Seeing the big picture

Introducing the Federal Institute of Hydrology

BfG Federal Institute of Hydrology

BfG is a departmental research institute whose remit is to provide advice and expert reports and to conduct research and development work in relation to the aquatic ecosystems.

Dr Birgit Esser
Director General of the Federal Institute of Hydrology

Dear Reader,

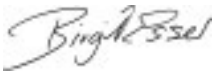
Delivering scientifically sound, evidence-based information to the Federal Government is the core function of federal departmental research institutes – research establishments that are directly linked to certain federal ministries. To be able to make relevant decisions, we all need up-to-date facts, figures and data, and it is extremely important that the source of the information is objective. Departmental research results are a vital source of information, since they are unfiltered and direct.

The Federal Institute of Hydrology is a departmental research institute whose remit is to provide advice and expert reports and to conduct research and development work in relation to our **aquatic ecosystems**.

BfG's experts bring in their individual knowledge at the interface of science, politics, operational administration and society. In a proactive approach, BfG takes account of topical socio-political issues to develop, based on specific projects, anticipatory options for action and practice-oriented solutions for government measures. Key questions we are addressing include the climate and biodiversity crises that impact nearly all spheres of public administration, society, business, culture and the environment. The national and global challenges involved highlight the need for integrated scientific structures. As part of the national and international science landscape BfG is engaged in multiple collaborations and networks aiming to develop cross-departmental solutions by merging a diverse set of technical skills.

From the abundance of issues BfG is currently working on, I would like to present you with a selection of topics that are of particular relevance to the public. **Extreme events such as flooding and low water levels, water quality and the ecological development of bodies of water, complete with their banks and floodplains** are just some of the issues people can relate to from a variety of perspectives. Since the issues we work on at BfG are important to many people – and will become even more important in the future – I would be delighted if reading this brochure gives you some personal insight into the topics addressed by BfG. After all, I am in no doubt that the sustainable development of our rivers is a subject that many of us care about deeply.

I hope you enjoy reading this brochure.



Dr Birgit Esser

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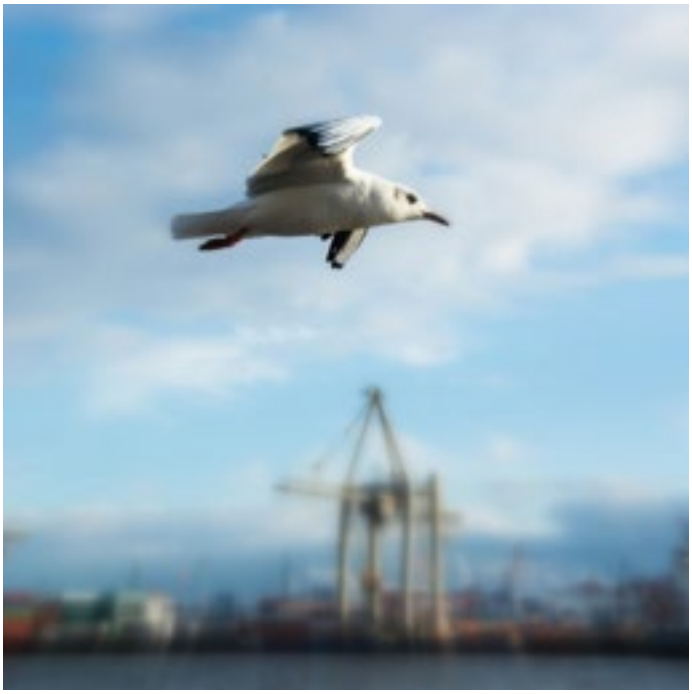
Tackling challenges relating to river policy

- VIEWING WATERWAYS AS LIFELINES.
- BALANCING THE NEEDS OF BUSINESS, PEOPLE AND NATURE.
- NATIONALLY AND INTERNATIONALLY.



Our major rivers – habitats and economic areas at the same time

Our aquatic ecosystems offer all this – and much more besides

Major rivers flow through our continent. People have made extensive stretches of them navigable and have also built additional links – canals – so as to create a coherent, interconnected transport system. These linked-up waterways cross borders and are a valuable resource for all European citizens. They connect inland areas to the sea and play an important part in getting supplies to regions that lie far from the coast. As well as serving a function in terms of transport, however, our waterways are also a habitat for animals and plants. They provide an energy source, too, form the basis of our water supply system and provide us with space for leisure and recreation. They connect cultural regions and natural landscapes, as well as cities, countries and people. In short, they are habitats and economic areas at the same time.

Contributing to a strong economy

In terms of the economy, our waterways have become more important over time, and the figures speak for themselves. In Germany, there are currently around 7,300 kilometres of navigable rivers and canals. There are also some 23,000 square kilometres of navigable maritime waterways in the North Sea and Baltic Sea. On average, some 230 million metric tons of goods, representing around 10% of our total freight volume, are transported every year on Germany's inland waters alone. These federal waterways – especially the large ones – thus contribute to Germany's strong economy.

Growing human influence – and growing environmental awareness

Given the many different functions served by aquatic ecosystems, a huge range of demands are also placed upon them. The greater the human influence over aquatic ecosystems, the more the effects of this are felt by all. Using them sustainably requires maintaining their ecological balance. Heavy pollution of our water bodies was therefore one of the reasons why environmental protection, environmental policy and, therefore, sustainable use of natural resources became an increasing focus of public interest during the 1970s. This was not merely the case in Germany, either. Approximately 80% of all national environmental legislation now stems from the European Union. The Federal Institute of Hydrology plays its part in developing these statutory regulations.

Aquatic ecosystems in 2030

Given the wide-ranging demands, influential factors and developments that are having an ever-increasing impact on our aquatic ecosystems, we have a concrete vision of the long-term goals we want to achieve through our work. After all, in all our tasks, both large and small, we need to keep the essentials in mind as we apply our expertise and conduct our scientific work to strategically piece together the many different parts of the puzzle. It is important that the political decision-makers can themselves take the pieces – in other words, the many individual measures recommended in relation to the aquatic ecosystems – and assemble the puzzle at any time.

The BfG experts are playing their part to ensure that, in the future:

- the habitat function for animals and plants will, to a large extent, be in harmony with anthropogenic uses of aquatic ecosystems and their catchment areas. The human influence over aquatic ecosystems is kept to a minimum by acting sustainably.
- concepts to prevent inputs of trace substances into aquatic ecosystems have been developed to the greatest possible extent. The remaining substance-related pollution of aquatic ecosystems is proactively recorded and analysed. Extensive methods are available to clarify the distribution and transformation of identified trace substances as well as how they impact aquatic organisms and human beings.
- the many different uses of aquatic ecosystems for the provision of state services of general interest (known as *Daseinsvorsorge*) are safeguarded on a sustainable basis, taking the effects of climate change into account, while forecasting and climate projection tools provide flexibility for the water management.
- the aquatic ecosystems boast the kind of stable diversity of species and habitats that is typical for such an environment. Innovative management of aquatic ecosystems has led to an increase in biodiversity.
- cutting-edge digital systems and tools that are capable of communicating globally are available for optimising working processes for the protection of aquatic ecosystems, thereby enabling effective, safe and participatory workflows at the highest technical level – always under the responsibility of people and to their benefit.
- the performance of Germany's federal waterways is based on transport infrastructure of a sustainable, environmentally responsible and future-oriented design that ensures it can react flexibly to changes in climate and society.
- the environmental awareness that is prevalent in society is also reflected in the way aquatic ecosystems and their contributing catchments are handled. Solutions for the environmentally responsible development of our aquatic systems are developed in consultation with the public.
- waterborne transport is optimised in regard to society's growing – and sometimes conflicting – requirements. The performance of the waterways is continuously developed with a view to providing networked infrastructure for all modes of transport.
- research scientists and interested members of the public have the easiest possible access to the ever-growing information and data available at BfG. A significant part of our digitally available knowledge is already accessible online in specialist and map applications via the BfG Geoportal.

Sebastian Messing
German Federal Waterways and Shipping Agency (GDWS)

3 questions for...

Society's demands on our rivers and coastal waters are changing. Mr Messing, in the view of the Federal Waterways and Shipping Administration (WSV), what are the current challenges facing Germany's federal waterways?

SEBASTIAN MESSING In recent years, there has been a paradigm shift in society, politics and the WSV. Today, we take an integrative approach to developing and maintaining our waterways. By combining the new water management tasks with our existing transport-related ones, we are achieving the best possible levels of synergy for both areas. This gives our work greater social significance that extends far beyond our original transport optimisation remit.

In concrete terms, what are your main fields of activity?

Alongside our transport-related duties, implementing the EU Water Framework Directive (WFD) has become the WSV's second key task. This involves restoring ecological connectivity at our barrages and making hydromorphological improvements to riverbeds and riverbanks. Alongside statutory duties, the Federal Government's 'Germany's Blue Belt' (***Blaues Band Deutschland***) programme, which is being co-managed with the Federal Agency for Nature Conservation, is helping to achieve these ecological objectives. Another major task is sediment management. Here, too, we are not confining ourselves to local, transport-related issues, but are instead looking at the entire river basin in close cooperation with the regional authorities. To give you a specific example, I cannot remove riverbank protection from a tributary without considering the additional sediment load – which may even be polluted – that will enter the main river as a result. We therefore need to develop and implement integrated concepts.

How does BfG help you accomplish these tasks?

We very much appreciate the advice we receive from BfG in relation to the environment and also when it comes to working on fundamental principles, such as the morphological correlations in our waterways or estimating the impacts of climate change. BfG works on our behalf, gaining a systemic understanding that enables it to identify and forecast trends and developments at an early stage. Given the complexity of current challenges at play, this information will become even more important in the future.

2

Research in the interest of river diversity

- SEEING THE BIG PICTURE.
- IDENTIFYING KNOWLEDGE GAPS.
- FINDING OUT NEW THINGS.

Researching our aquatic ecosystems – providing political, practical and social guidance

Scientific institute of the Federal Government

BfG is a departmental research institute within the portfolio of the Federal Ministry for Digital and Transport (BMDV). It advises both the Ministry itself and subordinate authorities, in particular the Federal Waterways and Shipping Administration. As the Federal Government's scientific institute in the fields of hydrology, water use, water quality, ecology and water conservation, BfG has wide-ranging expertise in all issues related to aquatic ecosystems. Since water is a topic that is relevant to many different ministries and departments, we also work for other federal ministries, especially the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV). In competition with other researchers, we also apply for external funding, such as from the German Research Foundation (DFG) and the German Federal Ministry of Education and Research (BMBF).

What does departmental research mean?

The ministries need sound scientific knowledge as a basis for making political decisions. They have therefore set up federal agencies and given them a research and development remit. These departmental research institutes have the necessary scientific expertise and help prepare, support and implement political decisions. We do not regard research and development as an end in itself; instead, the purpose of these activities is to enable us to carry out the tasks assigned to us by law on a scientific basis. Alongside this, we carry out our own essential, purposeful research, which enables us to continuously expand our understanding of the aquatic ecosystems. We have monitoring networks, laboratories, databases, expert systems and numerical mathematical models to support our work.

Work on rivers and coasts

As a federal institute, we are primarily responsible for Germany's federal waterways, i.e. the navigable rivers, canals and coastal waters. However, since the impact of transport infrastructure measures often extends beyond the immediate local area, we always adopt an integrative approach and factor the entire river basin into our considerations. The aim of our scientific work is to develop the federal waterways not only as effective transport links, but also as living areas for people and habitats for animals and plants. Our research scientists measure, analyse, model and evaluate. In this way, we reveal processes and interactions and derive concepts for the sustainable development of our river landscapes.

Cornelia Schütz
Federal Institute of Hydrology (BfG)
Roman Weichert
Federal Waterways Engineering and Research Institute (BAW)

2 questions for...

Transversal structures serve a useful function for shipping, flood protection and energy generation. So what makes them a problem for our rivers?

CORNELIA SCHÜTZ They fundamentally alter a river's ecological properties. For example, they block migration pathways, preventing primarily fish but also other creatures that live in the water from getting through. They also impair the natural dynamics of sediments. Fishways for upstream and downstream passage at least ensure that these creatures can migrate again. However, this is a challenging task, especially in large rivers, since fish need to be able to find the entry to these facilities. Before we can offer an effective attraction flow, we need to understand how fish get their bearings in rivers.

ROMAN WEICHERT We are working together with scientists from BfG to gain an understanding of how fish behave in different flow conditions. One of the resources we use in our work is our experimental flume in Karlsruhe, which helps us work out important key principles for planning effective fishways for upstream passage.

Other uses of our water bodies also lead to conflict. How do you deal with that?

CORNELIA SCHÜTZ You're right. When it comes to weighing up different interests, I believe it's our job to give ecological issues a voice – one that's backed up by sound knowledge and expertise. When making concrete plans, it is often difficult to assert the benefits of ecologically intact aquatic ecosystems in the face of economically or socially relevant demands such as shipping, the use of hydropower or the discharge of treated effluent. Working with everybody involved to find sustainable solutions, including for future generations, is therefore a huge challenge, but it's a very motivating task, too.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The worlds of water are highly complex – but, together, we can understand them better

Working in interdisciplinary teams

Human actions have a wide-ranging impact on aquatic ecosystems. Although these effects are sometimes immediately obvious, in other cases, they only become apparent in the river catchment at some point in the future. Either way, analysing these impacts calls for comprehensive knowledge about runoff patterns, the aquatic structure, the substance pollution and its effects, and the diversity of species and habitats in both the body of water and the adjoining floodplains. BfG's staff cover a range of around 50 different academic disciplines. They pool their knowledge and find solutions to many issues by working across BfG's departments and divisions. Only in this way can topics be tackled with the required breadth and depth. However, our scientists do not only collaborate internally . They are also involved in various interdisciplinary teams externally, and they commission researchers in other institutions to carry out work, too. BfG is therefore closely linked to both the national and international scientific landscape. Our staff are also involved in many different national and international committees and working groups.

Becoming part of these teams

Our committed staff work all over Germany. Our decision on which aspects of the interface between people and the environment we address is based on the current issues faced by our target groups. Therefore, our staff can expect to be working on wide-ranging, highly varied tasks with a high level of responsibility right from the outset. Professional development, further training and a productive working atmosphere are particularly important to us.

Pulling together as a team

At BfG, excellent technical infrastructure and workplace resources that are specifically matched to the tasks at hand are key to delivering outstanding research results and effective advice. Our resources and infrastructure are the responsibility of our colleagues in administration and IT support, who purchase equipment and vehicles, fit out our laboratories with high-quality analytical instruments and supply the high-performance computers we need to run our models. Our HR team is also kept hard at work as we compete to attract the best brains. We offer flexible working hours as standard, and modern forms of working such as working from home are also possible.

Rivers are not bound by borders – and we work in international networks, too

Working for the United Nations

Many water systems cross borders, so it is only when many different countries work together that the responsible management of water – a valuable resource – can become a reality. UNESCO's International Centre for Water Resources and Global Change (ICWRGC) has been located at BfG since July 2014. Together with BfG, the ICWRGC runs the GEMS/Water Data Centre under the auspices of the United Nations Environment Programme. The Global Runoff Data Centre is also located at BfG. Furthermore, in 2022, the ICWRGC and BfG took over the long-term operation of the International Soil Moisture Network (ISMN) pilot developed by Vienna University of Technology (TU Wien).

Researching water resources and global change

The aim of the International Centre for Water Resources and Global Change is to estimate the impacts of global change on water resources. We also support international education and further training. The primary research focus is the worldwide availability and quality of water. To this end, the ICWRGC also supports UNESCO's Intergovernmental Hydrological Programme (IHP) and the Hydrology and Water Resources Programme (HWRP) of the World Meteorological Organization (WMO). The ICWRGC is one of 36 UNESCO Water Centres and is therefore networked with scientific partners and with operational hydrological services, data centres and other water-relevant UN organisations.

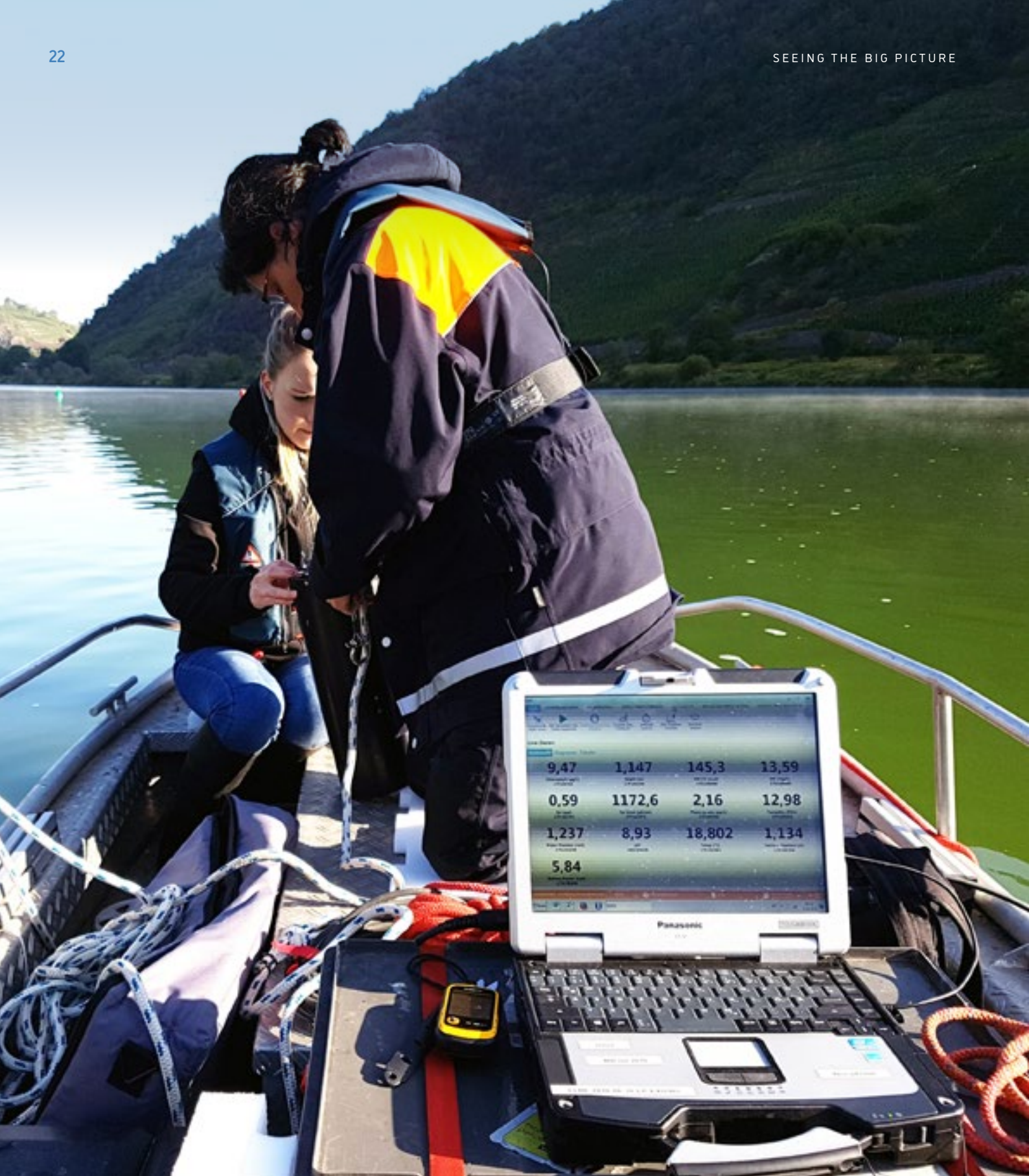
Collecting global data on runoff and water quality

Operating under the auspices of WMO, the Global Runoff Data Centre (GRDC) collects hydrological data from river basins all over the world. There are currently 10,000 stations in 160 countries providing runoff data that is stored in an ever-growing database, where it is available for the purposes of science, research and education. Depending on the gauging station, some of the global runoff data stretches back up to 200 years. The data is used for various purposes, including research into global change and as input data for the world water balance. As part of the Global Environment Monitoring System for Freshwater (GEMS/Water), which comes under the United Nations Environment Programme, the GEMS/Water Data Centre hosts the Global Freshwater Quality Database GEMStat, collecting data for more than 250 parameters from over 4,000 stations in more than 75 countries.

3

Factoring in climate change and the transformation of society

- USING CUTTING-EDGE TECHNOLOGIES.
- POOLING KNOWLEDGE.
- PROVIDING SUPPORT FOR DECISIONS.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Measuring and modelling water bodies – an excerpt

A wealth of data

How often do extreme events involving major rivers, the North Sea or the Baltic Sea occur? What causes these events – and are they early manifestations of climate change? Do processes related to waterway transport and water management need to be changed to account for climate change and, if so, in what way? In hydrology, we need data sets that go back a long way, cutting-edge observation methods, up-to-date measurement values and numerical models that let us look into the future – and not just in relation to extreme events. Before a hydraulic structure can be planned, for example, it is necessary to know the water levels and flow volumes it will have to withstand. Furthermore, we also need an extensive collection of data so we can evaluate the environmental impact of construction and maintenance measures on German federal waterways. Looking at the past helps us better understand and assess the processes of nature we have observed, while also enabling us to improve our models. This is why we use digital databases to store the diverse range of measurement data that we collect on an ongoing basis at fixed measuring stations or as part of special survey campaigns. Over the years, we have built up a wealth of knowledge and data in this way.

Monitoring the health of rivers and seas

River flows and currents continuously undergo both short-term and long-term changes – and the same is true of sea conditions, tides and sea levels. The extent of these changes can only be determined by using cutting-edge measurement technology. BfG provides the Federal Waterways and Shipping Administration (WSV) with support for choosing its survey design, maintaining its monitoring network and calculating measurement uncertainties. To give just two examples, we use radar sensors to measure swell in the North Sea and we conduct our own discharge and sediment transport measurements in our major rivers. However, extensive data is vital for other purposes, too. These include analysing the management of water volumes in canals and impounded areas of rivers under both present and future conditions, and examining the impact of rising sea levels on the management of transitional and coastal waters.

Models – using maths to understand aquatic ecosystems

Data collected from observations of nature, sampling, field measurements and laboratory tests is all ultimately fed into our numerical mathematical models. In these models, our scientists use mathematical equations to describe processes that take place in nature, e.g. physical, chemical and biological processes. Even if we can never replicate the full complexity of a river catchment with these models, they still help us estimate future developments, such as the effects that changes in land use or climate change will have on our rivers. The numerical calculation methods also help us analyse patterns of runoff, predict hydrological events and model the geomorphological development of a riverbed. We can also use special model components to calculate the spread of pollutants or effluent dispersion plumes, and their environmental effects. There are many more possible uses of models. They are suitable for investigating all issues that require a deep understanding of the aquatic ecosystems.

Extreme water levels call for a rethink

The many faces of rivers

A lack of rain, combined with high temperatures and high levels of evapotranspiration, can result in low water levels. Conversely, heavy precipitation and snow melt can lead to flooding, although the development and extent of this will vary, depending on the characteristics of the river and its catchment area. Over the centuries, natural buffer zones have been lost due to the construction of river embankments as areas of land have become populated. The straightening of watercourses results in faster flows in some sections and more pronounced flood waves. Residential areas close to rivers and industrial use can also increase vulnerability in former or active floodplains, resulting in high economic losses when, for example, dykes break or are overtopped.

Forecasting hydrological events

BfG produces transport-related water-level forecasts. Particularly in the case of extreme hydrological events such as low water levels, BfG supplies a comprehensive assessment of both the current and future situation on Germany's federal waterways to the Federal Waterways and Shipping Administration (WSV), the shipping industry, the scientific community, politicians and other stakeholders. We do this by simulating water levels, using data from more than 500 gauging stations provided by the WSV, weather forecasts supplied by Germany's National Meteorological Service (*Deutscher Wetterdienst* – DWD) and other meteorological services. Series of measurements dating back to 1727 also help us assess the current hydrological situation. This data enables us to investigate not only the frequency of such events, for example, but also changes in terms of substance pollution and the environmental effects that are to be expected. As we look to the future, it is clear that low-flow events may become more frequent due to climate change. This is why BfG scientists are already helping develop suitable precautionary measures.

The Federal Government and federal states working hand in hand

A well-coordinated, cross-regional risk management strategy can help mitigate the effects of flooding events. This is why, immediately after the devastating floods in the Elbe and Danube basins in June 2013, the Federal Government and federal states decided to draw up the German National Flood Protection Programme. This includes a set of cross-regional protective measures to be implemented as a matter of urgency. The aim is to combine these measures within a river basin in such a way that all riparian residents and businesses benefit from them. BfG offers an advice and modelling service for this purpose and is therefore able to answer questions about the cross-regional effectiveness of measures. BfG supplies essential foundations for efficient flood protection and the targeted allocation of resources, and supports the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) in its coordination role.

Estimating the impacts of climate change

Climate change is altering rivers

Scientific studies conducted by BfG show that the runoff patterns of major rivers are changing and that the tide levels on the coast are rising significantly. Our scientists carry out research into how frequently extreme events will occur in the future and how climate change is affecting our waterways. If extreme events become more common, this will also have an impact on shipping and infrastructure. For example, the economic vulnerability of our waterways becomes apparent when ships are no longer able to carry full loads – or cannot navigate at all – due to low-flow conditions. During flooding events, if certain defined thresholds are exceeded, shipping may even have to be stopped temporarily due to insufficient bridge clearance height or the risk that the wave action caused by ships will damage riverbanks and dykes. This is why we are already looking at adaptation options that are needed to address these challenges. In recent years, we have therefore created a solid foundation that can be used for making investment decisions in relation to Germany's federal waterways.

Modelling climate impacts

Various models have been methodically linked up in a model chain, making it possible to estimate how climate change will impact the regional water balance in the future. In this modelling work, our scientists consider a whole host of factors, including runoff, hydrodynamics, morphodynamics, water temperature and important environmental parameters. Even changes in ship operating costs are factored into the calculation. Since different developments are possible, calculations are performed for a variety of climate scenarios, thus producing a whole range of results. Despite modelling uncertainties, the projections suggest that there will be an increase in extreme events, especially in the second half of the 21st century, and that we will see a faster rise in sea levels if no adaptation measures are implemented. This has potential implications for maritime and inland navigation and the associated logistics chains, as well as for water quality, the creatures that live in our water bodies, power plant cooling and many other aspects of water management. Improved forecasting systems, a climate advisory service as part of the German Strategy for Adaptation to Climate Change in relation to water-related issues and proposals for anticipatory adaptation are the first steps that will enable us to continue using our aquatic ecosystems, even under changed climate conditions.

Adapting transport infrastructure and designing it to be environmentally friendly

To leverage synergies, BfG has also joined forces with other departmental research institutes to set up the interdisciplinary 'BMDV Network of Experts'. The aim of this network is to pool innovative knowledge and methods and make them available to political decision-makers and those responsible for maintaining our roads, railways and waterways. The findings produced by this collective research help provide guidance to the relevant transport operators. BfG is working on climate impact analyses that span different modes of transport, for example. The aim of these analyses is to reveal potential threats and stresses across the whole of Germany's transport infrastructure and make it possible to compare them.

Dirk Engelbart
Federal Ministry for Digital and Transport (BMDV)

3 questions for...

Mr Engelbart, as a head of division in the Federal Ministry for Digital and Transport (BMDV), you are responsible for the areas of environmental protection of Germany's federal waterways and adaptation to climate change. At the same time, you have a specialist supervisory role in relation to BfG. How does this collaboration work?

DIRK ENGELBART As a ministry, we approach BfG when we need information. BfG helps us answer parliamentary questions, for example. BfG also draws on its specialist expertise to advise us about draft legislation and regulations relating to water – as a specialist division of the ministry, it is our job to review and help shape these. We then incorporate this input into the coordination that takes place between various government departments. We value BfG's scientific expertise in relation to further developing water level forecasting, for example, or contributing to the German Strategy for Adaptation to Climate Change (DAS). Scientific policy advice provides the foundations upon which sound political decisions are made.

How does the advice side of things work?

The BfG scientists draw on their specialist expertise to look ahead and identify social trends, global challenges and the impact these will have on our aquatic ecosystems. They draw up well-founded technical statements and incorporate these into their policy advice. These statements are available to the BMDV and, as required, can also be actioned by the Federal Waterways and Shipping Administration in its role as manager of our waterways.

Can you give us an example?

One of the things the BfG scientists are working on is the impact that dissolved substances in our water bodies have on plants and animals. They are searching for pollutants that are still currently unknown and their possible sources. If you think about building materials or transport-related emissions such as small particle pollution from tyre and brake wear, it makes sense to consider additional modes of transport such as our roads and railways. This is why BfG also contributes its expertise to the BMDV Network of Experts – so it can work in collaboration with other BMDV authorities to develop joint solutions such as a database of environmentally friendly building materials. This kind of input provides the BMDV with a valuable basis for making decisions about future investments and changes that need to be made in relation to the operation of infrastructure.

Sustainable sediment management

Always enough water under the keel

To navigate a ship safely, you need to be able to count on the navigation channel being deep enough. However, rivers are constantly shifting large quantities of particulate matter downstream. This results in 'subaqueous dunes' of various sizes that are constantly moving. In contrast, sediment accumulates in sections with a weaker flow. When shipping is affected by these processes, the Federal Waterways and Shipping Administration(WSV) implements sediment management to ensure vessels can navigate freely. This sometimes involves adding gravel and sand to eroded sections of the riverbed, or even fixing the riverbed locally at a set level when needed. The sea also deposits large volumes of silt and sand in estuarine areas of major rivers. This can also have a negative impact on navigation, so dredgers need to shift or remove sediment here, too. Each year in Germany, dredgers shift some 45 million cubic metres of sediment – much of it in coastal areas.

Sediment – the river's memory

Riverbed sediment is a habitat for organisms, and the fine-grained components are particularly rich in nutrients. However, the specific properties of these fine-grained components also mean they are perfect for transporting contaminants. Although many of these contaminants may have entered the water in the past, they can still be a source of pollution decades later. In such cases, disturbing the polluted sediment poses risks to a river's biotic community – both locally and downstream.

Sediment analysis and modelling

Cutting-edge sediment management takes all relevant processes into account. We support the WSV in this complex task so they can implement measures as gently as possible. Our experts advise the WSV about different measurement methods. In addition, we collect in situ sediment samples and then analyse their composition. By using numerical models and applying our specialist expertise, we can ultimately forecast the impact of planned measures on water bodies and the environment. If we add further data to our models, we can also estimate the consequences of a land use change in the catchment area or the impact of climate changes on the sediment budget, and put adaptation options to the test.

Observing rivers and coastal waters with a bird's eye view

Determining water quality and other parameters remotely

Satellite data can be used to observe certain water quality parameters. Microscopically small particles contribute to the turbidity of inland water bodies, and satellites enable us to see this effect and measure it. Remote sensing can also be used to supply additional valuable data about large areas. This includes information about chlorophyll content, aquatic structure, and flooding and low-flow situations, for example, as well as soil moisture in catchments and vegetation on coasts and floodplains. Since data related to water bodies is generally required in a high spatial resolution, measurements taken from aeroplanes or by smaller, remote-controlled systems are used in addition to satellite data. It is usually the combination of remote sensing data, in situ measurements and numerical mathematical models that provides the overall big picture required. BfG develops suitable methods and advises on the possible uses of remote sensing. It is also part of the network of experts in Copernicus, the Earth observation component of the European Union's Space Programme.

Remote sensing for monitoring oil in the North Sea and Baltic Sea

Oil contamination pollutes marine ecosystems – and it is not only major tanker disasters that cause serious environmental damage. Smaller incidents also add up and play a part in this. This is why Germany, within the scope of international agreements, has undertaken to continuously monitor the German North Sea and Baltic Sea exclusive economic zones. Two aeroplanes and a European satellite service are used for this purpose and in the event of a ship disaster. BfG advises the Central Command for Maritime Emergencies (*Havariekommando*) and the Federal Ministry for Digital and Transport (BMDV) on the aeroplanes' sensor systems and the further development of these, and about remote sensing in general. Other BfG scientists form part of a group of environmental experts that advises the Central Command for Maritime Emergencies.

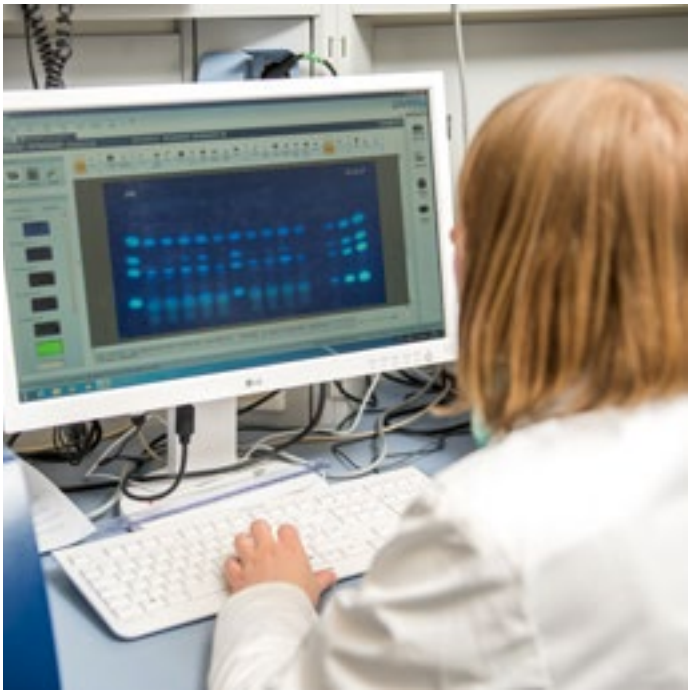
Surveying bodies of water

Precise surveys of riverbeds are vital for safeguarding transport, detecting underwater obstructions , maintaining the riverbed, expanding waterways and determining discharge quantities. The Federal Waterways and Shipping Administration (WSV) uses an echo sounder to conduct surveys of this kind on a regular basis, since sediment in the bed is constantly being moved by the flowing water. Unmanned drones equipped with laser measurement systems are also flown over foreshore areas to record the structure of these. Every recording generates huge volumes of data, and we develop analysis algorithms for the WSV so it can further process this data. We also implement the WSV's height reference system along Germany's federal waterways and link this to higher-level national or European reference systems. This is the only way in which water levels measured at different monitoring stations can be compared and changes in sea levels can be precisely determined. The geometry of hydraulic structures is also monitored on a regular basis to ensure the transport infrastructure remains in good working order. For all these areas of application, we test and optimise measurement systems and processes, and advise the WSV on technical concepts.

4

Minimising the input of substances

- MONITORING BODIES OF WATER.
- ASSESSING RISKS.
- MAKING PROTECTION POSSIBLE.



Chemistry and ecotoxicology labs – tracking substances and impacts

Substances in rivers and other water bodies

Water is the elixir of life for people and nature alike. Despite improvements to the performance of wastewater treatment plants, treated effluent is still a significant point source of pollution by heavy metals, organic contaminants, nutrients, active pharmaceutical substances and other inputs. Many of these substances also get into our rivers as a result of diffuse pollution. Examples include air-borne pollution, contamination via precipitation and substances from mining, traffic areas, residential areas and agriculture. For instance, large quantities of nitrogen and phosphorus compounds are released into bodies of water via manure and mineral fertilisers. However, crop protection products and pesticides also pose a threat to rivers, when either the products themselves or their degradation products get into the water. Many of these substances accumulate in suspended matter and sediment, and are a problem for the ecosystem.

Studying water, suspended matter and sediment

When maintenance and development measures are being carried out on the federal waterways, we conduct chemical and ecotoxicological analyses so that these measures can be properly evaluated. For example, we analyse contaminants in sediment and dredged material and the biological effects of these substances, drawing on our extensive experience and using the innovative analytical technology available to us at BfG. This enables us to reliably detect even substances that are present in the water in very small concentrations only. Biotests are used not only to record the acute toxicity of sediment and dredged material, but also to identify chronic damage to the genetic material and endocrine and immune systems of aquatic organisms. While uncontaminated dredged material can be moved and therefore remain in the water, contaminated sediment needs to be disposed of at landfill sites in what is usually a costly process.

Measuring known and unknown substances

As part of the measurement programme for monitoring substances in cross-border rivers and coastal waters, we regularly conduct water, sediment and suspended matter measurements for the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV). Over the years, we have noted that not only are new substances constantly being released into our waters, but also that the transformation products formed during the degradation process sometimes have very different properties and that these can even be toxic. Innovative concepts for monitoring water bodies therefore detect not only known but also unknown pollutants. This new process – known as non-target analysis – makes it possible to also detect unknown substances and to identify their input sources. This enables our scientists to draw important conclusions about substance pollution in a river catchment, propose suitable measures for minimising the input of these substances, and estimate potential risks.

Environmentally friendly building materials of the present and future

The materials that make hydraulic engineering

When it comes to maintaining and developing the federal waterways, many different building materials are used. These range from concrete, bricks and armour stones to soil-like materials such as gravel and sand, and all the way through to pillars made of steel and other metals. Other materials are used, too, such as sealing materials made from bitumen and plastics, various coatings and geotextiles to protect stream banks and coastal shores. The water constantly 'eats away' at the surface of these building materials, and both inorganic and organic substances are released into the water as a result of abrasion, corrosion and dissolution processes.

Measuring emissions in the lab

It is vital to ensure that every building phase on our federal waterways – building a new structure, for example, or maintaining or dismantling an existing one – is environmentally sustainable. It is also important to ensure that the structure will remain in use for as long as possible. The BfG experts start by examining the potential emissions of the individual building materials. For example, this might involve immersing building materials or coated steel plates in water in the lab for several weeks and then analysing this water for substances that have been released. Since the additives used in these materials are often made up of complex mixtures of substances, and degradation products that are still unknown are sometimes formed by the original materials, we also use non-target analysis to study the water. Given that most building materials are used for different modes of transport, the results can often be applied to railway and road construction work, too. Tests are therefore also performed in close collaboration with the German Federal Railway Authority (EBA) and Federal Highway Research Institute (BASt).

Conducting modelling and field studies

In addition to the building material properties identified in the lab, there are other factors that play an important role – exposure, the specific construction method and environmental effects on the structure. Our staff therefore also conduct modelling and field studies in close collaboration with the Federal Waterways Engineering and Research Institute (BAW). It is only thanks to this collaboration that they can make well-founded statements about the useful life of building products, the emission of substances and the ecotoxicological effects of these. Expert reports about the release of substances contained in building materials, assessments of the mobility of these substances in the environment, and concepts for disposing of rubble all provide the WSV with practical assistance. Finally, we use random sampling to measure noise produced by ships and emissions released into the air and compile expert reports on these issues.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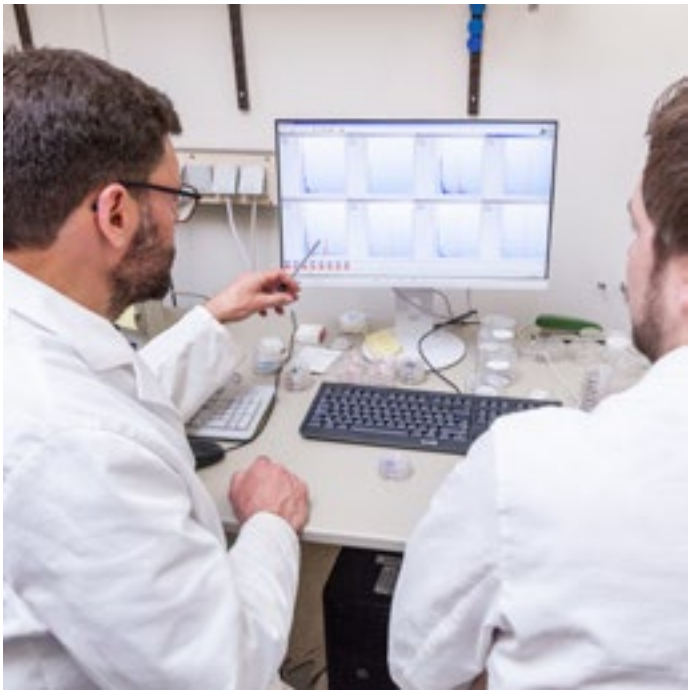


Radiological monitoring of water bodies – a sovereign function

A focus that extends beyond the federal waterways

The radioactive substances contained in our water bodies come from natural cosmic and terrestrial radiation and from anthropogenic sources. Considerable quantities of artificial radionuclides were released into the atmosphere and, therefore, into the environment by the above-ground nuclear weapon tests in the 1950s and 1960s and following the Chernobyl reactor disaster in 1986. When the Federal Republic of Germany signed the EURATOM Treaty in 1957, it became legally obliged, for the first time, to monitor radioactivity in the environment. We have been performing this official state task for the sediments, suspended matter and surface water of Germany's federal waterways since 1958. In addition, in our role as a federal coordinating office, we also assess the federal states' measurement results from their inland water monitoring activities.

Measuring in bodies of water and in the lab

To this end and on the basis of the German Radiation Protection Act (*Strahlenschutzgesetz*), BfG, in collaboration with the Federal Waterways and Shipping Administration (WSV), operates and maintains 40 radiological monitoring stations on Germany's federal waterways, two radiochemical labs and a monitoring network centre in Koblenz. The measurement values are transmitted to Koblenz on a continuous basis. Automatic samplers at the monitoring stations also collect samples of water and suspended matter for laboratory measurements. If certain thresholds are exceeded at a monitoring station, this immediately triggers an alarm at the monitoring network centre. If necessary, further steps are taken straight away. We assess all the data and transmit it to the Federal Government's Integrated Measuring and Information System for the Surveillance of Environmental Radioactivity at the Federal Office for Radiation Protection (BfS).

Keeping an eye on the spread of contaminants

BfG also operates computer-aided models to forecast the spatial and temporal spread of radioactive and water-soluble contaminants in the federal waterways in the event of a nuclear incident. This involves conducting experiments with the trace substance tritium, for example. Tritium is formed naturally in the stratosphere, but is also released into the environment as a result of authorised emissions from nuclear power stations. BfG experts can track water that contains tritium as a radioactive tracer over long distances and check and further develop their models accordingly. We also use other natural radioactive and non-radioactive tracers to address hydrogeological questions, including in relation to groundwater.

Plastic in rivers – what action do we need to take?

Plastic in rivers and oceans

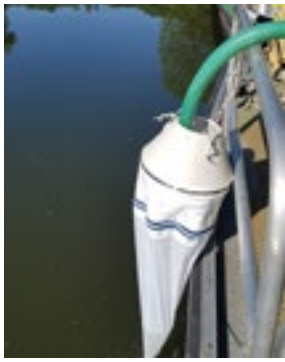
Every year, society generates vast quantities of plastic waste – the worldwide figure for 2018 alone was 359 million metric tons. Some of the plastic waste that ends up in the sea creates gigantic garbage patches comprising floating plastic debris. However, our watercourses also contain many plastic particles, both large and small, that are formed as a result of the decomposition of discarded macroplastics, such as plastic bottles or bags, or from other sources. Equally, some microplastics that are deliberately manufactured in a microscopic size for use in cosmetics or laundry detergents, for example, are contained in the effluent that is released into our rivers. Our water bodies also contain particles originating from the natural wear process that affects tyres and shoes, for example, and by the washing of synthetic fibres. Ultimately, it is rivers that transport a large proportion of plastic debris into coastal waters in the first place.

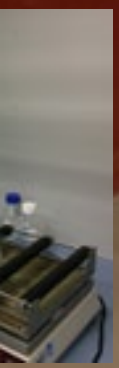
Small particles cause big problems

Microplastics – plastic particles with a diameter of less than five millimetres – can have a detrimental impact on the food intake, physiological fitness and capabilities of animals that live in water or on land. As plastic decomposes, it can also release toxic substances and endocrine-disrupting chemicals into river waters. Whether environmental chemicals from the water attach themselves to microplastic particles and are later released again inside the organism's body is a subject of controversy. There is also concern that the consumption of invertebrates and small fish might be causing microplastics and similar products to get into the human food chain. Researchers also believe it possible that nanoparticles may be able to penetrate tissue – in other words, that they can be absorbed by cells and thus accumulate in the body.

Closing gaps in research

With the support of funding from the BMDV, the German Environment Agency (UBA), the BMBF and other external sources, BfG carries out intensive research into microplastics in inland waters and sediments. Various sampling concepts and analytical detection methods have already been developed. There is good reason for this – to date, there has been very little research to investigate the questions of what quantities of plastic particles are getting into our rivers and, ultimately, the marine environment, and by what routes. How these plastic particles spread in the water and how quickly they break down into microparticles is largely unknown, too. If we can advance our knowledge in this area, we will be able to identify the associated risks for both the river habitat and people. Using sediment deposits from the Rhine, BfG scientists want to find out a number of things, including how pollution has changed over the years. After all, one thing is clear – it was only in the 1950s that mass production of plastics really got going.





Heide Jekel
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV)

3 questions for...

Ms Jekel, at the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection, you are head of the Cooperation in International River Basins, Freshwater Management Conventions and International Freshwater Protection Law division. How are the two worlds of the BMUV and BfG linked?

HEIDE JEKEL BfG and the BMUV are linked by a long history of successful collaboration. After all, there's a large amount of overlap in the areas we focus on, such as aquatic chemistry and aquatic ecology. Originally, our collaboration centred around monitoring major rivers that also serve as waterways, such as the Rhine and the Elbe.

And now?

The collaboration between the BMUV and BfG has developed significantly, partly as a result of the EU Water Framework Directive and other EU directives relating to water, such as the Marine Strategy Framework Directive. Many experts from BfG are working tirelessly on behalf of the BMUV on a wide range of topics within the context of international river basin commissions, such as those set up to protect the Elbe and Oder Rivers. In some cases, these experts also head up working groups in these commissions. For example, BfG chairs the chemical monitoring expert group within the International Commission for the Protection of the Rhine. This demonstrates that BfG's expertise is greatly valued both nationally and internationally.

Can you give us a few examples?

One example is that BfG takes care of electronic reporting to the European Commission for us. This reporting is a requirement of water-related directives, and the 'WasserBLIcK' platform that was set up for this purpose has been proving successful for years now. However, to give you another example, BfG is providing the BMUV with support in implementing the German National Flood Protection Programme. What's more, BfG scientists are developing new analytical methods for detecting microplastics and new substances. They are also studying the ways in which these sorts of pollutants get into the sea via rivers and conducting research into the effects that these kinds of micropollutants, such as pharmaceutical residues, have on river and marine organisms. We particularly appreciate the applied research approach of BfG's work.

5

Promoting biodiversity

- RECORDING DIVERSITY.
- IDENTIFYING INFLUENCES.
- DESCRIBING IMPACTS.

River and coastal ecosystems – closely interlinked and rich in species

River and floodplain systems provide a multitude of ecosystem services

Our watercourses and remaining active floodplains are some of the most species-rich ecosystems in Central Europe. They offer many migratory birds a place to rest and landmarks that help them navigate, and also provide a habitat for a large number of highly specialised animals and plants. The reason for this diversity is changing water levels and small-scale differences between sites. However, intact river floodplains do even more – they remove excess nutrients from the water and help break down contaminants. In addition, due to high levels of evapotranspiration and thus cooling, they also create a favourable local climate. They store large quantities of water and are therefore highly significant in terms of flood protection. Floodplain forests and soils also store enormous quantities of carbon and thus play a part in climate protection. What's more, river landscapes provide people with space that is important for health, leisure and recreation. However, as floodplains are increasingly used for residential areas and agriculture, it is becoming more and more difficult for them to deliver these services.

Exposed to human intervention

Estuaries – the major river transitional areas between freshwater and marine habitats – also constitute valuable ecosystems of international significance. These transitional waters and adjoining coastal waters are highly important for protecting biological diversity, and yet they also serve as access routes to major German seaports. Similarly to the river and floodplain landscapes, there is a risk of conflicts of use here, too. Nutrients and crop protection products pollute the aquatic ecosystems, while engineering interventions alter the stream channel or even the entire water body – and suddenly whole ecosystems come under threat. This is why BfG considers the sustainable development of Germany's marine and inland waterways, banks and floodplains to be a key objective.

Assessing the ecological impact of planned measures

To protect ecosystems successfully, our experts must be able to decode the processes and interactions between rivers and floodplains and in the transitional areas between freshwater and salt water and map these as precisely as possible. To gain a better systemic understanding, they research water and substance transport processes, as well as the metabolic processes of bacteria, algae and zooplankton. Their work includes other activities, too, such as taking robust inventories of fish, amphibians, benthic macroinvertebrates, aquatic plants, and floodplain and coastal vegetation. This data, along with hydrological parameters, is incorporated into the further development of our floodplain and water quality models. These models can then be used to generate forecasts about the ecological impacts of river development or climate scenarios.

Ensuring rivers achieve a good ecological status

Water quality and the EU Water Framework Directive

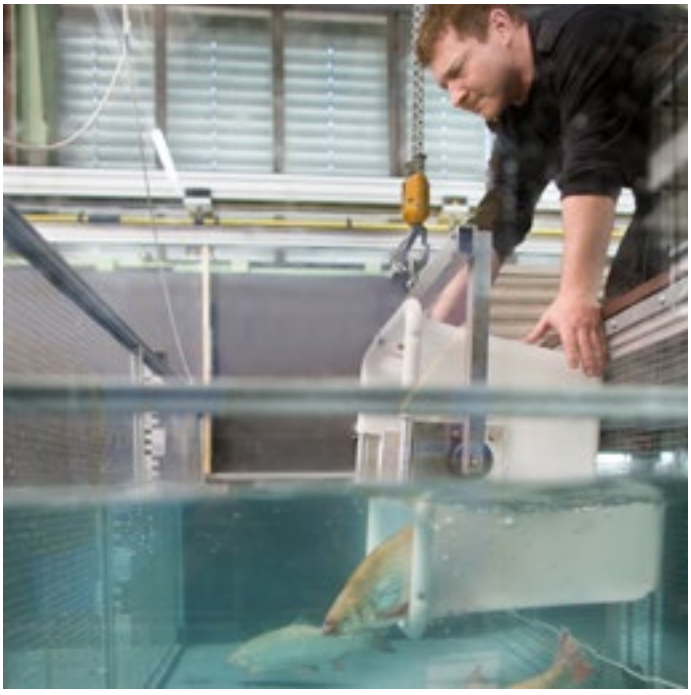
Although significant improvements have been made to water quality in recent decades, many rivers in Germany still fall short of the good ecological status that the EU Water Framework Directive (WFD) demands. The key reasons for this are pollution by nutrients and pollutants on the one hand and an aquatic structure that is heavily modified as compared to its natural status on the other. However, only surface waters that have a good status can be used sustainably and deliver their wide-ranging ecosystem services. The German federal states are responsible for implementing the WFD. Our experts support them in creating and updating management plans and programmes of measures relating to Germany's federal waterways. We also advise the federal state authorities and the Federal Waterways and Shipping Administration (WSV) on the implementation of these measures. We cooperate with the joint German Working Group on water issues of the Federal States and the Federal Government (LAWA) and also offer the federal states technical support, e.g. for developing and operating the national data and reporting portal for water ('Wasser-DE', 'WasserBLIcK').

Surface waters are dynamic systems

Runoff, erosion and sedimentation shape our river landscapes. Consequently, if watercourses are to be managed in an ecologically sound way, then the priority must be to protect the very processes that characterise them. After all, only a natural dynamic of its own over a sufficiently large area and the formation of structures that are characteristic of the river in question will encourage the return of plant and animal species that are typical for a specific site and thus result in high levels of biodiversity. When it comes to water quality, the oxygen balance is an important factor, and this is determined to a large extent by the bacteria, animals and plants that live in the water and sediment. A high nutrient input into the river can lead to the overgrowth of algae. As bacteria and fungi break down dead material, the oxygen content of the water decreases. It is only when the anthropogenic input of nutrients has been successfully reduced and the organisms that are typical of the site have returned that the surface water can be certified as being of good quality.

Flora and fauna as surface water status indicators

The ecological status of a surface water section can be assessed based on its benthic macroinvertebrates, that is the invertebrate community living on the riverbed, such as worms, mussels, snails, crustaceans and insect larvae. Other important indicators in this respect are fish, macrophytes (i.e. aquatic plants that are visible to the naked eye) and the phytobenthos (algae living on the surface of the sediment). Phytoplankton – in other words, algae that float freely in the water – are another important indicator. Taking an inventory can be a good way of helping to review biodiversity targets. Since organisms are still primarily identified in conventional ways, based on their morphological characteristics, a microscope and literature have so far been the tools of choice. In the future, the time-consuming identification and counting processes conducted on site will be supported by DNA tests.



Creating ecological connectivity and linking habitats

Creating longitudinal connectivity

Our river systems connect different sub-habitats with each other – not only cut-off meanders and floodplains, but also freshwater and salt water biotopes. Transversal structures such as barrages, weirs and hydropower plants disrupt the movement of river sediment along waterways. Additionally, they restrict the migration of small organisms and fish. In particular, fish species such as salmon, sea trout and eel migrate between the upper reaches of rivers and the sea during their lifetime. This is the only way they can travel to their feeding areas or their typical spawning grounds to reproduce. If they are prevented from doing so, their numbers decline sharply, as has been observed in German waterways over the past hundred years. The EU Water Framework Directive (WFD) therefore requires authorities to restore the connectivity of watercourses for fish, small invertebrates and river sediment.

Overcoming barriers

River landscapes and their various uses have adjusted to the water levels that have been prevalent for many years. Although dismantling transversal structures would be the preferred option in terms of the ecology of the watercourse, this is not easily possible in most cases. Consequently, it is vital to at least make provision for fish migration at transversal structures. It is only by creating a network of interconnected federal waterways that large parts of Germany's entire aquatic system can be made accessible to migratory fish again. However, an initial inventory has shown that, in Germany's federal waterways alone, there are around 250 hydraulic structures impeding the way. Even though fishways are constructed to help fish make their way upstream, there are generally no effective measures in place to help them return safely downstream. The downstream route carries major risks, since complex flow situations sometimes result in fish going over weirs or even through power plants. If these do not have adequate protections for fish in place , there is a major risk that the fish will be injured in the turbines. Our research scientists are therefore working on suitable solutions to ensure fish can migrate both upstream and downstream. The current within and around the fish and their structural design must be suitable for both large fish and species that are weaker swimmers. Since fish behave differently depending on whether they are migrating upstream or downstream, facilities designed for upstream passage are usually unsuitable for downstream passage.

A functioning fishway for upstream migration requires careful planning

Solutions for fish migrating upstream are more common than for fish migrating downstream. There are two aspects to be considered – how easy a fishway is for fish to navigate and how easy it is for fish to find it in the first place. The transversal structures in Germany's federal waterways are often extremely wide, with hydropower plants attached to them. Since fish are guided by the current, upstream fish passage structures are built in the area where the current is strongest. To help the fish find the entrance to the fishway, it is also vital to create an attraction flow that is stronger than the competing flow produced by the power plant. Rest zones are also built into the fishway to let the fish recover their strength for the next stage of the strenuous upstream journey. Biologists from BfG and hydraulic engineers from the Federal Waterways Engineering and Research Institute (BAW) work hand in hand to plan upstream fish passes that are efficient from a fish ecology perspective. Together, they conduct behavioural experiments with fish, both in the lab and out in the open, to determine how easy it is for fish to find a fishway. With the help of models, they also combine biological knowledge with hydraulic options. Finally, they develop techniques for the automated and standardised recording of migrating fish so they can subsequently review how well the fishways are working. Together, experts from both institutes thus support the Federal Waterways and Shipping Administration (WSV), which has had a legal obligation to create ecological connectivity at transversal structures on Germany's federal waterways since 2010.

A biotope network of national importance – 'Germany's Blue Belt'

Connecting biotopes across Germany

Most of the original floodplains in Germany are no longer flooded at high water due to the historical construction of river embankments. Only 10% of active floodplains can be considered near-natural, since the natural aquatic structure is missing from many waterways. It is for this reason that particularly the federal waterways that are very rarely used for transport purposes are now to be restored to their natural state. There are also plans to establish ecological stepping stones along major rivers. As part of this approach, river landscapes are once again to be regarded as a whole instead of being viewed as separate components – watercourse channel, bank and floodplain. This is the basic principle of 'Germany's Blue Belt' programme that was introduced by the Federal Government in February 2017. Under this scheme, the BMDV and BMUV joined forces to create a biotope network in which the waterways and other watercourses are connected both to one another and to coastal waters.

Restoring ecologically functional river landscapes

The development of rivers and floodplains is to be returned to as natural a state as possible, so that they are populated by the animals and plants typical for the location. Weirs that are no longer used are to be dismantled where possible, and near-natural aquatic and floodplain structures restored. The Federal Government has plans to invest up to 60 million euros per year into the programme for the next 30 years. The Federal Government, federal states, municipalities and associations will work closely together. BfG will provide the partners in the programme with specialist and conceptual advice, such as in regard to the way river reaches should be designed for the national biotope network. Renaturation measures are never planned in isolation – instead, they are always planned in conjunction with the predominant functions and uses and, wherever possible, implemented as part of a joint effort by all parties involved.

Restoring rivers to their natural state

Some modelling projects in which we are involved have already been launched, including at the Rhine and Weser Rivers. The aim of these projects is to explore various implementation options, and they involve measures to improve the structure in the river profile, the riverbank zones, at existing bodies of standing water and in the adjacent floodplains. Whether or not a measure is sustainable and successful will only become evident in the long term. This is why we carry out comprehensive monitoring of the hydromorphological effects and the return of animal and plant species that are typical for a specific location. As our understanding improves, this knowledge is incorporated into the ongoing development of the biotope network. Future measures could include re-watering habitats and transforming areas that have been intensively farmed into natural refuges.

Andreas Schöl
Federal Institute of Hydrology (BfG)

3 questions for...

Mr Schöl, what is it about ecology that fascinates you so much?

ANDREAS SCHÖL I am particularly fascinated by the processes, correlations and interactions between living things, water and the climate. Everything comes together in ecology, and it's the big picture that counts. To be able to describe the interplay between the different environmental compartments in scientific terms, I first need to work out which processes are particularly important and how they interact with one another. We do this by developing ecological models. In these models, we construct certain correlations in the environment and map these in a simplified form by using rules and mathematical equations.

Which problems do you specifically solve with these kinds of models?

One example involves algae in the middle reaches of the River Elbe. The water there is shallow, so a lot of light can penetrate, resulting in large algal blooms during the summer months. Due to the river current, the algae ultimately end up in the much deeper areas of the Port of Hamburg. The algae die there, because there is much less light at those depths, especially where there's a lot of suspended matter, too. Small crustaceans also eat the algae. Bacteria break down the crustaceans' faecal matter and the dead algae, which uses up dissolved oxygen in the water. As a result, large oxygen holes form in the tidally influenced area of the Elbe. We can use water quality models to simulate and quantify these processes, and thus propose measures to avert this risk.

What do you particularly like about your work at BfG?

Personally, I really enjoy working with our mathematical models. I also see a major benefit for society in this work – our natural resources can be managed sustainably with the help of our tools. Our aim is always to identify reasons behind a poor status, so what we do helps rectify undesirable developments. Of course, I also appreciate having the opportunity to work directly out in the field. The Federal Waterways and Shipping Administration helps us in this wherever it can. It provides us with boats for our work out on the water, and also looks after our measuring stations when we can't be on site .

Sources

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Address Am Mainzer Tor 1
56068 Koblenz, Germany
Phone +49 261 1306-0
Fax +49 261 1306-5302
Email presse@bafg.de
Website https://www.bafg.de/EN

Coordination, content and design concept, text and picture editing and implementation
Melanie Schulz
Susanne Schäfer
Dr Martin Labadz
Technical direction
Dr Sebastian Kofalk
Susanne Schäfer
Technical editing
Dr Anna-Dorothea Ebner von Eschenbach
Dagmar Kronsbein
Dr Daniel Schwandt
Volker Hüsing

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BfG Federal Institute of Hydrology

BfG at a glance

As the German Federal Government's scientific institute specialising in hydrology, water use, water quality, ecology and the protection of aquatic ecosystems, we work on long-term issues and urgent recommendations for the Federal Ministry for Digital and Transport (BMDV), the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and other ministries. As a departmental research institute, we support the near-natural and, at the same time, efficient development of the waterways for a variety of functions within society – transport, the environment, water management, and leisure and recreation. Working together with the Waterways and Shipping Administration (WSV) and the German federal states, our aim for the coming years is to expand the scientific principles for the integrative, sustainable development of the waterways and put these into practice. Since 2011, the Scientific Advisory Board has provided quality assurance support for the strategic direction of our research.

Interdisciplinary collaboration

We employ scientists from more than 50 specialist disciplines in our laboratories and research centres who work in three divisions, subdivided into 13 departments. Key areas of focus include the natural sciences of biology, chemistry, hydrology and geosciences. In total, we have more than 450 employees from a wide range of disciplines. We also play a part in fostering up-and-coming scientific talent (internships, bachelor's and master's dissertations, doctorates) and provide training in a range of professions.

International networking

Three international units are also located within BfG. In July 2014, the International Centre for Water Resources and Global Change (ICWRGC), which was set up by the German Federal Government under the auspices of UNESCO, started its work in Koblenz. UNESCO water centres combine expertise in individual countries or regions, serving as international reference platforms for sharing knowledge and methods. A national committee is in charge of the German contribution to the UNESCO Intergovernmental Hydrological Programme (IHP) and the WMO Hydrology and Water Resources Programme (HWRP). The IHP/HWRP secretariat, which was integrated into the ICWRGC in Koblenz in 2014, manages both programmes. The Global Runoff Data Centre (GRDC) works under the auspices of the World Meteorological Organization (WMO).

Organisation chart

Division
Department

ICWRGC*
UNESCO Centre
IHP+HWRP**
GEMS/Water Data Centre

Director General of BfG
Dr Birgit Esser

C
Controlling, Public Relations

M
Quantitative Hydrology

- **M1** General Hydrological Issues, Hydrometry and Hydrophysics
- **M2** Water Balance, Forecasting and Predictions
- **M3** Fluvial Morphology, Sediment Dynamics and Management
- **M4** Geodata Center, WasserBLIcK, GRDC
- **M5** Geodesy and Remote Sensing

G
Qualitative Hydrology

- **G1** General Water Quality Issues
- **G2** Aquatic Chemistry
- **G3** Biochemistry, Ecotoxicology
- **G4** Radiology and Water Monitoring

U
Ecology

- **U1** General Ecological Issues, Environmental Protection
- **U2** Microbial Ecology
- **U3** Vegetation Studies, Landscape Management
- **U4** Animal Ecology

Z
Central Services

- **Z1** Organisation, Human Resources and Internal Services
- **Z2** Information Technology and Information Management
- **Z3** Legal Affairs, Budget and Public Procurement

* International Centre for Water Resources and Global Change
** Secretariat for the UNESCO IHP/ WMO HWRP National Committee chaired by the Federal Foreign Office