obstacles to implementation

The Water Framework Directive deadlines and objectives are ambitious. For one thing, the majority of the necessary measures are still in their implementation, planning or construction phases. In many cases, the requisite implementation procedures are lengthy and it often takes a long time for the effects of the relevant measures to become palpable. Nonetheless, the status of some water bodies has already improved, even if overall good status under the stringent Water Framework Directive requirements for surface waters has yet to be achieved. And in fact, overall status of some water bodies has nominally deteriorated for a number of quality elements, owing to the advent of new or more stringent requirements. For even if considerable progress has been made for a number of quality elements or environmental standards, all it takes is a single component with poor status for the status of an entire water body to be ranked as poor. Hence, in the future it should be made clearer in exactly which areas, and why, progress is being made in certain areas through the implementation of measures.

The overall situation in the groundwater sphere has likewise not improved very much, despite the numerous measures that have been implemented. And while the baseline situation is somewhat better than for surface water bodies, relative to the latter it takes longer for some of the positive effects of protective measures to become observable.

Implementation of the Water Framework Directive has also shown that nature responds slowly to measures. For instance, owing to slow groundwater flow rates and lengthy lake water retention times, which can amount to decades in some cases, past pressures still have an effect today. Once river and stream usage has been reduced or discontinued, it can likewise take many years for their waters to become clean again and for restoration of their habitat diversity. Characteristic aquatic organisms can colonize such stretches early on only if they are already present in close proximity to upstream and downstream areas. Given the fact that it often takes years for ecological improvements to actually occur, the actual effects of certain previously implemented measures in terms of elements such as water ecology, need to become observable first.

However, time lags attributable to the implementation of extensive measures and lengthy natural amelioration processes should not be used as an excuse for avoiding further activities and measures. Many water bodies are still “awaiting” renaturation or pressure reduction measures, because water protection is in competition with many other endeavours such as food production, public-infrastructure preservation, and the German Energiewende (energy transition). Thanks to the Water Framework Directive, such pros and cons can be weighed in a transparent fashion, and exemptions can be invoked in substantiated cases – deadline extensions, for example, or setting less stringent management objectives.

Future challenges

In the coming years, the water resource management community will be facing a number of challenges that are significant not only in and of themselves, but also from a big picture perspective. In addition to the implementation of ambitious management plans and programmes of measures, these challenges are as follows, in particular:

Drafting of an amended Düngeverordnung (Fertilization Ordinance) (as at 16 December 2015) constitutes a new and greater challenge in terms of fertilizer use. Relative to the current version of the Düngeverordnung (Fertilization Ordinance), the envisaged more stringent rules aim to achieve more efficient and resource-saving use of nutrients such as nitrogen. But such reductions would not be sufficient in many river basins to achieve the mandated objectives for coastal water bodies. Hence the various federal states need to adopt more extensive measures; whereby the draft Düngeverordnung (Fertilization Ordinance) should be revised in light of current treaty violation proceedings.

Ecologically sustainable agriculture

Furthermore, pesticide inputs into groundwater and surface waters should be reduced once and for all. Accordingly, direct payments under the next reform of Common Agricultural Policy should be more robustly keyed to environmental regulations in the interest of ensuring that government funds are used for the common good. In addition, efforts should be made to leverage all available ecological optimization options in the current funding period as well. Thus for example, under EU law more than 4.5 percent of direct payments (first pillar) could be shifted to the second pillar – a move that would be beneficial for programs such as the voluntary agri-environmental program and that would move us closer to the goal of expanding organic farming to 20 percent of existing farmland. This is a goal worth pursuing from a water protection standpoint, in that organic farming affords greater water protection than any other agricultural activity.

In the interest of reducing pharmaceutical-drug pressures on surface waters, the European Commission has proposed a strategic approach which, where necessary also contains recommendations to the effect that drug approval authorities should give greater weight to the ecological sustainability of these compounds. By virtue of a dialogue with the federal states and with water resource management stakeholders, the federal government plans to elaborate a comprehensive micro pollutant strategy with a view to reducing water body pressures from micro pollutants. Measures aimed at avoiding inputs of micro pollutants such as pesticides and pharmaceutical drugs via various discharge paths (e.g. sewage treatment and disposal in sewage treatment plants) should be looked into and suitably tied in.

Further reductions in micro pollutants

Moreover, the manner in which substance pressures that have yet to be adequately addressed are handled should be reviewed via the following measures: addressing the issue as to whether, for example, Germany's national pesticide action plan goes far enough in terms of water body protection; or whether further measures need to be taken aimed at limiting inputs of ubiquitous substances such as mercury, as well as polycyclic aromatic hydrocarbons from fossil fuel combustion

Taking demographic change into account

Demographic change entails the following two dimensions from a water resource management perspective: an aging and shrinking population, along with increasing urbanization. These phenomena impact water body inputs (more medications) and the sewage infrastructure, particularly in rural areas (less sewage). Future planning processes should take these phenomena into

account, including from the standpoint of fee adjustments.

Climate change can potentially exacerbate existing water resource management problems. The vulnerability assessment undertaken by the federal government in 2015 within the framework of the German Strategy for Adaptation to Climate Change revealed the need for action in the water resource management and hydrological regime domains. Increasingly frequent heavy rains may need to be taken into account to a greater degree. But the likelihood of low-water scenarios in the future, particularly in combination with more frequent hot days, increases the risk of recession and of higher water temperatures in natural water bodies, with the consequent impact on water quality and the drinking water supply. These phenomena will also bring about changes in water body biological processes and species composition. We are already seeing the effects of climate change. It is necessary to monitor these effects further and in greater detail, in order to take suitable countermeasures or adaptive measures. To this end, pursuant to a resolution adopted by the 86th Environmental Ministers' Conference (86. Umweltministerkonferenz (UMK)), the Bund/Länder-Arbeitsgemeinschaft Wasser (LAWA) will revise adaptive water resource strategies necessitated by climate change.

Adapting to climate change

In terms of improving water body system ecology and avoiding ecological deterioration, water body use for energy generation should be based on strategic concepts which, for example, allow for the identification of suitable hydropower plant site designation and the elaboration of continuity strategies. All such actions should seek to minimize conflicts between climate protection and water protection, by virtue of ecologically sustainable power plant designs and operating modalities.

Accordingly, it should be borne in mind that more than 80 percent of Germany's technically and ecologically usable hydropower potential has already been tapped. Any potential in terms of output increase should only be tapped by replacing old power plants with new ones, or by modernizing existing hydropower plants. There are also many different ways to reduce the impact of hydropower via suitable measures related to hydropower plant construction and operation.

Reducing plastic inputs in water bodies

The impact of the input of plastics into inland and marine waters is a current concern that should be explored further. Whereas a certain amount of knowledge has been amassed in the marine domain, knowledge concerning inland waters is still lacking. In both of these domains, for example, no research has been carried out concerning the impact of microplastics on aquatic organisms.

Linkage between EU directives needs to be improved and water related issues need to be addressed in a more integrative fashion

Given the fact that many EU directives contain water protection provisions that are similar to or complement each other, these directives should be implemented in an integrated fashion both EU-wide and in the various member states. This applies to the Water Framework Directive, the Flood Risk Management Directive, the Marine Strategy Framework Directive, the Natura 2000 Directive, the Renewable Energy Directive and REACH. Harmoni-zation of non-uniform provisions should be improved, and measure implementation synergies in particular should be identified and strengthened. At the

EU level, it is essential that in particular water protection-related matters be integrated into agricultural policies, and that extensive coordination between the agricultural and water and environmental domains be undertaken. Discussions of these matters have been underway at the EU level for quite some time, and Germany is committed to making efforts to find solutions in this regard.

The outlook for the Water Framework Directive

The Water Framework Directive has proven to be an effective water protection instrument, in that it has established structures that promote better national and international cooperation, as well as integration oriented mindsets and approaches. Thus measures have been and will be implemented that would have been unthinkable without the Water Framework Directive, and a great many technical requirements have been elaborated and harmonized at both the national and EU levels.

Although clear signs that we are headed in the right direction are discernible, 20 years is simply not enough time in which to achieve good status at a reasonable cost for water bodies that have been subject to anthropogenic pressures and changes for a very long time.

The overarching goal of the Water Framework Directive is for all EU water bodies to achieve good status by 2027. But as it is foreseeable that none of the EU member states will be able to achieve this objective, a determination needs to be made as to how the Water Framework Directive will be handled in the post-2027 period. The Directive itself calls for the European Commission to review it by 2019 and to recommend any changes that are deemed necessary.

The Water Framework Directive, its mandated objectives and the processes that it has set in motion over the past 15 years are indisputably steps in the right direction. Thus from an environmental standpoint, further Water Framework Directive management cycles should be mandated for the post-2027 period, in view of the fact that it will not be possible for the Directive's objectives to be reached by 2027 in heavily polluted economic areas and in the presence of intensive farming. Thus the goal should be not only to extend the relevant deadlines, but also to keep ambitious water protection objectives in force. In their capacity as guidelines for sustainable water resource management in Europe, the Water Framework Directive's objectives and provisions should be upheld and updated.

To this end, discussions are underway at both the national and EU levels with a view to determining exactly how the Water Framework Directive provisions and objectives can be updated and how it can be modified in light of the experience gained from the implementation process thus far, without watering down the level of requirements.

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Statewide Donauried-Hürbe Projekt (DHP)	https://www.landwirtschaft-bw.info/pb/MLR.ULBUL,Lde/Startseite/Fachinformationen+Landwirtschaft/Donauried_Huerbe+Projekt+_DHP_
Aktion Backgetreide (Baking-grain initiative)	http://www.aktiongrundwasserschutz.de/legro/baeckereien/modellprojekt-backgetreide/
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LINKS TO THE MANAGEMENT PLANS AND PROGRAMMES OF MEASURES

International river basin reports

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Elbe	http://www.ikse-mkol.org/publikationen/wasserrahmenrichtlinie/1/
Ems	http://www.ems-eems.de/wasserrahmenrichtlinie/berichte/
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Oder	http://www.mkoo.pl/index.php?mid=28&aid=693&lang=DE
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National river basin reports

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