Federal Ministry
for the Environment, Nature Conservation,
Nuclear Safety and Consumer Protection

National Water Strategy

Cabinet decision of 15 March 2023

nationale
WASSERSTRATEGIE

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List of abbreviations

AbfKlärV	Sewage Sludge Ordinance (Klärschlammverordnung)
AbwAG	Waste Water Charges Act (Abwasserabgabengesetz)
AbwV	Waste Water Ordinance (Abwasserverordnung)
AwSV	Ordinance on installations for handling substances hazardous to water (Verordnung über Anlagen zum Umgang mit wassergefährdenden Stoffen)
BAT	Best available techniques
BBodSchG	Federal Soil Protection Act (Bundes-Bodenschutzgesetz)
BfG	Federal Institute of Hydrology (Bundesanstalt für Gewässerkunde)
BLE	Federal Office for Agriculture and Food (Bundesamt für Landwirtschaft und Ernährung)
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz)
BZfE	Federal Centre for Nutrition (Bundeszentrum für Ernährung)
BZL	Federal Information Centre for Agriculture (Bundesinformationszentrum Landwirtschaft)
CO_2	Carbon dioxide
DART 2020 and 2030	German Antibiotics Resistance Strategy (Deutsche Antibiotika-Resistenzstrategie)
DAS	German Strategy for Adaptation to Climate Change (Deutsche Anpassungsstrategie an den Klimawandel)
EU	European Union
GAK	Joint Task of Improving Agricultural Structures and Coastal Protection between the federal government and federal states
GHG	Greenhouse gases
HELCOM	Baltic Marine Environment Protection Commission (Helsinki Commission
LAWA	Working group on water issues of the federal government and the federal states (Bund/ Länder-Arbeitsgemeinschaft Wasser)
NHWSP	National Flood Protection Programme (Nationales Hochwasserschutzprogramm)
OECD	Organisation for Economic Co-operation and Development
OSPAR	OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic
OGewV	Ordinance for the Protection of Surface Waters (Oberflächengewässerverordnung)
OZG	Online Access Act (Onlinezugangsgesetz)

PAHs	Polycyclic aromatic hydrocarbons
PFASs	Per- and polyfluoroalkyl substances
RAS-Ew	Guidelines for the Design of Roads – Drainage (Richtlinien für die Anlage von Straßen – Teil Entwässerung)
RCP8.5 scenario	Representative concentration pathway scenario 8.5
RiStWag	Guidelines for Structural Engineering Measures on Roads in Water Protection Areas (Richtlinien für bautechnische Maßnahmen an Straßen in Wasserschutzgebieten)
SDG	Sustainable Development Goal
TN	Total nitrogen
TP	Total phosphorus
UBA	Federal Environment Agency (Umweltbundesamt)
UN	United Nations
UNEP	United Nations Environment Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNOPS	United Nations Office for Project Services
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
WASH	Water, sanitation and hygiene
WFP	UN World Food Programme
WHG	Federal Water Act (Wasserhaushaltsgesetz)
WMO	World Meteorological Organization

I. Motivation for and foundations of the National Water Strategy

I. 1. Why do we need a National Water Strategy?

Water is the basis for all life. Springs, streams, rivers, lakes, groundwater, wetlands, seas and oceans provide habitats for a wide variety of plants and animals. Access to clean drinking water is also a human right. Water is therefore not a typical commercial product; it is a public resource that has to be protected and treated with care. We need water for our food supply (including food production) and use it for our daily hygiene, as a source of energy, an input material for production and a means of transport as well as for industry and agriculture and for recreation and tourism. The water sector (water supply, wastewater disposal) is part of Germany's critical infrastructure.

In Germany, we are accustomed to having enough high-quality water available whenever we need it. But water as a resource is also increasingly exposed to hazards. These are caused in part by the climate crisis, which is having a widespread impact on the water regime, albeit with regional differences. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) shows that a temperature increase of just 1.1°C would have negative impacts (e.g. extreme events) resulting in losses and damage for nature and people. Climate scenarios predict further increases in temperatures and changes in precipitation patterns. As to how this will impact on the water regime, precautionary climate modelling shows hotter and drier summers, declining soil moisture and decreasing groundwater levels in the medium to long term, especially for regions that are already experiencing lower groundwater levels, taking into account human interventions in the water regime.[1] [2] This will adversely affect agricultural crops and grassland, along with forests and other ecosystems, especially water-based terrestrial ecosystems with their protected species and habitats. At the same time, heavy rainfall and flooding will become more frequent and less snow will fall in winter. This means that the climate crisis has serious implications for water availability, and the risk of overuse has thus increased significantly. Unsustainable uses of water also play a role. All urban and rural water uses and needs must therefore be continually adapted to the potential worst-case scenario.

A second environmental policy challenge compounds the issue, namely, water pollution caused by nitrogen and phosphorus and various other substances (e.g. trace substances) and pollutants (e.g. microplastics). This pollution threatens the good ecological status of water bodies and makes the process of abstracting and supplying water in the quality and quantity required for its many uses increasingly complex and therefore costly.

Water resources and water management are also affected by developments such as demographic trends, changes in lifestyle and the interdependencies between urban and rural areas, developments in economic structures including digitalisation, as well as overall changes in land use.

During the National Water Dialogue held by the Federal Environment Ministry (BMUV) and the Federal Environment Agency (UBA) between October 2018 and October 2020, the diverse challenges facing water management# were discussed with experts from the affected sectors, strategic goals were formulated and initial ideas for solutions were developed.[3] In addition, a citizens' council made up of randomly selected members of the public from different regions of Germany formulated their demands and recommendations for federal policy[4], which are essentially addressed in the National Water Strategy. The two dialogue processes confirmed the need for a National Water Strategy and

[1] Wunsch, A., Liesch, T., Broda, S.Deep learning shows declining groundwater levels in Germany until 2100 due to climate change.(2022) Nature Communications, 13 (1), art. no. 1221.

[2] For an evaluation of median-based climate models, see https://www.dvgw.de/themen/forschung-und-innovation/forschungsprojekte/dvgw-forschungsprojekt-wasserdargebot

[3] The documentation of this process can be found (in German) at https://www.bmu.de/wasserdialog.

[4] The documentation of this process can be found (in German) at https://dialog.bmu.de/bmu/de/process/54586.

provided important impetus for the development of this strategy. The Federal Environment Ministry then submitted its draft for a 2050 National Water Strategy in June 2021. This draft served as the basis for the development of the federal government's 2050 National Water Strategy, which has now be published. It has again incorporated proposals and comments from the federal states (Länder) and associations as part of a consultation process.

Water management# faces enormous current and future challenges and will require considerable investments, for example to adapt the water infrastructure#. A precautionary, integrated approach is needed to ensure a sufficient supply of high-quality water for human use and ecosystems. In future, the impacts of human activities on water resources and water bodies must be integrated into all areas of life, business and policymaking. This integration can only be achieved together with all stakeholders. To prevent water resources from being overused in future, society needs to agree on what kind of uses are permitted and to what extent. At the same time, measures to improve and increase water resources to sustainably meet these needs (quantity, quality, availability, reliability, resilience) must be planned and implemented. The ecosystem services# provided by water ecosystems, which are also important for humans, must be taken into account and guaranteed over the long term.

Implementation of the National Water Strategy will not always be free of conflict with other public interests and goals. The strategy acknowledges these conflicts and shows different ways and means to deal with them constructively or to resolve them.

Within its (financial) constitutional powers, the federal government aims to implement the strategy together with the federal states, municipalities and other water-sector actors and water-using stakeholders. All measures within the federal remit mentioned in the strategy or arising from it are to be implemented within the framework of the financial and human resources available in the individual federal budget plans. The National Water Strategy explicitly targets different stakeholder levels (especially the federal government, federal states and municipalities) and creates a framework for complementary strategies and plans at federal state level that are adapted to regional conditions. Further coordination, discussion and agreement on priorities, responsibilities and financing will be necessary for implementation.

The strategy aims to mobilise and combine all forces in society to take the crucial steps necessary to meet the long-term challenges for water management# and water resources as well as for waterways. The National Water Strategy therefore also contributes to raising awareness of the special importance of water among the public and decision-makers at all political levels and in society.

The National Water Strategy outlines a clear vision for the future and identifies the need for action ("What needs to be done?") and measures in key strategic areas. Starting from the concept of strong sustainability, which regards the preservation of the natural foundations of life as the basis for social and economic sustainability#, environmental, social and economic aspects have been incorporated into the strategy.

Precautionary measures are at the core of this National Water Strategy:

- **Precautionary measures as a public service**: It is important that in the future, too, the general public and other key water users (industry, agriculture, etc.) can continue to rely on safe, affordable and efficient water supply and wastewater disposal systems that adequately meet their needs. And they should also be able to count on effective risk and crisis management in the event of extreme events such as heavy rainfall or water shortages. It should be ensured that water bodies can be used for food production, as transport routes, for industrial production and energy supply. This also requires the management and maintenance of the water bodies.

- **Precautionary measures for plants and animals**: Healthy water bodies, intact, water-based ecosystems and a functioning water regime are key requirements for preserving the diversity of our flora and fauna.
- And finally **precautionary measures for future generations**: They, too, should be able to make sustainable use of surface waters and groundwater. This means, among other things, using available freshwater quantities responsibly, rigorously pursuing all means of reducing water consumption, taking measures to tackle and adapt to climate change and reducing pollutant discharge on a large scale.

The National Water Strategy is interlinked with a number of other national strategies of the federal government, including the National Sustainable Development Strategy, the National Security Strategy, the Climate Action Plan 2045, the Climate Action Programme 2030, the Strategy for Adaptation to Climate Change, the BMEL Forest Strategy 2050, the Arable Farming Strategy 2035, the National Strategic Plan for Aquaculture 2021-2030 of the federal government and federal states (NASTAQ), the Peatland Protection Strategy, the Federation-Länder target agreement on climate change mitigation through peat soil conservation, the Strategy for Strengthening Resilience to Disasters (Resilience Strategy), the National Strategy for Critical Infrastructure Protection (CIP Strategy), the preparatory work for a National Ecosystem Restoration Plan, the Trace Substance Strategy, the National Biodiversity Strategy (NBS), the Action Plan on Nature-based Solutions for Biodiversity and Climate and the federal Blue Belt programme, the Strategy for the Future of Research and Innovation, the White Paper on Urban Greenery and the Federal Programme for Adaptation of Urban Spaces to Climate Change. To ensure successful implementation of the National Water Strategy, the latest research findings are needed on an ongoing basis, among others from ministry-funded research and federal research programmes (e.g. Wasser: N - Research and Innovation for Sustainability).

The National Water Strategy primarily focuses on challenges and the measures needed for the protection and use of inland waters and groundwater, including the relevant impacts of sea level rise related to dike infrastructure and lowland drainage. This strategy addresses marine protection only in relation to the measures needed in the catchment areas of inland waterways that drain into the seas to ensure that marine protection goals are met or to make an indispensable contribution to the achievement of these goals. This essentially involves measures to reduce nutrient inputs and pollutant discharge as well as plastic waste from catchment areas into the seas. However, the protection of the seas and oceans in their entirety, especially with regard to the pressures resulting from their use, will be covered in a separate marine strategy.

I. 2. Timeline and evaluation

The timeline for achieving the vision (see section II. 4.) and strategic goals outlined in the strategy ranges from today until 2050. From now on, basic steps will be necessary to achieve the goals. The National Water Strategy's programme identifies specific measures that will gradually be undertaken over the next years until 2030. This timeframe also reflects the time-consuming planning and implementation periods for infrastructure projects as well as the length of time it takes for measures to take effect. The programme of measures will be evaluated, updated and continued over the years.

Monitoring success is part of the change process. It makes a significant contribution to evaluating the effectiveness of the strategy and the supporting measures. The extent to which the strategy is accepted and implemented in the social, political and economic context will also be an indication of its success. To coordinate and monitor implementation of the strategy, the federal government will set up an interministerial working group with the participation of the federal states. It will submit a report on implementation of the National Water Strategy every six years (which coincides with the frequency of the management plans under the Water Framework Directive (WFD). This will provide information

in condensed form on the implementation status of the activities contained in the programme of measures and outline a process for further development and corrective action.

I. 3. Basic principles of the strategy

The National Water Strategy is based on the tenets of federalism and the following principles of environmental law:

- The precautionary principle and the polluter pays principle, as enshrined in Article 191(2) of the Treaty on the Functioning of the European Union, which says: "Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay." According to the **precautionary principle**#, environmental damage must be prevented wherever possible, i.e. it should not occur in the first place. This means that risks associated with human activities must be identified and assessed at an early stage so that appropriate measures can be taken to minimise risks. For example, potential environmental risks must be taken into account as early as the product development stage or when planning investments or granting approvals for chemicals. To achieve this, it must be possible to collect, provide and link information and data. According to the **polluter pays principle**#, the party responsible for environmental pollution is also responsible for remedying or paying for the damage caused.[5] This requires, among other things, clear legal allocation of environmental responsibility for the impacts on water bodies of products along their life cycles and of human activities, e.g. through the regulation of extended producer responsibility in accordance with the standards of current EU law, which includes all producers selling products on the European market. There is a wide range of instruments available for proportionate cost allocation, ranging from regulatory requirements to fee-based solutions such as wastewater charges or water withdrawal charges. The **community pays principle**#, which is inherent in any regulation where external costs are not fully internalised[6], is also relevant for the National Water Strategy, for example where measures to restore ecosystem services (natural flood protection, water retention over a large area, capacity of water bodies for self-purification, rewetting of peatlands, preservation of water-dependent habitats) are financed by the general public.
- The **principle of shared responsibility** completes the traditional triad of principles in environmental law. It reflects the realisation that environmental protection efforts made solely by the state are doomed to fail and only the closest possible cooperation between the state and society, i.e. with the entities of its legal system, can bring about effective environmental protection. Protection of the environment is therefore also the responsibility of society. The principle of shared responsibility seeks to involve the affected members of the public, relevant stakeholder groups (e.g. land use, tourism/recreation) and the business community through information and participation and thus strives for empowerment and equal opportunities. A consensus-based approach, involving balanced cooperation, increases the acceptance of decisions and improves the level of information among all parties, especially in terms of the knowledge contributed. The principle of shared responsibility is applied, for example, in the legislative process in the form of consultation procedures and in environmental agreements.[7] The implementation of the National Water Strategy therefore

[5] Kloepfer, Umweltrecht in Deutschland, https://www.kas.de/c/document_library/get_file?uuid=45c5f490-f212-96fb-8894-84c2fee510dd&groupId=252038.
[6] UBA texts 73/2015, (p. 97), "Gerechtigkeit im Umweltrecht", https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_73_2015_gerechtigkeit_im_umweltrecht.pdf.
[7] UBA texts 73/2015, (p. 84), "Gerechtigkeit im Umweltrecht", https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_73_2015_gerechtigkeit_im_umweltrecht.pdf.

relies on cooperation with stakeholder groups and on platforms for dialogue and outlines proposals for greater participation in planning and decision-making processes.

- Several years ago, a fourth principle was added to the traditional triad of principles: the **principle of integration**. This requires the environment to be protected in its entirety – above and beyond German environmental law, which is traditionally still largely based on media or sectors. In this sense, the National Water Strategy is geared towards leveraging synergies with other environmental policy regulatory areas and identifying how other policy areas can contribute to achieving the goals defined in the strategy.[8]
- The **principle of sustainability** aims to preserve the natural foundations of life on Earth for the long term and to enable all people to live in dignity, now and in the future. To achieve the 2030 Agenda and its 17 Sustainable Development Goals (SDGs), economic performance, the protection of the natural foundations of life, social justice and equal participation must be viewed in tandem in all decisions, taking into account systemic interactions as well as technological and social innovations. The only chance of still achieving the SDGs lies in a concerted effort by the international community and all of society to move much more quickly and ambitiously in implementing the 2030 Agenda.[9]
- According to the **principle of subsidiarity**, a state function should only be transferred to a higher administrative and decision-making level when there would be demonstrable benefits because the lower level cannot be expected to perform the function and achieve the objectives as effectively. The National Water Strategy is intended to contribute to supporting or improving how the respective competent authorities perform their functions, e.g. through guidance and guidelines, advisory services, providing and interlinking information and data and, where appropriate, funding measures.
- In accordance with the principle of **municipal public services**[#], it is the responsibility and right of the municipalities and districts to provide basic economic, social and cultural services for all citizens necessary for human existence and to regulate these services within the framework of municipal laws. Municipal public services[#] in the water sector involve supplying safe drinking water, also in public spaces, to public, commercial, agricultural and other users as well as disposing of wastewater properly. An intact environment with functioning ecosystems and services is a basic prerequisite here. Protecting them is becoming increasingly imperative as pressures on the environment intensify. In addition, strengthening the resilience of the water infrastructure is another essential prerequisite for guaranteeing municipal public services.

I. 4. What is our vision and mission for 2050?

During the two-year National Water Dialogue, participants developed proposals for a common vision for water management[#] in 2050 and a mission for making it a reality. Thanks to the broad approval of these proposals in the National Water Dialogue, the vision and mission developed as part of this dialogue will be included as guiding principles in the National Water Strategy, with only a few minor changes to wording.

The vision for 2050

[8] Kloepfer, Umweltrecht in Deutschland, https://www.kas.de/c/document_library/get_file?uuid=45c5f490-f212-96fb-8894-84c2fee510dd&groupId=252038.

[9] German Sustainable Development Strategy 2021, (p. 11), https://www.bundesregierung.de/resource/blob/998006/1873516/3d3b15cd92d0261e7a0bcdc8f43b7839/2021-03-10-dns-2021-finale-langfassung-nicht-barrierefrei-data.pdf?download=1.
UBA texts 73/2015, (p. 98), "Gerechtigkeit im Umweltrecht", https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_73_2015_gerechtigkeit_im_umweltrecht.pdf.

The protection of natural water resources and the sustainable use of water in times of global transformation have been implemented in all areas of life and the economy in Germany for the benefit of people and the environment.

The mission for 2050

A sufficient supply of high-quality water is essential for humans and nature, and for people's social and economic activities. This valuable resource must be preserved for current and future generations. Protecting water as a habitat and as a central element in many ecosystems over the long term is therefore an important mission for our society. This is especially true in view of the advancing climate and biodiversity crises, dwindling availability of water resources worldwide and the need to preserve the carbon storage function of wetlands.

Water bodies and their catchment areas must therefore be managed in such a way that their functional capacity and resilience are maintained and, where possible, improved, restored and protected for the long term. This involves, among other things, a semi-natural# water regime and more natural structures. It is crucial that the impacts of the climate crisis and the need to conserve biodiversity are taken into account. This requires a more integrated and systemic approach to water body management#. This approach must reconcile habitat functions with the various water uses that humans want and need, under dynamically changing overall conditions. The aim of this approach is to ensure that:

- the precautionary principle# and the polluter pays principle# are more rigorously implemented in all sectors dependent on water
- water bodies and biotopes dependent on water are developed and preserved as diverse habitats in a semi-natural state#, taking into account the different uses, and disruptions to the water regime# are kept to a minimum
- future public water services# (drinking water supply, wastewater disposal) are guaranteed for people living in urban and rural areas, i.e. an adapted and climate-resilient sustainable water infrastructure is in place
- harmful discharge of pollutants, nutrients and waste are prevented or reduced, and efficient and sustainable practices and methods are successfully used to reduce water pollution caused by humans to a negligible level, taking into account the precautionary principle
- the status of water bodies and water resources is improved and overuse and degradation of water bodies and water resources is prevented; it is possible, also taking into account the impacts of the climate crisis, to align water availability and water consumption to promote sustainable management with the aim of counteracting, among other things, the decline in groundwater levels
- precautionary measures are taken to protect people, animals and the environment, including to prevent and reduce damage caused by extreme events
- energy and resources are used sustainably

This kind of systemic approach extends beyond the current scope of water management# and should include stakeholders from other sectors (such as agriculture and forestry, fisheries and aquaculture, the food sector, shipping, raw material extraction, construction and energy, industry, commerce, tourism/recreation, nature conservation and research) with their responsibilities and scope for action and takes their interests into account. It is important to keep in mind that large parts of Germany's landscape have been engineered by humans, and it

would be impossible to completely restore its natural state due to the historical, current and future uses of its water bodies.

The National Water Strategy addresses the expectations resulting from this approach for society as a whole as well as for the water sector# and other affected sectors and policymakers. It outlines options and opportunities for sustainable development over the long term. In addition, it provides the framework for precautionary and polluter pays solutions as well as for necessary regulatory, legal and structural adjustments. Beyond national issues, the National Water Strategy outlines Germany's contribution to global implementation of the 2030 Agenda goals.

I. 5. The National Water Strategy in the context of European and international goals, developments and processes

It is not possible to achieve the vision and mission of sustainable water management formulated above without considering developments at EU and international level. The National Water Strategy is not a stand-alone instrument; it must be seen in a European and global context. It will support implementation of EU water law and relevant multilateral conventions.

The way we manage water and water bodies is largely determined by an EU regulatory framework that must not only be implemented, but also further developed and adapted. The management# of our international river basins must be closely coordinated with neighbouring countries.

The National Water Strategy builds on the existing EU legal framework and seeks to contribute to achieving the goals it defines. However, it also aims to provide guidance on where the EU legal framework needs to be further developed – also above and beyond water law – to ensure that the visions formulated in the following sections on selected strategic issues can be achieved. In many cases, the necessary measures can only be effectively implemented at European level or do not lie within the (sole) regulatory powers of the individual member states. The presentation of the National Water Strategy comes at a time when proposals and goals for strategic direction in key regulatory areas (agriculture and Farm to Fork Strategy, biodiversity, intact ecosystems, nature-based climate measures, water conservation law, chemicals, circular economy and resource conservation, adaptation# to climate change, implementation of the EU climate change law including the 55% reduction target for greenhouse gas emissions by 2030 and greenhouse gas neutrality by 2045) are being formulated as well as intensively discussed within the scope of overarching strategies (e.g. zero pollution action plan, Chemicals Strategy for Sustainability, EU Soil Strategy for 2030, etc.), which are also of great importance for sustainable water management. The EU Mission "Restore our Ocean and Waters" also aims to restore, protect and maintain the health of Europe's water bodies through research, innovation and investment. The EU Council conclusions (19 November 2021) "Water in diplomacy" reaffirm the EU's diplomatic engagement on water, especially transboundary water cooperation, as a tool for peace, security and stability. The National Water Strategy contributes to achieving these goals.

The water footprint# associated with our business practices and consumption patterns is an expression of an increasingly interconnected world in which decisions taken domestically have impacts on water resources and water bodies in other countries and regions that must be taken into account and reduced to a sustainable level. Principles agreed at international level, such as the human right to safe drinking water and adequate sanitation, and the global water goals, as formulated in particular in the 2030 Agenda, are central points of reference for the National Water Strategy. The National Water Strategy also addresses how Germany can contribute to the sustainable management of water and water bodies in other countries and to ensuring that the human right to clean water and sanitation is respected internationally.

Many of the water-related SDGs set forth in the 2030 Agenda, which were adopted by the UN member states in 2015, have been achieved in Germany. However, despite undeniable progress, shortcomings still exist in Germany, e.g. in the protection and improvement of aquatic and water-dependent ecosystems or the further reduction of water pollution caused by substance discharge. This is where the National Water Strategy comes into play.

In addition, the National Water Strategy will contribute to the global implementation of the goals of the 2030 Agenda and the initiatives undertaken in this context such as the UN Decade of Action on Water for Sustainable Development and the UN Decade on Ecosystem Restoration. It identifies ways to reduce Germany's water footprint# and outlines necessary steps to improve multilateral structures to support accelerated implementation of the global water Sustainable Development Goals in line with the UN Water's Global Accelerator Framework (GAF) to speed up implementation of SDG 6 "Clean water and sanitation". An overarching approach that addresses the interdependencies between the 17 SDGs while upholding the principle of leave no one behind (LNOB) is particularly important. For example, implementation of SDG 6 will help to achieve many other SDGs like SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 11 (sustainable cities and communities) and SDG 14 (life below water), but is also highly dependent on progress made on SDG 7 (affordable and clean energy) and SDG 12 (sustainable consumption and production). SDG 13 (climate action) and SDG 15 (life on land) are also closely linked to water issues. In addition to achieving the SDGs, it is important to contribute to implementing the goals of the Paris Agreement, the Ramsar Convention and the future Global Biodiversity Framework by managing water resources sustainably.

II. What needs to be done – ten strategic issues:

Challenges, vision and transformation to sustainable water management

The challenges for water management# are diverse and complex. The solutions and options for transitioning to viable water management# for the future are similarly complex and interlinked. The National Water Strategy is not intended to fully reflect and resolve this complexity. It focuses on ten strategic issues (Figure 1) that address the key challenges and needs for action that were also discussed in the National Water Dialogue. The challenges, the vision for 2050 and the main steps towards achieving this vision are outlined below for each of these ten issues. The strategic issues were intentionally selected to tackle challenges and solutions across sectors and action areas. Individual issues of central importance to water management, such as flood risk management, precautionary measures against water shortages and ensuring the good status and good ecological potential of water bodies and public water services, are therefore addressed under different strategic issues, each from a different perspective. The measures proposed for the different strategic issues must be viewed in combination. Specific measures are identified in an initial programme of measures.

Figure 1: The ten strategic issues of the National Water Strategy

II. 1. Protect, restore and ensure a semi-natural water regime for the long term – prevent water scarcity and conflicting goals

Baseline[10]

- The long-term average of renewable water resources in Germany is 176 billion m³. In recent years, however, this figure has been significantly lower in some cases, e.g. just 116 billion m³ in 2018 and 2020. A comparison of the 30-year periods 1961 to 1990 and 1991 to 2020 shows a decrease in the long-term average of renewable water resources in Germany by 12 billion m³.[11]
- In Germany, water is withdrawn for energy supply (44.2%), manufacturing, including mining and industry (26.8%), public water supply (26.8%) and agriculture (2.2%). In total, these user groups have withdrawn around 20 billion m³ of water from groundwater and surface waters (as at 2019). Groundwater and spring water account for around 70% of public water supply, while river water is mainly used for energy[12].
- Germany has not experienced water scarcity ("water stress") on a national scale to date. Water stress is defined as water withdrawals exceeding 20% of the water resources (water supply) that are renewable over the long term. Despite the generally adequate water resources, there are sometimes significant regional shortages in water availability and soil moisture in the spring and summer months, with major implications for nature, water management, agriculture and forestry, industrial production, fisheries and aquaculture. The climate crisis has led to an increase in very dry periods.
- In 2019, agriculture (incl. aquaculture) used around 445 million m³ of water sourced by the farms themselves. Agricultural water withdrawals amounted to 2.2% of total water withdrawals in Germany in 2019.
- Due to the current climate conditions in Germany, national demand for irrigation water for farming and gardening is lower on average than in many other regions of the world or Europe. However, as climate change has intensified, the need for irrigation has increased in recent years. According to calculations, it could increase 20-fold in the federal state of North Rhine-Westphalia by the year 2100 – if current crops continue to be farmed. In the northeastern part of the federal state of Lower Saxony, if agricultural practices remain unchanged it is assumed that there will be a 30% increase in the amount of water needed by the end of the century; an amount that could no longer be met with groundwater alone. [13]
- In the six warm months of the year, there has been a significant decrease in the mean flow rate since 1961 at 80 monitoring sites distributed across the river basins in Germany. This suggests a change in summer water availability.
- The Federal Water Act (WHG) ties authorisation for the use of water bodies to the preservation of the natural functioning of the hydrological regime and stipulates a general duty of care.
- Water withdrawals, drains, hydromorphological modifications, soil compaction, management not adapted to local conditions and extensive sealing of land affect and impair the natural water regime#. Watercourse engineering has led to increased and faster runoff, increased the risk of flooding for downstream users along with other factors, impeded water retention and impaired the ecology and natural dynamics of watercourse and wetland systems.

[10] The information provided in the baseline sections can be found with all sources in the scientific background on the strategy (see UBA texts 86/2021).
[11] https://www.umweltbundesamt.de/daten/wasser
[12] Water withdrawals are the focus here. The withdrawal of cooling water for energy supply must be included in the assessment, as it may also be limited when water levels are low.
[13] KWRA 2021 (UBA), Teilbericht 3, page 257

- Two thirds of river floodplains in Germany are no longer available as inundation areas when flooding occurs. Along many sections of major rivers, only 10-20% of the former floodplains still exist.
- Semi-natural landscape hydrology is essential for all water bodies, wetlands and peatlands. More than 90% of Germany's peatlands are severely degraded by drainage and use. This is directly linked to the climate crisis (e.g. emissions of carbon dioxide due to peatland drainage), loss of water retention, impaired water quality (e.g. increased phosphorus yields) and biodiversity loss. A semi-natural landscape hydrology results in improved groundwater recharge and an increase in the amount of water available for plants. This also has direct implications for agriculture and forestry, especially with regard to irrigation needs.
- Around 45% of land used for human settlements and transport infrastructure in Germany is sealed. Surface sealing impairs important soil functions, infiltration capacity and groundwater recharge. From 2017 to 2020, an average of 54 hectares of new land was used per day (rolling four-year average) for human settlements and transport infrastructure in Germany, i.e. previously undeveloped land was newly designated for human settlements and transport infrastructure under planning law. According to Germany's National Sustainable Development Strategy[#], the federal government aims to limit the use of land take for human settlements and the transport infrastructure to 30 hectares per day by the year 2030. The goal is to achieve circular land use management by 2050. This means that no new net land take should occur for human settlements and transport infrastructure.[14]
- The land requirements for groundwater recharge, water retention and flood protection, for water body development[#] and drinking water abstraction often have great potential for synergies with nature-based solutions, nature conservation, organic farming, low-impact aquaculture and for leisure and recreation and, at the same time, compete in part with the land requirements for other uses such as residential areas, energy, industry, transport and agriculture.
- Prolonged periods of low water have significant negative impacts on hydroecology, water quality and quantity management, water supply, the energy sector, industry, inland shipping, fishing and aquaculture. This is why low water has such a significant impact on the national economy.
- According to the Intergovernmental Panel on Climate Change (IPCC) report, emissions from inland waters account for almost one third of greenhouse gases released from natural sources. Global warming and eutrophication foster the formation of methane in water bodies. Microbial processes can partially degrade the methane in bodies of water. If methane is emitted, it is many times more potent than CO_2 in terms of the greenhouse effect, despite being present in the atmosphere for a much shorter period of time. Reducing methane emissions can therefore make a significant contribution to achieving climate targets.

What are the challenges?

Since the drought events in the summer months of 2018, 2019, 2020 and 2022, water resources, water uses[#] and potentially conflicting objectives related to water as a resource have become the focus of public attention in Germany as well. Due to the current overall conditions, especially the impacts of the climate crisis on the quantity and quality of water, it will be necessary in future to develop cross-sector and joint approaches to solutions to prevent competing uses and conflicting objectives for water resources in the medium and long term, taking into account regional differences. A regional water

[14] Germany's National Sustainable Development Strategy 2021; p. 269
https://www.bundesregierung.de/resource/blob/974430/1940716/4bdf89ceea3b1e4367918384b8839a37/2021-07-26-gsds-en-data.pdf?download=1

regime that is as semi-natural[#] as possible will be an important prerequisite for stable water resources and for protecting the environment.

The water regime[#] spans precipitation, evaporation, storage, infiltration and runoff. Soil condition, groundwater recharge and vegetation all play an important role here. The water regime is profoundly influenced and changed by how land and water resources are used, e.g. water withdrawals, hydromorphological modifications and flood protection measures such as dikes, as well as by the drainage of mineral soils and peat soils (e.g. through drains or drainage ditches) and by management practices that are not adapted to local conditions. These developments also impair the ability of the soil, water-dependent ecosystems and water bodies to store greenhouse gases and even facilitate their emission.

In addition, the climate crisis affects the water regime[#] and leads to changes in precipitation, evaporation, storage, infiltration and runoff. The extent of the impacts of the climate crisis varies greatly from region to region, e.g. with regard to groundwater resources. Permanently receding groundwater levels particularly affect regions where low and possibly further declining groundwater recharge due the climate crisis goes hand in hand with an increase in water demand and a relatively low level of groundwater overall.

Impairments in groundwater recharge, e.g. due to drainage of wetlands and peatlands, changes in use and soil degradation (loss of humus, compaction, erosion by water and wind, biodiversity loss and sealing), also have a negative impact on the water regime.

A semi-natural[#] water regime[#] allows soils, wetlands, water bodies and vegetation to cope better with prolonged dry periods. It helps ensure that the ecosystem services related to evaporation, e.g. reducing heat in towns and cities, can also be adequately provided.

A (nearly) semi-natural water regime for all water-dependent habitat types listed in Annex I of the Habitats Directive is also essential for ensuring or achieving a favourable conservation status; significant impairments are not permitted (Habitats Directive, Article 6 prohibition of deterioration).

Soil is of crucial importance for the water regime because healthy soil with the right pore volume can absorb water, retain it over a large area and channel it to the groundwater, thus alleviating floods as well as acting as a buffer that can temporarily mitigate the impacts of dry periods on plants, groundwater levels and drinking water supplies.

The dry soil, low groundwater levels and low water levels in rivers in recent summers had a significant ecological impact, led to severe impairments in water-dependent ecosystems and directly affected various economic sectors such as agriculture, forestry, fishing, aquaculture, energy production, shipping and industry. Regionally, conflicts arose in individual cases between irrigation for farming and drinking water supply. Increased water withdrawal from rivers and lakes has negatively impacted their ecological status in some cases. The climate crisis is expected to increase extreme events such as heavy rainfall during the summer months and potentially increase the number of prolonged dry periods. This will lead to a change in how precipitation is distributed throughout the year and to longer vegetation periods with higher evapotranspiration losses. This will considerably exacerbate the pressure on groundwater bodies, on the one hand as a result of water withdrawal, and on the other hand due to the fact that during these phases, hardly any soil water is available to replenish and regenerate the groundwater. Since wet conditions are crucial for the successful establishment of water-dependent species, these developments can make climate conditions more difficult for the conservation and restoration of many natural ecosystems and especially water-dependent habitats such as peatlands. Under these conditions, water may also be needed for projects to preserve and restore ecosystems that are naturally dependent on precipitation or groundwater such as raised bogs, fens and humid

forests. This is why we are seeing an increase in competing uses and conflicting objectives as a result of the ever diminishing amount of water available.

Water use conflicts are likely to occur in future when different uses compete for the available amount of groundwater and surface waters that can be withdrawn. These types of conflicts occur within a single type of use (e.g. cooling water) or between different types of use (public water supply, agricultural irrigation, aquaculture, restoration/rewetting projects, nature conservation/minimum ecological flow rate, minimum flow rate/groundwater-dependent ecosystems, the food industry, mineral water extraction, water needed by industry and the energy sector). Especially during phases of low flow rates in surface waters, water withdrawals lead to conflicts between shipping and water and nature conservation (minimum ecological flow rates) as well as fisheries.

Conflicts can also arise from the deterioration of water quality due to discharge from diffuse and point sources, which mean that withdrawn water can either no longer be made available for other uses or only with considerable expenditure. These kinds of conflicting objectives can arise between drinking water supply and agriculture if, for example, fertilisers and pesticides[15] from agriculture enter the groundwater and surface waters, increasing the complexity and cost of water treatment. The same applies to conflicting objectives between wastewater disposal and drinking water supply as discharge from wastewater treatment plants, especially when water levels are low, can also lead to changes in the water quality of the raw water abstracted from surface waters and contribute to the eutrophication of surface waters.

In addition, there are conflicts arising from different uses of the water bodies due to different requirements for water quality, water quantity or water level, for example ensuring navigability versus protecting and restoring floodplains and flood protection.

Competition for land use along water bodies is also significant: For example, the areas next to water bodies are needed as buffer zones (riparian buffer strips) or for the preservation and restoration of semi-natural water body structures (water body development) and floodplains, which thus ensure flood protection. In many cases, these areas are also needed for agriculture, transport infrastructure and the development of human settlements. Finally, competition for land along water bodies can arise between water body development and uses such as recreation, leisure, sport and tourism. In addition, conflicts of subsoil use can be expected to increase, for example between the protection of groundwater resources, the use of geothermal energy (in particular higher groundwater temperatures, boring through protective surface layers) or the creation of underground storage facilities for water and energy, possibly also captured carbon dioxide.

The various competing uses can overlap and intensify the conflict and, individually or in combination, have negative impacts on hydroecology and ecosystem services.

To preserve or restore the semi-natural landscape hydrology (e.g. of water bodies or large wetlands/peatlands), it is necessary to consider how to manage the water of the entire catchment area and adapt it in such a way that greenhouse gas emissions are prevented, and that the water regime is resilient to the impacts of climate change and develops in line with the needs of all users. A project of this kind requires extensive coordination between different stakeholders and a willingness to compromise.

[15] UBA/BMUV - Auswertung “Die Wasserrahmenrichtlinie - Gewässer in Deutschland 2021 - Fortschritte und Herausforderungen” “https://www.umweltbundesamt.de/publikationen/die-wasserrahmenrichtlinie-gewaesser-in-deutschland”

Vision – Semi-natural water regime in 2050

The water regime is as semi-natural[#] as possible, while the natural soil functions have been preserved, water retention improved over a large area and land consumption and soil sealing minimised. The transition to circular land use management is complete. No more net new land is taken for human settlements and transport infrastructure.

The water regime of all surface waters has been aligned with natural conditions as far as possible; watercourses are maintained with the aim of semi-natural development, which supports the water retention function of floodplains (retention areas) and the preservation of an ecologically functional, high-value water body floor. The use of the groundwater body is sustainable. All groundwater resources are managed with a view to maintaining their regenerative capacity, also given the impacts of climate change. This prevents extreme events. Overuse has been identified and the groundwater bodies have been regenerated to a level compatible with sustainable use. The groundwater level does not drop any further.

The soils in the different land uses are in good condition and are able to perform their natural soil functions. Soil degradation has been reduced through locally adapted management[#] or intact natural vegetation, and soil erosion into surface waters has thus been reduced as far as possible. Locally adapted humus content and high soil biodiversity[#] contribute to high water storage capacity and carbon sequestration. Soil compaction has been largely minimised through the use of locally adapted technology. Sealing has decreased significantly due to the reduction of land take for human settlements and transport infrastructure as well as measures to unseal previously sealed surfaces.

To this end, guiding principles exist for a semi-natural, area-specific water regime at sub-catchment level that take into account adaptation to the impacts of the climate crisis and the goal of greenhouse gas neutrality in 2045 (contribution to nature-based climate action) and adequately reflect use requirements. Sustainable use of water resources minimises the damage and impacts of global warming and its extremes for humans and nature. Those responsible at regional level continuously monitor water withdrawals and water resources, creating the basis for preventing overuse of water resources (risk-based approach).

Potential and existing synergies[#] and conflicts of use are shown transparently and clearly. Synergies are maximised through forward-looking and integrated planning, conflicting objectives in the use of water resources are addressed proactively. In the event of prolonged dry periods, regional water use priorities are coordinated between those responsible at the various levels and with the users on the basis of a national guideline and are communicated transparently to everyone.

Integration of all interests at an early stage and a joint coordination process prior to deciding on possible measures are common practise in the regional management of the water resources in the catchment areas. A strong and competent water administration makes decisions on quantitative withdrawals, taking into account all stakeholders and interests. A guideline agreed upon nationwide is available as a frame of reference for these decisions, containing rules and criteria for transparent decision-making by the responsible bodies during shortages with regard to prioritisation. The public water supply system continues to be very important in providing public water services[#] to ensure the supply of drinking water as a priority. Alternative water resources – e.g. process water and rainwater use, treated municipal wastewater – are included in regional water use plans to preserve scarce freshwater resources, taking into account human health and environmental protection aspects.

The water needs of ecosystems have been defined and are ensured. Industrial and agricultural needs are taken into account when balancing water withdrawals. All water users are aware of their responsibility for water as a resource. Requirements for efficient water use in all sectors have been established to ensure that scarce water resources are used wisely and economically and to prevent conflicts of use in advance. Efficient water use is the prerequisite for withdrawal permits.

The agricultural sector efficiently and sustainably manages irrigation needs and contributes to increasing the capacity of the soils for infiltration and water storage. This is done through formation of humus adapted to local conditions, through suitable cultivation methods and crops and appropriate crop rotations. Irrigation needs are met as far as possible with environmentally friendly and sustainable methods by collecting rainwater or, if there is sufficient runoff, by withdrawing water from surface waters and using water-saving, efficient irrigation technology (e.g. drip irrigation). Agriculture has successfully completed the process of adapting to the climate.

Nature-based climate action, which restores and strengthens ecosystems and their function as carbon stores and sinks, combined with the careful use of water resources, contributes significantly to achieving the goal of greenhouse gas neutrality by 2045. The impacts of the climate crisis on the water regime, such as high and low water levels, but also changed groundwater levels, are also taken into account and are an integral part of management# plans and programmes of measures. Water quality in streams, rivers, lakes and groundwater is continuously improved. This also significantly reduces conflicting objectives for water resources due to water quality.

The considerable potential for synergies# with nature conservation strategies and objectives (e.g. biodiversity strategy), especially in nature-based climate action (e.g. Action Plan on Nature-based Solutions for Biodiversity and Climate), in floodplain and flood protection and in the biotope network (e.g. Germany's Blue Belt programme), is harnessed whenever possible. Water-dependent habitats such as floodplains, wetlands and semi-natural peatland areas are preserved, restored and protected. The preservation of pond landscapes used with minimal impact as well as the creation of low-impact peripheries around peatland areas support this goal. They stabilise the water regime and meet the requirements of the Habitats Directive with regard to the preservation of water-dependent habitats and their species. The prerequisites for sustainable peatland protection have been fulfilled.

Land development and regional planners are informed extensively and at an early stage about water management plans and integrate them. Since planning covers an entire area, it offers possibilities for securing areas for groundwater recharge, water body development#, flood protection, drinking water abstraction and other water management uses in its plans. Suitable technical groundwork has been laid as a prerequisite. This is intended to strengthen water management interests into overall spatial planning vis-à-vis other land use claims.

The regional demand for water resources is met by sufficient groundwater and surface water resources, by water management measures (e.g. decentralised rainwater retention) and designating the required priority and retention areas for water abstraction with spatial planning instruments (e.g. development plans). Areas and routes for water infrastructure# (also supraregionally if necessary as long-distance water supply) are balanced with competing use interests and, as a result, designated in spatial plans as binding vis-à-vis other public planning authorities.

Spatial planning instruments (e.g. development plans), which are binding for municipalities, also ensure large-scale flood protection, nature conservation, infiltration and retention areas. Regional plans secure areas for the protection and development of water bodies and wetlands, the management of heavy rainfall and the infrastructure required for this purpose, as well as priority areas for future water abstraction.

Water-smart urban development ensures the ecosystem services made possible by a semi-natural hydrological cycle for the quality of life in towns and cities. This relates to direct water services in towns and cities for the water supply, recreation and leisure, climate adaptation and, where applicable, mobility (ferries). It also involves indirect services related to water availability for vital urban greenery and its regulating, producing and cultural services.

What needs to be done?

The best way to address conflicts of use is to prevent them from arising in the first place or to minimise these conflicts by taking proactive and preventive action. Proactive planning to address water use conflicts first requires a reliable knowledge base through targeted monitoring of the entire water regime and the impacts of climate change on it, as well as better models and scenarios for regionally differentiated projections of the water resources available in the required quality in the future on the one hand and the water needs on the other. Drawing on their work and experience in this area, the competent higher federal authorities can make important contributions and should cooperate closely with each other and the competent federal state authorities. The data of the water suppliers will also be used for this purpose. The goal must be to improve predictability. This requires modelling of the possible developments and trends in the variables responsible for changes in water management systems, as well as making different variants and the consequences associated with each of these variants accessible for evaluation. Both historical and current observational data is needed, as well as comprehensive model assessments at different regional levels. Building on existing modelling, this includes comprehensive water regime models (including hydrogeological models) that have been developed according to coordinated guidelines and are thus compatible with one another as well as their link to climatological models as a basis for medium- to long-term comprehensive regional water resources and multi-sectoral water demand analyses, including the water required by ecosystems.

On this basis, water supply plans that are as comprehensive as possible must be developed in cooperation with the federal states, water suppliers and wastewater management companies, water body maintenance authorities, municipalities and the main groups of water users. These will include an analysis of the current and future water resources and needs and reconcile them to secure the public water supply for the long term – within and outside the public water supply (see also section II. 5). Here, the supply of ecosystems and the public drinking water supply as well as the provision of the quantities of water required for the production of food and animal feed (basic supply) must be permanently ensured in sufficient quality.

A nationally coordinated guideline, which will be developed together with the federal states and in dialogue with stakeholders, is intended to create a uniform framework for setting priorities in regional decision-making. The aim, in particular, is to ensure that sufficient resources for drinking water supply and other priority uses for the common good are available at all times and as close to the location as possible. In addition, rules and criteria for transparent decision-making to set use priorities in the event of regional temporary water scarcity and dry soil will be developed. It is important to view the water situation from a transregional perspective, beyond individual supply regions, at federal state or catchment level. This makes it possible to balance out needs between different sub-areas, to the extent that it is not possible to compensate for shortages close to the location, and to lay the foundations for any infrastructure that may be required to interlink supply regions or long-distance supply, as well as for low water and drought management. Strengthening resilience and the associated guarantee of the security of supply (public water supply) must be taken into account as connectivity increases. Furthermore, water supply plans must support the integration of water management aspects into

plans at federal state and regional level. Existing and future conflicting objectives in land use will be acknowledged and described at regional level, and appropriate areas and sites will be identified based on nationally agreed criteria. All relevant land requirements for water management are taken into account, e.g. for groundwater recharge, water retention over a large area, nature conservation, nature-based climate action, water body development#, drinking water abstraction, flood protection, use for mobility and energy production, etc.

To be able to adequately take into account the public water supply issues outlined in regional water supply plans when designating building areas, building, planning and water law will be reviewed for coherence and adapted if necessary.

Another reason that water conservation goals remain unfulfilled is their lack of integration in areas outside of water law. It must be determined how water management planning can be linked more effectively to spatial planning and urban land use planning and thus how water management interests can be better asserted when balancing all spatial interests and their implementation improved. The possibility of defining priority areas for groundwater recharge and future water supply (future water protection areas) should also be considered in the process.

An essential prerequisite for reducing or even preventing conflicts of use is a water regime that is as semi-natural as possible, e.g. that has the necessary resilience to withstand prolonged periods of low precipitation. In order to restore or ensure an adaptable water regime, water-efficient, water-optimised land use will play an essential role, but it must meet regionally varying requirements. As orientation and a guide for the implementation of this kind of water-optimised approach to land use, regional guiding principles for a regional semi-natural water regime or adapted use of the landscape hydrology should be drawn up with the participation of the relevant land users. To ensure that the findings in all regions of Germany can be compared, a uniform methodology must be developed together with the federal states to create specific guiding principles for the regional, semi-natural water regime. It must contain proposals for a regionally specific categorisation of the semi-natural water regime on the basis of different natural areas. Guiding principles and methodologies must be used by planners and decision-makers at regional level, e.g. water authorities and associations, to develop nature conservation expertise and improve how nature conservation and climate concerns are taken into account.

Incentives and specifications for economical and efficient water use as well as relevant requirements for installations and systems are other instruments to prevent the overuse of available water resources. Accordingly, measures for the sustainable use of water quantities will be developed, e.g. minimum standards for efficient water use using state-of-the-art technology for household, industrial, commercial and agricultural use. An assessment will be carried out to determine whether to include a general requirement for the use of water-saving processes in the Waste Water Ordinance (AbwV). The further development and harmonisation of water withdrawal charges, including the possibility of a federal regulation, will also be explored. The income from these charges could be used, for example, to finance measures to achieve the objectives of the WFD. A research project will explore how “smart” water tariffs for domestic and drinking water could be used to influence developments.

The water administrations of the federal states and the competent federal authorities, e.g. the Federal Waterways and Shipping Administration (WSV), will be equipped with the necessary capacities and access to the required information and data. This information and data will enable them to take decisions on the management# of the usable water resources independently, taking into account all relevant aspects, within a reasonable timeframe and after consultation with all stakeholders. The

decision-making powers will be defined, and the authorities responsible provided with technical support, e.g. in the form of decision-making support systems. The competent (federal, federal state and municipal) administrations and other affected stakeholders will develop mechanisms to implement the guidelines outlined above, taking into account issues such as enforcement (formation of crisis management teams, if necessary) and monitoring, dealing with resistance, compensation as well as transparency and evaluation.

To protect groundwater resources, a quantitative real-time system to monitor the actual amounts of groundwater withdrawn will be developed to serve as a basis for risk[#]-oriented groundwater management. In addition, a requirement to document the water withdrawals actually made (water register) will be introduced, and exemptions from the permit requirement (use not requiring a permit) for groundwater withdrawals will be reduced. The establishment of a low water level information system (Niedrigwasserinformationssystem, NIWIS) will provide data and analyses for the assessment and management of low water levels. Uniform parameters on low water levels and water scarcity will provide a necessary basis for developing and harmonising information, forecasting and warning systems. For precautionary management of water quantities and the reduction of flood hazards, the water retention function in the entire catchment area including the floodplains will be improved (in particular through semi-natural water body maintenance[#], restoration of semi-natural watercourse morphology, expansion of retention areas and the development of integrated protection strategies for watercourses and their floodplains) and measures for the sustainable use of water quantities implemented. This will be accomplished within the framework of structures that allow for participation of and mediation among the stakeholders affected.

Rainwater[#] management measures (e.g. use, infiltration and evaporation) will be prioritised over discharge via sewers in municipal urban land use planning. To make this possible, an amendment to Section 55(2) of the Federal Water Act, which does not give priority to infiltration, should be considered, with the aim of prioritising infiltration – where practical, proportionate and feasible. The current drainage of rainwater from roadways, in particular infiltration on green verges (road shoulder drainage), must be reviewed by the relevant authorities and the requirements and measures assessed for ecological aspects. In the case of infiltration, the pollutant load of the rainwater must be taken into account to protect the groundwater from contamination in order to prevent any adverse change in groundwater quality if possible. More priority will be given to semi-natural rainwater management measures in municipal urban land use planning. The water law permits for groundwater and surface water withdrawals as well as for hydraulic complexes must be reviewed on the basis of the improved data available and adjusted if necessary.

In addition to the natural function of soils to mitigate climate change, soil management should be increasingly geared towards strengthening the functions for the water regime as well as maintaining and promoting soil biodiversity[#]. The functions of the soil must be ensured or restored in accordance with the Federal Soil Protection Act (BBodSchG) and the EU Soil Strategy for 2030. The legal framework should be reviewed with a view to its contribution to ensuring a functioning water regime. The Federal Soil Protection Act will therefore be evaluated, taking into account the different uses. This also includes looking at the natural soil functions with regard to soil hydrology, water retention over a large area, the filter and purification capacity and groundwater recharge. Peat soils will be extensively rewetted and a wet use (e.g. paludiculture) is to be developed and established under the Federation-Länder target agreement on climate change mitigation through peat soil conservation and the National Peatland Protection Strategy adopted by the federal government. Unsealing projects will encourage rainwater infiltration and mitigate the risk of flooding.

All the recommendations for measures referred to in section II. 4. to reduce the risks and hazards of pollutant discharge and improve water quality will also help prevent conflicting water use objectives arising from poor water quality.

II. 2. Ensure that land use in rural and urban areas is compatible with water bodies and adapted to the climate

Baseline

- According to data from the third National Forest Inventory in 2012, forests cover around 11.4 million hectares of Germany's total area, which is just under one third of Germany's total area (31%).
- Agricultural land in Germany accounts for around 16.6 million hectares (46%). Roughly 11 million hectares is used for farming, followed by grassland with 5 million hectares and permanent crops (e.g. viticulture). 1.8 million hectares of Germany's agricultural land is farmed organically.
- In 77% of surface water bodies and 29% of groundwater bodies, the impact on the water status can be attributed to the surrounding land being used for agriculture. In 67% of all surface waters and in 7% of all groundwater bodies, impacts on water status can be attributed to industry and mining. In 35% of surface water bodies and 3% of all groundwater bodies, pollution can be traced back to municipalities and households[16].
- In Germany, inland fisheries currently manage around 225,000 hectares of lakes, dams, rivers and canals. This corresponds to around one quarter of existing water areas in Germany. Most of these areas are used for recreational fishing.
- The majority of Germany's freshwater fish production stems from aquaculture, with the most important being fish in flow-through, cold-water systems (trout farming). The total area of managed ponds is estimated at around 24,000 hectares. In addition, fish are also farmed in technical aquaculture facilities with recirculating water that operate largely independently of the availability and quality of surface waters.
- Land for human settlements and transport infrastructure accounts for 14% of the total area. Of this total, about 45% is currently sealed, i.e. built up, covered by concrete or cobblestones, paved or otherwise sealed. Diverse substances run off from these areas to mix with leachate.
- The impacts of the climate crisis are intensifying the already existing pressure on land-use systems, ecosystems and water resources and impairing ecosystem services (e.g. self-purification of water bodies, water retention, filtering and purification in living soil, groundwater recharge, sink function).
- The more frequent occurrence of extreme events (such as dry soil and heavy rainfall) caused by the climate crisis poses a serious problem for agriculture and forestry, but also for the preservation of nature conservation assets (e.g. habitats and species). Extreme events can lead to nutrient input and pesticide discharge as a result of the associated erosion (drift or runoff) and surface runoff and drainage, and contribute to local damage and pollutant discharge into surface waters.
- Climate change leads to longer periods of high temperatures, which foster the formation of heat islands, especially in town and city centres. They pose a risk to human health.

[16] BMUV/UBA "Die Wasserrahmenrichtlinie - Gewässer in Deutschland 2021 – Fortschritte und Herausforderungen" - https://www.umweltbundesamt.de/publikationen/die-wasserrahmenrichtlinie-gewaesser-in-deutschland

- Promoting semi-natural and sustainably managed forests increases groundwater recharge rates, water availability and water quality.
- The further drop in groundwater levels and the changed precipitation regime are causing more greenhouse gases to be released from floodplain and peat soils and making rewetting measures more difficult. The vast majority of peatlands are used for agriculture and forestry. These drainage-based land use types generate high greenhouse gas emissions as well as nutrient inputs into the adjacent water bodies.
- A wide range of nature-based solutions#, but also technical processes for use, evaporation, infiltration and storage of rainwater are already available in urban areas.

What are the challenges?

Shaping land use to meet future needs has recently become the focus of social and political discussion for many reasons. The type of land use will also play a major role in achieving the goal of greenhouse gas neutrality by 2045 and in preserving species-rich natural and cultural landscapes. It is also highly relevant for maintaining a semi-natural water regime and protecting water resources. At the same time, a stable, semi-natural water regime is a key prerequisite for viable land use in future.

Agriculture and forestry produce food and animal feed as well as renewable raw materials for use as materials and energy. They are therefore extremely important for the security of supply in our society both today and in the future. The impacts of the climate crisis and shrinking water resources, especially in the spring and summer months, will affect agriculture and forestry in particular, as well as aquaculture but also nature conservation. Longer and more intense dry periods will pose an increasingly serious problem for agriculture, resulting in crop failures and shortages in animal feed. These crop failures can affect food security in Germany. Adapting# agriculture and forestry to these new climate conditions can lead to interactions with nature and the environment, including water bodies.

The economic and regulatory conditions (set by sector-specific legislation and the EU's Common Agricultural Policy, state support, food retail, etc.) and our eating habits shape the way we treat nature in agricultural production. In some regions, for example, when too much livestock is farmed on land inadequately equipped to cope with the accumulated nutrients, this can lead to excess nutrients that pollute water bodies. In the long term, livestock farming oriented towards the amount of land will contribute to a semi-natural water regime and the functional capacity of water ecosystems. When it comes to protecting water bodies and drinking water, organic farming has advantages over conventional farming as no synthetic chemical pesticides and mineral fertilisers are used. The goal pursued in organic farming of nutrient cycles that are largely closed also generally contributes to significant reducing nutrients in the system and lowering the risk of discharge.

Fine sediment from topsoil removed from agricultural land can often cause blockage (colmation) of the water body floor in water bodies with coarse substrate. This effect is intensified by insufficiently low runoff levels, which do not allow water to flow unhindered due to reduced water resources as a result of climate change on the one hand and competing uses on the other. The gravel gap system serves as a valuable habitat, for example for macrozoobenthos and as a spawning ground for some species of gravel-spawning fish (such as salmon, brown trout and grayling). When colmation occurs, they can no longer spawn successfully. Both functions, as well as the interchange between water bodies and groundwater, can be severely impaired by excessively high fine sediment loads. Unused or low-impact riparian buffer strips along water bodies are of particular importance. They not only reduce the discharge of nutrients and pollutants, but also provide shade for the water bodies. Topsoil erosion must also be prevented to protect the soil and maintain soil fertility.

Forest ecosystems are of immense importance in terms of their ecosystem services[#], e.g. as water reservoirs, water filters, habitats, carbon sinks, climate and heat regulators, recreational areas and raw material suppliers. Sustainable forestry with the aim of developing and maintaining climate-resilient and species-rich forests is particularly beneficial to the long-term preservation of these services.

Fisheries and aquaculture contribute to the food supply for the population. From a global perspective, sustainable aquaculture in particular is believed to have the potential to contribute significantly to food security for future generations as it has the best life cycle assessment compared to other animal protein production methods. However, aquaculture in Europe (especially in Germany) is developing increasingly counter to the international trend and is stagnating. For aquaculture, the main challenge is likely to be preventing additional pollutant discharge in line with the EU Water Framework Directive.

In German towns and cities, the degree of soil sealing is still on the rise due to pressure to establish more and more settlements and increasing population density. Most of the rainwater is discharged into the sewage system. This impairs rainwater infiltration and leads to high surface runoff at certain points during heavy rainfall. The result can be more urban flash floods and flooding. At the same time, the effect of heat islands occurs more frequently in town and city centres due to the high degree of sealing and/or the lack of green spaces and cold air corridors. The natural cooling function of damp soil and groundwater recharge are diminished by the immediate runoff of falling precipitation. Making the concept of a water-smart city a reality continues to be a challenge. The aim of water-smart cities is to keep changes to the natural water regime caused by residential activities low in terms of quantity and pollutants.

Solutions to the practical implementation of water-smart cities can essentially be divided into the following five areas: 1) Remove obstacles in the planning process, 2) Advance semi-natural and technical planning and design of measures, 3) Review the legal framework, 4) Create funding and financing opportunities and 5) Eliminate other barriers to implementation, e.g. by empowering stakeholder groups.

In all five areas, systematic transfer is generally possible. However, widespread implementation often fails due to other individual objectives or political and practical constraints, such as financing issues.

These obstacles to implementation are particularly relevant in existing buildings. Even though it is much easier to implement water-smart urban development measures in newly planned areas, the percentage of new areas is small compared to existing residential buildings. This is why the basic potential for improvements in terms of water-smart cities and water services that help protect the population from heat and cool the environment (e.g. drinking water fountains, tree pit installations or green roofs) must be used more intensively, especially in existing residential areas. Planning processes and solutions for existing and new developments must be approached in different ways.

In addition to implementation of the sponge city concept and thus increased structural integration of rainwater into the water supply through the retention, storage and use of rainwater, the options also include the use of process or grey water, especially in urban areas. Existing solutions for the (re)use of rainwater or some wastewater flows in households (for purposes other than water for human consumption (drinking water) as described in the Drinking Water Ordinance (TrinkwV)) as well as for watering urban green spaces should be increasingly put into practice, taking into account hygienic and ecological aspects, and new solutions should be tested. To this end, obstacles must be removed (for example, to using rainwater from private roofs for watering public green spaces) and general conditions (including a review of financing options) must be improved.

The interconnections and interdependencies between towns and cities and their surrounding areas are often functional and not always free of conflict. Towns and cities rely to a considerable extent on the surrounding region for their water supply. Land uses and land-use changes in the surrounding areas therefore affect the urban water supply. Towns and cities discharge wastewater and rainwater, including the substances they contain, into water bodies; they affect the regional water regime, which impacts the surrounding area. Water uses in towns and cities can compete with uses in the surrounding areas, for example between different water users such as farmers, public water suppliers, nature conservation or even tourism and irrigation in urban areas. When it comes to land use, competing needs for space can also lead to conflicts of use between towns and cities and their surrounding areas, for example when land needed for flood risk management (retention areas) or water supply (water protection areas) is reallocated to benefit urban areas in the surrounding region for instance energy production or the production of food or animal feed. The surroundings of towns and cities are also often popular recreational areas. Due to these interdependencies, closer cooperation and coordination between regional administrations pose a challenge for the future (see also section II. 7.).

Vision – Land use in rural and urban areas is compatible with water bodies and adapted to the climate in 2050

Much progress has been made in the implementation of the EU Water Framework Directive. The status of water bodies is good in terms of water quality, species composition, structural richness and continuity. The semi-natural[#] water regime has been restored in terms of quantity, quality and dynamics (see section II. 1.). Conflicts of use are prevented with established management and use strategies for the landscape hydrology. The needs-based and efficient irrigation of farmland and green infrastructure in towns and cities, as well as the conservation of water-dependent habitats and species, are ensured. Springs and spring channels have been restored.

Water is retained as long as possible over a large area, the soil and landscape hydrology have been stabilised (balance between rainy and dry phases). Drainage channels and drains for agricultural and forestry land have been, as far as possible, dismantled or repurposed for water retention or even irrigation. Irrigation ponds and cisterns help offset the need for agricultural water during dry periods.

The possibilities offered by digitalisation in farming are used to determine and properly meet irrigation and fertilisation requirements tailored to the location so as to reduce nutrient inputs and pollutant discharge from agriculture. In accordance with the principles of integrated pest management, pesticides are only applied as a last resort and using drift- or loss-reducing application methods, while also taking ecological damage thresholds into account wherever possible.

Sustainable agriculture is based on location factors, protects the soil with its natural soil functions, integrates water reservoirs and contributes to pollutant-free groundwater recharge. Agricultural land is managed such that it supports the goals of water and nature conservation and flood protection, adaptation to the climate crisis as well as climate change mitigation and greenhouse gas neutrality, while ensuring the supply of safe food and animal feed as well as the income needed by farmers to practice sustainable farming. The development of livestock numbers must then be based on the amount of land available. In addition, cooperation between livestock farms and farms growing market crops can expand crop rotations and increase crop diversity. This increases the elasticity of farmland use and helps to compensate for a shortage of land available for animal feed production caused by the climate crisis. Regionally produced animal feed is mainly used for livestock, thus creating regionally closed nutrient cycles, which reduce the risk of water pollution.

Using a combination of instruments, e.g. support for ecological services and regulatory requirements, it is possible to manage floodplains and riparian buffer strips with minimal impact, as well as to restore floodplain habitats and natural river dynamics with semi-natural retention areas. Low-impact wetland management on suitable sites beyond floodplains and riparian buffer strips as habitats and for the production of essential renewable resources has also been achieved. The potential of organic farming to protect water bodies and water resources is increasingly harnessed. The goal of expanding organic farming to 30% of agricultural land by 2030 has been achieved.

Climate-resilient forest ecosystems help in particular to preserve biodiversity, mitigate climate change, adapt to the climate and protect water bodies. They protect the water regime and water bodies by filtering, storing and releasing water over time, thus contributing to groundwater recharge. They therefore alleviate flooding by delaying peak runoffs. They counteract erosion by water and wind, landslides and humus loss. They sequester nutrients and carbon in their biomass and in the soil. Sustainable forestry with the aim of developing and maintaining climate-resilient and species-rich forests is particularly beneficial to the long-term preservation of these services.

Sustainable fisheries and aquaculture make an important contribution to food security. Inland fisheries benefit from the conservation or restoration of biodiversity and intact ecosystems in inland waters. Environmental pollutants, increased nutrient levels or lower oxygen levels no longer lead to direct or indirect impairments of the fish population and the fishing yield. Ecosystem services of low-impact aquaculture, such as pond landscapes, have positive impacts on the water regime, economic added value (aquaculture), nature conservation (amphibians, birds, etc.) and recreation. The importance of sustainable fisheries and aquaculture is also recognised from a legal, political and social perspective as part of the implementation of the EU Water Framework Directive.

Water-smart urban development is well established. It pursues the goal of unsealing as many surfaces as possible and promoting the storage, infiltration and evaporation of rainwater as well as the use of rainwater and grey and process water in urban areas. An intact urban water regime is characterised by good water availability for urban vegetation and irrigation of the green infrastructure, enhanced evaporative cooling and reduced risks from flooding. Urban bodies of water are important habitats for native animal and plant species and provide opportunities for local recreation as a space for experiencing nature. The good chemical quality of the city's water bodies and the rainwater it uses is ensured.

Municipal, regional and federal state administrations cooperate closely at all levels and in all areas and ensure that water policy objectives are incorporated into other policies and, in particular, that land requirements for water body development[#], quantitative and qualitative drinking water resource protection and green-blue infrastructure are prioritised in spatial planning commensurate with their considerable importance.

What needs to be done?

With regard to farmland and forested areas, a framework strategy that aims to permanently maintain a semi-natural and functional water regime must be developed in dialogue with representatives of agriculture, forestry, water, soil and nature conservation. The aim is to identify and describe practical measures for water use in agricultural management and in particularly vulnerable areas of forestry management so that enough water is available to preserve and restore ecosystems and biodiversity and maintain the water supply for humans, as well as to support consistent pursuit of best practices. At the same time, water availability must be ensured to secure the supply of food for the population, and it must be possible to integrate new strategies, e.g. sustainable biomass strategy. In this way,

components will be agreed upon by regional stakeholders for regionally and locally adapted management measures related to the implementation of regional guiding principles for the semi-natural water regime (section II.1.). These components combine ecological effectiveness with economic efficiency#.[17] Changing overall conditions, in particular due to the climate crisis and the potential scarcity of water resources, must be accounted for through regular evaluation.

A national practical handbook that summarises and explains the relevant legal and sub-legal regulations on water conservation and links them with proven solutions and management methods will be created in an interdisciplinary process (practitioners' dialogue on water and agriculture taking into account nature conservation and climate action) and made available to farms to facilitate implementation of water-optimised and climate-adapted land use practices. This can also be used as a basis for agricultural vocational training.

By implementing specific measures and support programmes tailored to organic farming, additional incentives will be created to ensure that 30% of Germany's agricultural land is farmed organically by 2030. In particular, these incentives should be established in drinking water protection areas and in the catchment areas of withdrawal points for drinking water abstraction.

The development of livestock numbers must be based on the available land. The European requirements to reduce nitrogen inputs into water and air are taken into account in the federal government's support.

The objectives of the National Water Strategy should be included when updating the National Strategic Plan under the EU Common Agricultural Policy (CAP). Measures on farms to improve natural water retention in the agricultural landscape should be promoted, in particular through agri-environment-climate measures (AECMs) and pillar 1 organic schemes.

Sustainable agriculture that is compatible with soil and water bodies will be supported by education, training and support programmes as well as incentive schemes and advisory services that minimise the impacts of the climate crisis and land management on the regional water regime and the risks posed by more frequent and more intense extreme events. The creation of irrigation ponds and cisterns will be supported in particular by simplified licensing procedures.

It is essential to have water use plans for large areas that take into account future planning and developments and provide guidance for permitting water withdrawals for the various uses. They must include the irrigation needs of agriculture primarily for food production as well as the requirements of water-dependent habitats for sufficient groundwater levels and landscape hydrology. In the process, they will promote implementation of water-saving measures by all water users and of appropriate quality standards for irrigation in agriculture, see also section II.5. on infrastructure.

Important measures, such as climate adaptation of farmland irrigation and drainage, protection of water body margins (or sustainable, low-impact use subject to certain conditions), the creation of semi-natural rainfall storage reservoirs (ponds of different sizes, fire water ponds), greater integration of pond areas into these types of reservoir systems, as well as the rewetting of peat soils and wetlands or the restoration of spring and floodplain habitats, will be implemented and promoted under the relevant programmes where possible. In line with the goals of the EU Biodiversity Strategy, 30% of water bodies will be protected under nature conservation law and 30% of degraded aquatic habitats will be restored. These measures will improve groundwater recharge, water retention over a large area

[17] Coalition agreement 2021, p. 58

and the regional water regime. Water conservation is firmly established in action plans and measures of the National Strategy on Biological Diversity (NBS). Coniferous forests will be consistently developed into climate-resilient and species-rich mixed forests with predominantly native tree species. They will therefore contribute to groundwater protection and recharge, but also to forest resilience.

To implement, regularly review and, if necessary, adapt these measures, the stakeholders should be well connected through cooperative regional approaches, e.g. legally legitimised regional participation formats with equal representation such as water councils[18] that advise and support authorities and land users.

Renewable raw materials will also play a role in achieving greenhouse gas neutrality by 2045. In line with the cascade principle, they must be used primarily as materials, to the extent that this is economically and technically feasible. In addition to taking into account the potential of available sustainable biomass, cultivation of these raw materials must also be consistent with water policy goals. For example, planting with native woody vegetation and reed species on suitable sections along the banks of water bodies can contribute to erosion reduction and to nutrient retention on water body margins. This serves to protect water bodies and produces renewable raw materials, while not impairing the natural habitats and species of the water bodies and their banks/floodplains. These forms of use that combine water and nature conservation with production, including the use of low-impact grasslands, must be promoted. In this way, nature-based climate action and water-optimised land use are combined.

Forests will be managed so as to maintain and, where possible, improve the water storage function and water retention capacity of the forest soil. Forest management must contribute, wherever possible, to mitigating surface runoff from precipitation and replenishing soil water reserves/groundwater. These goals should be supported by appropriate incentives for additional water ecosystem services provided by forests. An assessment conducted as part of the planned revision of the Federal Forest Act (BWaldG) will determine the extent to which progress can be made on these issues.

To the extent that requirements of the aquaculture sector are compatible with the objectives of the EU Water Framework Directive, competent authorities of the federal government or federal states will seek to take these requirements into account when implementing the Directive. Low-impact aquaculture facilities, such as pond landscapes, will be maintained and promoted for use as fish ponds. The interests of sustainable fisheries and aquaculture will be taken into account and supported.

To prevent soil erosion caused by water, a wide range of practical measures must be formulated in detail in the soil protection and agricultural recommendations. These recommendations for measures must be implemented more fully in practice. Agricultural measures designed to reduce erosion must be effectively supported by structural agricultural measures involving land development and land consolidation. In this context, greater account must be taken of the dangers posed by water runoff and soil erosion.

In the Integrated Rural Development funding area of the GAK (Joint Task of Improving Agricultural Structures and Coastal Protection between the federal government and federal states), the measures will be continuously developed to reflect the challenges mentioned above. In future, land development instruments, in particular those involving land organisation, will be used more intensively for climate

[18] In this case, similar to hunting councils or water associations.

change adaptation, precautionary measures to prepare for extreme weather events, sustainable water use and peatland protection and development. Increased attention will be paid to carrying out and supporting complex planning and to mobilising participation of the public, municipalities and other local and regional stakeholders. By using land organisation instruments, conflicts of use can be prevented over the long term. Ways to simplify the relevant procedures (land consolidation) should be explored.

Water-smart urban development is a key component of climate-friendly, liveable towns and cities and an important part of integrated planning. The guiding principle of the water-smart city will be further developed with a practical and feasible approach and linked to proposed measures for implementation in the municipalities. The aim is to strengthen the sustainable use of water in general, specifically rainwater, in towns and cities. This includes issues such as infiltration, evaporation, storage of rainwater and management of heavy rain, use of process water and rainwater, minimisation of pollutants and the development of ways to adapt to hot and dry periods in towns and cities (e.g. prioritising decentralised rainwater management# in new residential and commercial areas over discharge into sewage systems, with particular consideration of heavy rainfall events, flood prevention, reduction of heat stress). Support will be provided for decentralised municipal rainwater management.

As a result of the climate crisis, the frequency of dry periods and prolonged phases of drought is expected to increase. The development of alternative water sources should therefore be promoted, taking strict account of legal, hygienic and environmental concerns, also for the water availability of urban green spaces and urban trees, e.g. through irrigation with treated wastewater, through the use of process, grey water and rainwater in households, public facilities and industry, and through the recirculation of process water.

Hydroecology and opportunities for people to experience their natural surroundings must also be integrated into the guiding principle of the water-smart city. To achieve this goal, a broad, interministerial and interdisciplinary discussion of the need for action as well as specific implementation activities to be taken in the various action areas is needed. The technical, planning and enforcement levels should be involved in the process from the outset. Targeted information materials or model plans provided in cooperation between the federal government and the federal states can support compliance with and implementation of the guiding principle of the water-smart city in municipal planning offices. In addition, municipalities must be supported in preventing and managing heavy rainfall events and in adapting to climate change. [19]

Specific projects will be carried out to demonstrate how unsealing land can restore infiltration capacity in different urban development contexts. In a dialogue format involving relevant stakeholders (municipalities, industry, agriculture, associations, etc.), the first step will be to jointly identify sector-specific challenges for unsealing and to develop solutions. To put these solutions into practice in the next step, tailored, i.e. stakeholder- and area-specific unsealing projects and foundations for integration in and coordination between relevant funding programmes (e.g. federal programmes for climate adaptation and nature-based climate action, village development under the GAK, urban development funding) will be developed. Greater prevention of land use through construction measures must be incorporated into building planning and laws. At the same time, requirements for new construction projects must prevent further increases in land used for human settlements and transport infrastructure beyond what is required to achieve the objective pursued by the construction

[19] Coalition agreement p. 93

project. Only by consistently employing all of these instruments will it be possible to achieve circular land-use management by 2050.

II. 3. Further develop sustainable management of water bodies – achieve and preserve good status

Baseline[20]

- Over 91% of all surface waters currently fail to achieve good ecological status and/or good ecological potential as defined in the WFD, The main reasons are inadequate habitats for aquatic fauna and flora, but also anthropogenic discharge and pollutants.
- In Germany, the water body structure of watercourses was mapped and assessed over a distance of nearly 105,000 km. As a result, more than 60,000 km were classified as significantly to completely modified. Many transverse structures in watercourses prevent the linear passage of fish fauna. Migratory fish that alternate between fresh and salt water are also particularly affected, such as eel, salmon, sea trout, river lamprey, whitefish and allis shad.
- Depending on their design, transverse structures can also trap considerable amounts of sediment. Coupled with river straightening and longitudinal obstruction, rivers often lack floodplain dynamics and possibilities for redistribution, resulting in a lack of sediments, especially gravel. This affects the quantity and composition of the sediments that flow to downstream sections of water bodies because coarse sediments in particular are lacking. This can erode the floor of the water body.
- 80% of the standing and running water habitats and 65% of the fish species listed in the Habitats Directive do not have the required favourable conservation status. 43% of the habitat types have a poor conservation status.[21]
- The fish communities also fail to achieve good environmental status according to the Marine Strategy Framework Directive.
- Floodplains are natural inundation areas that can ease floodwaters and prevent or mitigate damage when flooding occurs. They are also hotspots for biodiversity. In the past, rivers have largely been cut off from these floodplains. Now, during major flooding events only around a third of former floodplains are available for inundation by rivers with catchment areas larger than 1,000 km^2.
- Due to coastal protection measures (embankments), there are no longer any large-scale floodplains in the proximity of the tidal rivers. Anthropogenic influence also has an impact on the hydrological conditions in tidal rivers. This impairs estuarine habitats, e.g. shallow water areas, in many ways, making coordinated sediment management in tidal rivers necessary.

What are the challenges?

Intact river landscapes and floodplains are among the most biodiverse habitats in Central Europe. Natural water bodies are an important component of species and biotope conservation. The immense potential of semi-natural rivers and floodplains to absorb and store carbon from the atmosphere must be leveraged for nature-based climate action. Semi-natural watercourses and floodplains also have the potential to increase resilience to the impacts of climate change and help protect biodiversity. Semi-natural floodplains regulate runoff when water levels are high or low and can mitigate the impacts of climate change on landscape hydrology. They retain significant amounts of water in the landscape with a positive impact on vegetation and microclimate (cooling).

[20] The facts provided in the baseline sections can be found with all sources in the scientific background on the strategy (see UBA texts 86/2021).

[21] The reference value for the percentages is the sum of the individual assessments of the freshwater habitat types and fish species in the specific biogeographic regions (Atlantic, Continental, Alpine) as there is no overall evaluation for the whole of Germany.

There are many ways to harness synergies[#] between water body development[#] and nature conservation, e.g. in flood protection and water retention over a large area. Tapping these synergies can facilitate the preservation and restoration of many ecosystem services[#]. This includes increasing the resilience of water-dependent ecosystems to changes, e.g. due to the climate crisis, as well as relevant claims for human use such as energy production, leisure and recreation, flood protection and shipping. Linking the necessary protection and preservation of ecosystems on the one hand and the appropriate use of water bodies and adjacent floodplains by humans on the other requires a high degree of cooperation, a willingness to compromise and effective strategies for integrated water body management.

The Water Framework Directive is the central instrument for water body development[#] and management at European level. It is intended to provide essential support for the implementation of the Habitats Directive for water-dependent species and habitat types of Community interest and is particularly important for floodplain protection in Natura 2000 protected areas. Implementation of these Directives will also contribute to achieving the goals of the Marine Strategy Framework Directive, for example to ensure conditions for the natural distribution and migration of species moving between marine and freshwater habitats. Many programmes of the federal government and federal states are designed to implement the Water Framework Directive with the aim of ensuring that all water bodies have good status or good ecological potential. The aim is to achieve this objective by 2027. Since the objective also applies beyond the target year, regular review and, if necessary, adaptation of the management plans and programmes of measures will continue to be necessary to account for changes that have occurred, for example due to the climate crisis or changes in use. The Natura 2000 network requires a favourable conservation status for species and habitat types. The sustainable management of water bodies and their floodplains is a decisive factor in successfully implementing the Water Framework Directive, the Marine Strategy Framework Directive and the Birds and Habitats Directives.

The protection of these valuable river-floodplain ecosystems is also a component of the EU Biodiversity Strategy for 2030 in the framework of the European Commission's Green Deal. The important goals here are increasing the number of protected area designations, restoring intact ecosystems using efficient measures, restoring continuity (target: 25,000 km of freely running water in Europe) and strictly implementing the existing legal provisions.

Despite the many efforts of the federal government, federal states and municipalities, water bodies have in many cases not yet achieved good status or favourable conservation status of water-dependent habitat types and species listed in the Habitats Directive as well as species of water birds. It has become clear that in our complex industrial and service-based society with diverse use interests, the status of water bodies and floodplains can only be improved using interlocking measures at all levels of management. Examples include nature-based solutions and measures that reflect environmental, social and economic concerns. The revitalisation of floodplains and river landscapes can therefore also create new goals for local recreation (e.g. water sports compatible with nature) or support groundwater levels near rivers, generating positive impacts for nearby water abstraction.

One particular challenge for the federal government and the federal states is to achieve the ecological objectives the WFD, especially the establishment of continuity for native species and sediments, and the implementation of hydromorphological measures.

Also as a result of the often restricted continuity for sediments, the watercourses become too deep, particularly in the middle and lower sections, which can result in the river and floodplains becoming disconnected. This leads to insufficient sediment at the mouths of many rivers (delta formation) and for replenishing coastal sediment. The sediment regime and a quantitative sediment management

approach based on this regime, which includes measures to improve sediment continuity or to compensate for insufficient sediment (e.g. by adding sediment artificially), must be taken into account. In order to prevent rivers from deepening further and to reconnect the floodplains to the water bodies, measures to raise the riverbed may be necessary.

The required measures must be aligned with, for example, the requirements for shipping use, hydropower and flood risk management on federal waterways. The Federal Waterways and Shipping Administration (WSW) is responsible for restoring the ecological continuity of hydraulic complexes along federal waterways that it builds or operates, as well as for development measures on federal waterways designed to implement the water management objectives of the WFD. The challenge for the federal states is also considerable due to their responsibility for implementing the WFD, e.g. for drawing up the management plans and programmes of measures.

For a variety of reasons, it is currently not possible to implement the necessary measures in all water bodies, or they can only be implemented slowly. This is often due to a lack of available land, e.g. for necessary restoration measures, but often also due to other priorities in how human and financial resources are used, complex planning and approval procedures, and a shortage of qualified professionals. For example, for these reasons, 60% of the planned measures to improve the structure of water bodies by 2018 have not started yet.

Successful implementation of the WFD also depends on measures in other sectors. A coherent and enforceable water conservation policy can only be achieved on the basis of further and stronger support for and integration of water policy objectives into other policy and regulatory areas such as agriculture, hydropower, spatial planning and regional development.

The great potential for synergies with the strategies and goals of nature conservation, particularly with regard to flood protection, protection of floodplains and creation of a biotope network, should be leveraged wherever possible. The Floods Directive refers explicitly to its synergies with the WFD (see also LAWA recommendations on the coordinated application of Directive 2007/60/EC and Directive 2000/60/EC – Potential synergies in measures, data management and public participation). Germany's Blue Belt programme can also play a key role in federal waterways.

The objectives of the WFD, MSFD, the Habitats and Birds Directives and the European Green Deal are ambitious; the challenge lies in balancing these objectives with the range of uses. Progress was made, for example, in restoring the continuity of watercourses. It is time to build on this progress; sustainable water body management remains an ambitious ongoing endeavour.

Vision – Sustainable management of water bodies in 2050

All watercourses and water bodies have achieved good ecological status or good ecological potential as defined in the WFD for a longer period of time; the freshwater habitat types and species listed in the Habitats Directive have a favourable conservation status. Where this is not yet the case due to natural circumstances, for example in ecosystems with longer regeneration phases, a clear trend towards improvement is apparent.

There are adequate numbers of high-quality habitats for the flora and fauna in surface waters and adjacent floodplains, especially for species that are classified as threatened in the Red List. Habitats, fauna, flora and the groundwater are protected by networked biotope structures. The uses of water bodies are designed to be compatible with the protection of these ecosystems.

Appropriate structural and technical measures have been taken in response to the climate crisis and biodiversity loss to enable sustainable, integrated water body management. This includes restoring and revitalising straightened and sealed rivers and streams, performing low-impact maintenance, reconnecting former floodplains and tributaries and linking them to groundwater reserves and creating

inundation areas and shallow water zones. Semi-natural landscape hydrology and adequately high groundwater levels are permanently ensured for as many peatlands, wetlands, water-dependent habitats and forests as possible. The water regime is in harmony with water uses.

Along federal waterways, the ecological objectives of Germany's Blue Belt programme have been achieved in all areas (modification and dismantling, continuity, maintenance, biotope network and floodplain development). The objectives of the WFD have been achieved and are reviewed and ensured on an ongoing basis. The development of the legal framework in Germany has fostered tighter links between management planning (in accordance with the MSFD, WFD and the Birds and Habitats Directives) and spatial planning, nature conservation and land management.

Sediment management plans exist for the river basins. The qualitative and quantitative inadequacies related to sediments are addressed through water body and sediment management measures.

What needs to be done?

The WFD and the Birds and Habitats Directives must be continuously implemented. In this context, the ambitious objectives of the WFD must continue to be pursued despite the still existing inadequacies in water body quality, the increasing pressure due to multiple uses and the challenges posed by the climate crisis. The evaluation principles of the directives ensure that all pressures are taken into account, including human uses of the landscape developed over decades.

When protecting ecosystems relevant for the water regime and water conservation, it is important to ensure that they retain their ecosystem functions despite the changes caused by the climate crisis, i.e. they are resilient. Protection and management may be limited by the lack of local water availability in water bodies due to climate change. Climate resilience requirements must also be aligned with the Marine Strategy Framework Directive, the Floods Directive and the EU's Green Deal.

The nature conservation and water management requirements for implementation of the Habitats and Birds Directives and the WFD must be jointly assessed at an early stage and included in the management plans, and specific measures must be effectively implemented, taking into account all interests. The hydraulic infrastructure and the maintenance measures on and around watercourses must enable both their continuity as well as semi-natural morphology and natural dynamic processes when integrating and reconnecting floodplains. The land users along water bodies must be sensitised to the need to strengthen the ecological function of the watercourses so that they are more likely to accept the measures. In addition, the institutions responsible for water body maintenance (federal state administrations, municipalities, water body maintenance and water management associations or other special purpose associations, the Federal Waterways and Shipping Administration) must undergo comprehensive further training and acquire the necessary implementation skills.

Efforts to create a coherent biotope network between federal states must be further intensified. Watercourses and their floodplains are particularly suitable as natural interconnected structures, together with semi-natural pond landscapes. This supports implementation of the goals and objectives of the Birds and Habitats Directives and the WFD, Germany's Blue Belt programme and the EU Biodiversity Strategy for 2030. For national implementation of the objectives of the EU Biodiversity Strategy, a plan must be developed, its implementation tested in a pilot region and the necessary measures integrated into the programmes of measures under the WFD and the Birds and Habitats Directives.

In addition to financial and human resources, sustainable water management also requires clear and transparent priorities and responsibilities for efficient planning and implementation of measures. Acceptance for carrying out measures needs to be strengthened by involving stakeholders and the public at an early stage, by holding consultations, providing recommendations for planning, financing and implementing measures and by supporting best-practice examples. The environmental, economic

and social benefits linked to the necessary measures must be clearly communicated by also showing the monetary value of ecosystem services. The consequences of inadequate water body management must be made clear to policymakers and private individuals.

The synergies between watercourse and floodplain development and conservation, promotion of biodiversity, climate adaptation, recreation, flood protection and low water management should be rigorously exploited and more space should be allocated for water body development. The land needed for this development must be determined and defined in land targets in order to establish a spatial allocation for restoration measures embedded in spatial planning and building law and to explore options for procuring and securing land. To this end, it would be helpful if the water sector made technical information on water body development corridors available to spatial planners in a user-friendly form. This requires nationwide planning to identify and map water body development areas. The aim is planning that secures the land needed for water body corridors and floodplains for the stringent, ecologically effective implementation of structural measures for water bodies. Greater use must be made of planning instruments for securing water body development areas (with the exception of federal waterways) in regional planning and urban land use planning under current law (inadequate implementation). The principle of developing, protecting and restoring the functional capacity of the water regime, which is laid down in the Federal Regional Planning Act (Raumordnungsgesetz, ROG) Section 2(2) (6), first sentence, generally allows for support of water body development areas such as water body corridors or future drinking water abstraction areas. The authorities responsible for water management and spatial planning at federal and federal state level will explore the specific implementation options in expert discussions on the basis of an evaluation of existing federal state spatial planning and development plans.

In addition, the introduction of a protected area category for water body development areas in the Federal Water Act should be considered in sectoral planning, following the example of flood control areas and water protection areas, in order to make the protection of water body development areas meriting special protection legally binding.

II. 4. Mitigate risks caused by pollutants

Baseline

- The level of anthropogenic pollutants discharged into water bodies captured by regular monitoring has decreased in Germany in recent decades.
- However, the level is still high enough that good chemical status of the surface waters (nationwide) and groundwater (33% of groundwater bodies) in Germany as defined in the EU's WFD has not been achieved. This is due in particular to ubiquitously occurring substances[#] caused by human activities such as mercury or brominated diphenyl ethers (found in flame retardants) or highly persistent per- and polyfluoroalkyl substances (PFASs) as well as inputs of nutrients and pesticides from various sources.
- Often, the higher concentrations of persistent substances measured in water bodies can be traced back to inputs from past years or even decades (PFASs have been in use since the 1950s). These inputs will negatively affect the status of surface waters and groundwater for many decades or even centuries to come.
- A nationwide sample carried out as part of an individual study to implement the National Action Plan on Sustainable Use of Plant Protection Products (NAP) shows that in more than 80% of small watercourses in the agricultural landscape, residues of pesticides exceed the concentrations deemed acceptable as part of the approval. Similarly, more than 80% of the water bodies studied show a reduced percentage of sensitive aquatic organisms such as

dragonflies and caddis flies. In other words, pesticides constitute a decisive stress factor for insects in small water bodies in the agricultural landscape.[22]

- Trace substances, e.g. pharmaceuticals and their residues, biocides, pesticides, cosmetics and other chemicals are detected in water bodies.
- Antibiotic-resistant bacteria and plastic particles are continuously detected in surface waters.
- In recent years, there has been an increase in the use of pharmaceuticals, partly due to demographic change. Studies show that this increase could be as much as 70% by 2045.
- 32.7% of groundwater bodies fail to achieve "good chemical status" as defined by the WFD due to excessive nitrate concentrations and other pollutants.
- 16% of groundwater bodies that do not meet the conditions for "good chemical status" show increasing trends in pollutant concentrations.
- Especially during periods when water is low, significant pollution is caused when treated wastewater is discharged into low-flow water bodies or in densely populated urban areas, e.g. through pharmaceuticals or biocides. Pollution also occurs during heavier rainfall when combined waste and stormwater systems overflow with untreated water.
- Sediments and floodplain soils continue to be contaminated with pollutants in some regions. Some of the removed sediments must therefore be deposited in suitable landfills instead of being returned to the water bodies. Low-impact use of floodplains is made more difficult by these kinds of pollutants.
- In the North and Baltic Seas, good environmental status according to the EU Marine Strategy Framework Directive is likewise not being achieved everywhere. Nutrients discharged into the seas through rivers cause eutrophication in coastal waters. Pollutants from rivers accumulate in marine waters.

What are the challenges?

The discharge of substances, substance groups[#], pathogens and particles[#] into water bodies can pose a risk[#] to human health and the environment. Despite considerable progress in a number of these parameters where water quality standards exist, the pollution of water bodies by pollutants discharged from various sources, such as industry, municipalities and agriculture, is still too high. In addition, new analysis and assessment methods have identified previously undetected pollutant loads in water bodies. There is often a considerable lack of knowledge and information about the hydroecological impacts of many substances and their combined impacts. Many substances only degrade very slowly or not at all in water bodies. In addition, some persistent transformation products are formed when substances degrade. These persistent substances can also be transported long distances into the seas and oceans and to remote places such as the Arctic or Antarctic. Persistent substances can therefore have long-term negative impacts on ecosystems and on nature conservation and species protection, as well as on the usability of polluted water bodies, both regionally and globally. Standardised methods for monitoring plastic particles and assessing their impacts on humans and ecosystems are lacking.

Already today, there is an extensive and complex set of rules to regulate substances. EU regulations play a key role here. They regulate, among other things, registration and authorisation requirements (which vary for chemicals, pesticides, biocides, pharmaceuticals, detergents and cleaning agents), emissions for wastewater discharge and quality standards for water bodies. However, the interaction of the different regulatory areas needs to be improved, also in the European Commission's view. For

[22] Liess M, Liebmann L, Lück M, Vormeier P, Weisner O, Foit K, Knillmann S, Schäfer RB, Schulze T, Krauss M, Brack W, Reemtsma , Halbach K, Link M, Schreiner VC, Schneeweiss A, Möder M, Weitere M, Kaske O, von Tümpling W, Gunold R, Ulrich N, Paschke A, Schüürmann G, Schmitt-Jansen M, Küster E, Borchardt D. 2022. Implementation of the National Action Plan on Sustainable Use of Plant Protection Products (NAP) – pilot study to identify the level of pollution in small water bodies of the agricultural landscape by plant protection products. UBA texts 07/2022

example, data from environmental risk assessments submitted as part of the drug approval process cannot be freely used to derive quality standards. European approval requirements must be further developed to make this possible.

One challenge is to significantly reduce the pollutant load of wastewater through measures along the entire value chain#. The wastewater load of the individual production stages as well as water-efficient products and manufacturing processes must be taken into account as early as the product design stage. This kind of integrated, multi-barrier approach# requires all stakeholders along the value chain, including producers and consumers, to act responsibly and cooperate with one other.

In addition to pollutants discharged from urban sources, including point sources, e.g. from wastewater treatment plants, pollution from diffuse sources plays a significant role. This includes the discharge of nutrients and pesticide residues, biocides and veterinary medicinal products from agriculture leached from soils into the groundwater or caused by surface runoff, drainage and erosion of land into surface waters. Risk mitigation measures, such as the creation of vegetated riparian buffer strips along water bodies, were stipulated in the 2020 Fertiliser Application Ordinance (DüV) and in Section 38a of the Federal Water Act for areas with an incline of >5%. In addition, the federal states have adopted their own regulations, some of which go even further. The amendment to the Use of Pesticides Ordinance, Pflanzenschutz-Anwendungsverordnung) in 2021 changed the general conditions for riparian buffer strips. It stipulates a ban on the use of pesticides along water bodies at a distance of 10 m and for vegetated buffer strips of 5 m. Monitoring the success of the measures requires a high level of enforcement and suitable monitoring strategies. In addition, ubiquitous substances such as mercury and polycyclic aromatic hydrocarbons (PAHs) from fossil fuel combustion are widely dispersed by atmospheric deposition and find their way into water bodies. Not to be underestimated are the diverse pollutants discharged from industrial and consumer products, such as additives or non-bonded monomers in plastics or from the use of materials containing PFASs, e.g. textile protectors, lubricants, fluorinated coolants and refrigerants, etc.

The input paths# are varied, and even where point sources (e.g. municipal or industrial wastewater treatment plants) can be identified, it is only in specific cases that measures and process combinations can be implemented to sufficiently reduce inputs into water bodies. In view of the large number of relevant substances – from the perspective of water conservation – which are already in circulation, it therefore remains a challenge to further improve production-integrated processes, operational chemicals management and wastewater treatment processes and to establish a best available technique standard in the existing regulations. To achieve this aim, it is important to work together at EU and international level, and close cooperation is needed in the international river basin districts to limit the risks posed by discharged pollutants.

Municipal wastewater, sewage sludge, livestock farms and slaughterhouses can be responsible for the spread of antibiotic resistance. These antibiotic-resistant pathogens are directly discharged into the environment together with wastewater, industrial fertilisers and sewage sludge. However, the antibiotics they contain can facilitate the emergence of resistance in the environment, also in water bodies, or promote which bacteria are selected, giving rise to antibiotic resistance. Other dangerous substances contained in wastewater, such as heavy metals, can additionally contribute to the selection of antibiotic-resistant strains. To bridge existing knowledge gaps, it is necessary to establish screening and monitoring capacities in wastewater, sewage sludge and water bodies. Other preventive and cross-sector measures are set out in the German Antibiotics Resistance Strategy (DART).

Plastics discharged into soils accumulate over the long term. The persistence of these substances coupled with mechanical fragmentation, causes ever smaller plastic particles (known as secondary microplastics) to accumulate, which can ultimately also be mobilised and enter the groundwater. Plastics contained in the soil can also enter surface waters through erosion caused by surface runoff.

Vision – Zero pollutants in 2050

The goal of the EU's zero pollution action plan is to ensure that pollutants discharged into water, air and soil are minimised to the extent that they no longer pose a risk[#] to human health and water bodies. This rules out any adverse effects on ecosystem functions or human health, also in the long term. Particularly harmful substances are limited to essential uses and are no longer in circulation.

The input paths[#] of substances[#], substance groups[#] and particles[#] relevant to water quality in water bodies are known along the entire value and use chains, and the risk of inputs is minimised by appropriate measures at the various stages of these chains. Producers, distributors and users take their responsibility for reducing and preventing relevant pollutant discharge seriously. Producer and product responsibility for water conservation is achieved through a combination of regulatory and market-based solutions at both EU and national level and creates incentives to continuously reduce discharge. In the area of agriculture and municipal wastewater management, measures have been implemented to reduce and prevent the discharge of relevant substances/substance groups into particularly polluted or sensitive waters and to protect the seas.

When developing, registering and approving substances, data about how a substance benefits or harms the environment is no longer inadequate and the uses and their risks for water quality have been fully identified and taken into account in the overall assessment. The precautionary principle is consistently applied (avoid, reduce, replace). Newly developed substances are required to be "safe by design"[#]. No authorisation is granted for substances or substance groups that, individually or in combination, have toxic effects on humans or aquatic ecosystems or have significant other unwanted effects on water quality, water bodies and their usability. In the case of exceptions, strict requirements apply to risk management based on an assessment of scientific risks. Uses are limited to yet to be defined essential uses to prevent unacceptable risks. Substances harmful to water bodies that were already introduced to the market in the past have largely been replaced by safer alternatives.

Proportionate financing by producers and distributors for the measures to be taken along the value and use chain, regulated at EU level, is an established component of the financing system, in addition to financing from the public sector and income from fees and charges. Knowledge and understanding of the behaviour and impacts of substances in the water cycle have vastly improved. Information on the risks to water bodies and their uses (e.g. drinking water supply) is available along the entire value and use chain. This is also true for information on the safe handling of products containing substances that pose a risk to water or water body quality, or possible alternatives to these substances. Transparent risk communication has improved general understanding and knowledge of the effects and their relevance (including combined effects) of point and diffuse source pollutants discharged into water bodies and seas, and makes it possible to assess and act independently. This enables consumers to make their choices and align their consumption habits with water conservation as well as other aspects.

Measurement and analysis methods that enable pollutants in water bodies to be systematically and efficiently identified and traced back to their sources are well established in water body monitoring. The analysis data is systematically integrated into the enforcement process. Substances, substance groups and particles are transparently assessed and prioritised with regard to their relevance for water bodies and their uses as well as their impact on nature and the environment. At the same time, the currently predominant focus on individual substances has largely been supplemented by a view based on substance groups. Methods and processes are available that prevent the discharge of dangerous

and persistent substances and make it possible to remove them from surface waters, groundwater and wastewater. This allows water body pollutants to be minimised or even eliminated, some of which have been polluting the environment for decades.

Nutrient pollution in groundwater and surface waters, including coastal waters, has been reduced to such an extent that the requirements for good status of groundwater and surface waters are reliably met and, for example, eutrophication processes in lakes and coastal waters are prevented.

What needs to be done?

Germany supports the zero pollution action plan presented by the European Commission as part of the Green Deal. This, together with the Chemicals Strategy for Sustainability, forms the European framework for measures to prevent harmful exposure to pollutants for humans and the environment. It will be supplemented by additional requirements, e.g. for emissions from industrial plants and agriculture, for the release of biocides, as well as strategies (of the European Commission) such as the Plastics Strategy, the Pharmaceuticals Strategy, the Strategic Approach to Pharmaceuticals in the Environment, the Farm to Fork Strategy and the EU Biodiversity Strategy for 2030. The last two aim, among other things, to reduce the overall use and risk of agricultural pesticides and antimicrobials by 50% and to achieve a reduction in nutrient losses of at least 50%. This is intended to achieve a reduction in fertiliser use of at least 20% by 2030. At international level, the current draft of the target for pollution reduction (Target 7) in the post-2020 global biodiversity framework (GBF) of the UN Convention on Biological Diversity (CBD) includes the aim to “reduce nutrients lost to the environment by at least half”. This target is still being negotiated under the CBD and is to be adopted with the GBF. The EU is working at international level to maintain this numerical target, in line with the EU strategies on biodiversity, farm to fork, zero pollution and soil. Germany’s National Sustainable Development Strategy defines a target of 70 kg N/ha as a five-year average by 2030 for the nitrogen surplus in agriculture. Major efforts are still required across sectors to meet these reduction expectations. To this end, the Federal Environment Ministry is drawing up a proposal for an overall strategy.

The activities envisaged at EU level and their implementation in Germany will help to reduce the exposure of humans and the environment to substances, substance groups and particles with a more integrated approach across the different environmental media and existing areas of environmental law. For example, the National Action Plan on Sustainable Use of Plant Protection Products already includes the target that by 2023, permanently vegetated riparian buffer strips have been established on 100% of water bodies on agricultural land, especially in drinking water protection areas, nature conservation areas and sensitive areas identified by hot spot analyses. The 2021 Use of Pesticides Ordinance also stipulates a ban on using pesticides next to water bodies at a distance of 10 m (without vegetated buffer strips) and 5 m for vegetated buffer strips. Extensive monitoring ensures nationwide implementation of the applicable law.

A diverse range of coherent measures in all sectors responsible will be developed to assess and manage the risk of substances along the entire chain – from production and use to recovery and reuse or disposal. The use of substances that exceed a relevant degree of harm or pose a relevant risk to water bodies, drinking water abstraction or agricultural irrigation, aquaculture and animal watering troughs will be restricted to essential uses to prevent unacceptable risks to water bodies and aquatic ecosystems from the very outset. Mitigation measures include substance substitution, measures integrated into production, water-saving measures, partial flow treatment and advanced wastewater treatment.

A milestone in this overall process are the results of the federal government's Trace Substance Strategy, which has been in development in a dialogue process since 2016. The recommendations from this process and other expert reports on the subject contain a variety of indications for the implementation and (further) development of measures to reduce trace substances. These will also be incorporated into the discussion at EU level. The German Centre for Micropollutants (SZB) founded in 2021, which is part of the Federal Environment Agency, supports these processes and provides technical advice. The measures from the trace substance dialogue with stakeholders must be continued and further developed. A list of especially relevant pollutants will be developed on the basis of the findings of this dialogue.

The federal government sees extended producer responsibility as a suitable instrument for providing incentives for measures to reduce the pollution of water bodies by trace substances and pollutants along the entire value chain. National, European and international producers or distributors of substances or products on the German market that lead to environmental pollution must contribute more to the prevention and elimination of the substances and the damage they cause to water bodies. Possible instruments are the enforcement of best available techniques, exclusion of certain applications, take-back or disposal obligations as well as contributions of producers or distributors to the proportionate financing of measures. For reasons of effectiveness and to avoid putting Germany at a competitive disadvantage, a suitable approach should be pursued at EU level.

Wastewater charges will be reformed with the aim of improving water conservation. In this context, polluter-based incentives[#] to reduce trace substance discharge must be considered.

Around many water bodies, further measures are necessary to reduce existing sediment loads, in particular to secure or, if necessary, remove existing contamination. To this end, national processing steps for sediments must be developed and linked to prevention measures. Alternative uses of extracted sediments must be further investigated in pilot projects.

Suitable instruments, also for the prevention of substance discharge into water bodies and soils as a result of operational malfunctions and incidents, in combination with constructing and retrofitting plants susceptible to malfunctions with best available techniques (see also BAT reference documents) to prevent and minimise relevant and unwanted discharge, will help to establish and implement measures in line with the multi-barrier principle[#] in the production of substances or products, in their use or in wastewater treatment. Examples include recommendations for low-pollutant construction, the expansion of wastewater infrastructure and the establishment of reduction targets for pollutants discharged into individual river basins, such as the 30% reduction target for micropollutants by 2040 for the Rhine agreed in 2020. Quality standards for protected assets, emission standards adapted to the best available techniques, substance- and product-related regulations as well as requirements for the reduction of pollutants prior to reuse or disposal must interlink and complement one other.

Further action is needed to define the quality requirements for protecting and monitoring surface waters, groundwater and the seas, and to define them for substances that have not yet been regulated but have been identified as risk substances. This will make it possible to continue to provide sufficient quantities of high-quality drinking water with semi-natural treatment processes[#] and to achieve the objectives of the Water Framework Directive.

At legal level, it will be necessary to identify and remedy the causes of enforcement shortcomings and regulatory gaps with the aim of facilitating enforcement. For example, water regulations to prevent or mitigate flooding must work in tandem with regulations governing plants that handle hazardous

substances (Ordinance on installations for handling substances hazardous to water (AwSV), Major Accidents Ordinance (12. BImSchV)) in order to prevent pollutant discharge from plants into water bodies as a result of flooding. The goal is also to lower the number of incidents and occurrences of damage in plants and thus reduce dangerous pollutants discharged as a result. National and international cooperation on harmful discharge must be improved not only in terms of alert and warning systems and hazard prevention, but also in terms of risk mitigation and prevention. One important prerequisite for this is across-the-board support for integrated risk management. Specific legal requirements for treating rainwater, reducing untreated water from combined waste and stormwater systems and preventing exfiltration of wastewater from leaking sewers can make an important contribution to reducing unwanted pollutant discharge into water bodies and soils. This also applies to the adaptation of the retention capacities of wastewater facilities to the anticipated more frequent occurrence of heavy rainfall events.

From 2023, the risk-based approach of the EU Drinking Water Directive for the catchment areas of drinking water withdrawal points for drinking water abstraction must be transposed into national law. Member states must ensure that by July 2027, the risk assessment and risk management of catchment areas of withdrawal points of water intended for human consumption is carried out for the first time. In addition to an assessment of this catchment area, which includes the identification of hazards and hazard events as well as the evaluation of their possible risks for drinking water quality, an appropriate risk management system must be developed and implemented. One of the aims is to protect the catchment areas of water withdrawal points for drinking water abstraction from contamination and thus reduce how much treatment is required for drinking water abstraction.

Soil protection laws will also be reviewed in this context, particularly with regard to plastics and new pollutants. In future, more importance must be attached to the precautionary principle in particular, so that contaminants do not lead to harmful changes in the soil and then to contaminated sites, especially as it is not always possible to clean up soil once it has been contaminated.

With regard to water conservation, the interaction between the EU Environmental Quality Standards Directive, the requirements for best available techniques under the EU Industrial Emissions Directive and the Urban Waste Water Directive, as well as EU legislation on chemicals, biocides, pesticides and medicinal products must be improved. This is also true for links to other areas of law such as agricultural funding law (including agri-environmental measures).

An important aspect here is sharing and linking information and data on substance properties and assessments (e.g. national substances database). To this end, models for mapping pollutants are an important tool, as is the transparent provision of data for precise information on and an assessment of input paths[#]. Newly designed monitoring systems (e.g. monitoring under the Fertiliser Application Ordinance (nitrogen, phosphorous), pandemic prevention) and analytical procedures for wastewater and water body monitoring should be used to improve knowledge of substances and substance groups and their impacts. Monitoring the impact of the Fertiliser Application Ordinance (DüV) on groundwater and surface waters is intended to allow regional conclusions to be drawn on whether the DüV measures are effective or whether adjustments are necessary. This will draw on land- and farm-specific fertilisation data for the first time. A digital, user-friendly nutrient origin system will be set up as a basis for monitoring. This system will record operational data on fertiliser use. In order to increase knowledge about antibiotic resistance and plastic particles, appropriate monitoring capacities should be developed and established in each case. Data on the risks of the spread of antimicrobial resistance in the environment, which is to be collected in future via the EU regulatory framework, should also be

incorporated here. Changes in temperature and precipitation due to the climate crisis may also promote the prevalence of vectors (e.g. mosquitoes) in water bodies, so that other surveillance/monitoring systems must also be used to detect the spread of vectors and associated infections at an early stage.

II. 5. Further develop water infrastructure adapted to the climate – protect against extreme events and ensure supply

Baseline

- Over 99% of the population, public institutions and companies in Germany are connected to the public water supply and over 97% to the wastewater disposal system.
- The length of the sewer system network is 608,052 km and the drinking water network spans approx. 544,000 km. Maintenance, refurbishment, replacement and expansion of these networks require considerable regular annual investments amounting to billions of euros (approx. 6 billion euros).
- Every year, roughly 5.4 billion m^3 of water is withdrawn for the public water supply and about 14.6 billion m^3 for non-public water abstraction for industry, commerce, agriculture and energy production. In Germany, approx. 9 billion m^3 of wastewater is treated by the public wastewater disposal system every year (of which nearly 4 billion m^3 is rainwater and infiltration water).
- The Organisation for Economic Co-operation and Development (OECD) estimates per capita annual expenditure in Germany in recent years on water supply and sanitation at just under 300 euros, and predicts that Germany will have to expect additional investment costs of around 25% by 2030 to comply with the Drinking Water and Wastewater Directives.
- The increase in extreme events (e.g. heavy rainfall, drought) as a result of the climate crisis increases the stress and risks for much of the water infrastructure and the water uses and services that depend on this infrastructure.
- The number of transverse structures in German rivers is estimated to be more than 215,000; in relation to the entire German river network, this is equivalent to about one transverse structure every 2 river kilometres. These transverse structures are generally used for flood protection, shipping, water retention, energy production, drinking water abstraction and other purposes.
- Especially in the lowlands and peatland regions in Germany, an extensive and large-scale system of drainage networks, including ditches, canals and pumping stations, is maintained.
- In Germany, there are currently about 8,300 hydropower plants in operation, of which about 7,300 supply the public power grid. A total of 20,000 gigawatt hours of electricity is fed into the public grid every year. More than 80% of this electricity is generated in Bavaria and Baden-Württemberg. Small hydropower plants (up to 1 MW) account for approximately 90% of the total number of existing plants; they generate around 15% of the electricity of the entire hydropower sector. 57% of large hydropower plants are over 60 years old. Some of the operating licences were granted on a permanent basis (known as legacy rights) or for long periods (100 years).
- Within the scope of implementation of the Water Framework Directive, hydropower generation is classified as a significant pressure by the federal states in 33% of rivers or 45,000 km of flowing waterways. The lower the electricity output of a hydropower plant, the less favourable the relationship between the costs of the necessary hydroecological development measures (in particular Sections 33-35 of the Federal Water Act) and the output of the plant.

- The German federal waterway network currently spans roughly 7,300 km of inland waterways, of which around 75% are rivers and 25% canals. Approximately 60% of the locks and half of the weirs were built before 1950. About 10% of the weirs and as many as 20% of the locks date back to before 1900. Many systems have already reached or even far exceeded their regular service lives. The federal waterways are comprised of approx. 23,000 km^2 of maritime waterways.
- Germany has around 380 large dams and water reservoirs, which form an important part of the water management infrastructure. Approximately 100 dams are used for the drinking water supply. These hydraulic complexes are increasingly being integrated to serve multifunctional purposes in the overall water management system in the catchment area, and are thus used not only for drinking and domestic water supply, but also for low-flow augmentation, flood protection, nature conservation and local recreation.
- Along the German North and Baltic Sea coasts, there are 12,000 km^2 of coastal lowlands with roughly 2.5 million inhabitants. Germany has a total of 1,471 km of sea dikes. The sea level has risen about 0.15 to 0.20 m along the German coast within the last 100 years. This corresponds to an average sea level rise of 1.1 to 1.9 mm per year – without the effect of land subsidence. The latest Assessment Report of the Intergovernmental Panel on Climate Change (sixth report, published on 9 August 2021) contains new projections for global sea level rises that can also be applied to the North and Baltic Seas. According to the current report, global mean sea level rise by 2100 will be 0.77 m with a likely range of 0.63-1.02 m (SSP5 8.5) compared to 1995-2014 levels[23]. Storm surge water levels along Germany's coasts will therefore be significantly higher in the future. In addition, inland drainage will become more difficult, and tidal characteristics can change, allowing more salt water to enter inland areas and impact on irrigation with water from the tidal rivers.

What are the challenges?

The supporting pillars of public services[#] in the water sector are, now and in the future, a reliable supply of high-quality water in a quantity sufficient for the various water uses[#] as well as effective wastewater and rainwater management. Precautions to counter the impacts of extreme events and disasters such as floods, low water levels and droughts as well as measures to prevent ecosystems and their services from further decline are other key elements. The safety of the public drinking water supply is of particular importance.

Germany has infrastructure for water management, shipping and flood and coastal protection [#] that has evolved over many decades and essentially functions well; its basic design has stood the test of time and has hardly changed for a very long time. Preserving the value of this infrastructure and modernising and adapting[#] it to changing conditions pose major challenges for society, particularly in terms of financing, but also as a result of competition for land due to compensatory, substitution and coherence measures. The fluctuating overall conditions relate to the impacts of the climate crisis (e.g. more frequent heavy rainfall events, long hot and dry periods, sea level rise), the requirements of climate-friendly circular economy geared towards resource conservation and efficiency[#] as well as changes in demographic trends and the structure of the economy.

These changes expand the range of tasks to be performed by the water infrastructure[#]. They must increasingly meet the requirements of climate change mitigation and the energy transition, climate adaptation as well as resource, nature and biodiversity conservation, and also make active contributions. This makes it even more important to consider interfaces with other areas, such as

[23] see Intergovernmental Panel on Climate Change (IPCC), AR6 Climate Change 2021: The Physical Science Basis, chapter 9 “Ocean, cryosphere and sea level change”, Table 9.8, *p. 2263*, available at: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf; Further information is available at https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/.

energy supply, environmental protection and nature conservation or urban infrastructure (transport routes, public squares, green spaces, buildings), and to cross-sector urban and infrastructure planning. If possible, infrastructure should not only be developed with a single goal in mind, but should serve several multifunctional goals. For example, river courses as well as flood and infiltration areas can provide various ecosystem services# (e.g. flood protection, groundwater recharge, material retention, increased biodiversity) and urban water areas and green spaces can be used for recreation and leisure, biodiversity, climate resilience, rainwater retention and groundwater recharge.

This is why, in addition to the traditional technically based "grey" water infrastructure# such as sewer systems, retention basins, dams, wells, shipping waterways, flood and coastal protection, it is necessary to increasingly create "green" and "blue" infrastructure, e.g. by restoring floodplains, peatlands and semi-natural watercourses in order to harness their ecosystem services and combine them with conventional technical infrastructure. Green-blue infrastructure can make it possible to manage rainwater differently in towns, cities and urban spaces, for example by unsealing areas for rainwater retention and for cooling towns and cities.

One of the challenges is to maintain the functionality and thus the reliability of waterway infrastructure while protecting other uses of the waterways and their ecosystem services. This also applies in particular to climate change adaptation and the climate-resilient design of the entire transport system. For example, even in the event that the frequency of extreme low-water events caused by the climate crisis increases, it should be possible to reliably calculate transport conditions on waterways like the Rhine. Without a combination of appropriate measures (infrastructural, but also organisational, logistical and navigational adjustments), this will otherwise inevitably have an impact on the population's security of supply.

At the same time, the water infrastructure is also facing new challenges in its core area of water supply and wastewater disposal. This applies, for example, to handling pollutants, including pathogens#, in drinking water treatment and wastewater management. Adaptation to changing settlement structures (differences in adaptation needs between urban and rural areas), to climate-related extremes (dry periods) or extreme events (e.g. floods or heavy rainfall), but also the digitalisation of systems and processes are other examples. In addition, both the physical and IT infrastructure of the water supply and wastewater disposal systems must meet high security standards to be effectively protected against manipulation, for example. As a result of the Russian Federation's invasion of Ukraine in violation of international law, with its consequences for the energy markets, dependencies on the supply of input materials (e.g. precipitants and flocculants) – essential for compliance with legal requirements – have also become evident in wastewater treatment and drinking water purification. High energy costs, declines in demand for key products and production constraints caused by disrupted supply chains also affect the availability of these input materials. The storage facilities for wastewater treatment plants and water works were generally not prepared for this development.

The different challenges can sometimes conflict with one another, e.g. stricter requirements for the purification capability of wastewater treatment and drinking water purification plants can be associated with increased energy consumption.

To meet these challenges, continuous and sufficient investments in water infrastructure must be made to counteract the obsolescence and decline in value of existing infrastructure. At the same time, it is important to harness the potential of emerging smart, new infrastructure solutions for the further development and gradual reorganisation of the water infrastructure to strengthen resilience and also take into account growing risks such as water shortage and flooding hazards.

Forward-looking and long-term infrastructure planning must be flexible and take into account the different temporal, spatial and systemic boundaries of infrastructure and integrate them into planning,

for example by increasingly combining green infrastructure with technical infrastructure or water infrastructure with transport and energy infrastructure. Improvements in ecology through green infrastructure are an important goal here.

For some types of infrastructure, the requirements of the EU Water Framework Directive and the Habitats Directive have so far only been implemented in part. Examples include non-adapted transverse structures, hydraulic complexes and drainage systems, which have contributed to the fact that the management objectives under the EU Water Framework Directive in Germany have not been achieved, and which also make it unlikely that a "favourable conservation status" will be reached for migratory fish of Community interest in accordance with Annex II to the Habitats Directive. One problem in this context is the large number of small hydropower plants(≤ 1 MW), which, even though they account for only a minimal share of gross electricity generation in Germany, can certainly be regionally relevant for electricity generation. Since legacy rights were granted on the basis of the legal regulations in force at the time, discrepancies exist at hydropower plants between the hydroecological requirements under water law in force today (Sections 33-35 of the WHG) and how they are implemented.

Vision – Water infrastructure in 2050

The technical and semi-natural# infrastructure in rural and urban areas plays a key role in enabling water uses# and services to be used, e.g. (drinking) water supply and wastewater disposal and treatment for households, public buildings, manufacturing, agriculture, industry and mining, energy production, flood and coastal protection, heavy rainfall and low water management, the biotope network, shipping and sport and leisure. The natural systems and semi-natural infrastructure, with their multifunctionality, have much greater significance for the functionality of the water sector than the technical infrastructure currently does, taking into account the goals of sustainability. Raw water is extracted in water abstraction facilities with sufficiently large water protection areas and treated to produce drinking water using semi-natural processes.

Water supply and wastewater management are not deregulated and continue to be a public function that is carried out with public infrastructure.[24] This infrastructure features a high level of technology, which is continuously developed by putting innovations into practice. The water infrastructure is designed so that it can be adapted with as little effort as possible to changing conditions such as the climate crisis, to changing public requirements for higher "ecological standards" or the changing water needs of users. It facilitates regional, local and district- or neighbourhood-specific solutions with smart management systems and modules. The infrastructure is – wherever possible – designed in the form of nature-based solutions#. It leverages the potential of linking water, energy and material cycles and is networked at an appropriate intermunicipal level. Sustainable and win-win solutions have been found between towns and cities as consumption centres and the areas they get water from, which also ensure an ecologically sustainable landscape hydrology in the main withdrawal areas. Towns and cities increasingly help to prevent urban water crises through measures in their own urban areas. As critical infrastructure, resilience in the water sector (water supply and wastewater disposal), for example, is protected throughout Germany against both climate-driven extreme events and threats from cyberspace (see the federal government's resilience strategy or CIP strategy). The availability of the necessary input materials is ensured by appropriate measures.

The water infrastructure meets the requirements of the WFD, the Habitats Directive and other relevant legal provisions. The water supply infrastructure is appropriately connected at a regional and, if necessary, supraregional level (long-distance supply networks, waterways) without facilitating a cascade effect and thus guarantees a nationwide water supply in line with demand, even in areas with

[24] However, there is also private infrastructure, e.g. owned by industrial and farming enterprises that supply their own water the basis of permits.

low local water resource availability and during dry periods. Overuse of local water resources is prevented. The potential for the multifunctional use of reservoirs for energy supply and high and low water management is used. The percentage of goods transported by inland shipping has been increased through appropriate shipping and logistical measures as well as through waterway infrastructure that meets demand and takes ecological requirements into account. Water tourism and water sports are possible in harmony with other requirements, creating opportunities for people to experience nature in, around and on water.

The flood protection measures involving inland water bodies and measures to manage rainwater within residential areas have been adapted to the climate and are compatible with the natural environment. Technical and nature-based flood protection measures and measures to protect against heavy rainfall complement one another. The synergies[#] between nature conservation and water protection can thrive.

The extensive surface drainage systems in managed landscapes have been removed or repurposed for multifunctionality to contribute to effective water management and stabilisation of the landscape hydrology. They support rewetting measures of peat soils and contribute to the reduction of greenhouse gas emissions from drained peat soils by stabilising the peat bodies. Adapted sustainable management of the rewetted areas is subsequently possible.

The coastal infrastructure is adapted to the climate and the coastal regions are protected by efficient flood protection and adapted systems for water management. Various measures have increased the resilience of coastal, marine and inland water ecosystems.

What needs to be done?

The existing water infrastructure[#] must be continuously maintained and modernised and its resilience increased. In addition, measures must be taken to maintain and increase the security of supply. Taking into account climate adaptation goals defined during the further development of the German Strategy for Adaptation to Climate Change (DAS), uniform conceptual guidelines must be developed nationwide or existing ones updated, and the technical regulations must be reviewed on an ongoing basis. These guidelines and revised regulations are not only important for the water sector, but often also for the transport and energy sectors or other economic sectors, as well as for coastal protection, nature conservation and spatial and urban planning. Adaptation must also include, where it makes sense, dismantling infrastructure that is no longer needed and promoting semi-natural and natural elements in infrastructure planning and implementation, for example in the form of nature-based solutions. When planning for the longer-term maintenance and financing of infrastructure, climate change must be factored in, as certain plants and systems may no longer be functional or economical under future conditions.

Taking into account the impacts of the climate crisis, a changing precipitation regime, but also changing runoff conditions, synergies and a good balance between flood and low water risk management, especially with regard to storage management, will be investigated and solutions developed. This requires, among other things, accelerated and digital mapping of areas that may be particularly affected by flooding during heavy rainfall (heavy rainfall warning maps).

To proactively address the challenges of the future, the federal states will develop area-wide regional and, if necessary, supraregional water supply plans at the level of supply areas (e.g. catchments) in cooperation with water suppliers, municipalities and other water users (manufacturing industry, skilled trades, service sector, industry, agriculture, nature conservation, Federal Waterways and Shipping Administration, etc.), which take into account different scenarios of the future development of water resources and needs as well as supraregional interfaces and are in line with the risk-based approach. The water supply plans should be based on nationally comparable methods to ensure that

the results can also be compiled to form a consistent overall picture across federal states. In the process, existing plans and methods already in use in the federal states will be taken into account as far as possible (see section II.1). A uniform nationwide framework plan, which also contains minimum standards, will be developed together with the federal states. This will help the federal states develop water supply plans that take into account different scenarios, including prolonged dry periods. These plans will prevent overuse as well as a deterioration in the quality of water resources, and lay the foundations for planning regional water supply infrastructure (interconnected supply areas, definition of corridors for long-distance water supply, reservoirs). They will take into account potential synergies with energy supply (shared use of reservoir infrastructure), groundwater recharge, water retention and flood protection plans, runoff management for surface waters and the potential for water reuse. Existing participation and mediation structures (e.g. water councils, water networks) will be used and further developed, but new structures will be created as needed that support implementation of national provisions on water use through participation of the authorities responsible, recommend regional water distribution and, most importantly, work to ensure that these provisions are accepted and successful.

As these are mostly long-term investments, administrations and infrastructure operators need to design and implement more cost-efficient, cross-sector framework plans and support systems (see section II.7) and take better advantage of opportunities to adapt obsolete infrastructure before creating new infrastructure. This must also take into account cost structures and distribute costs equitably across generations. The financial burden on public budgets and fee payers must be kept within reasonable limits. Similarly, cooperation between different users must be encouraged e.g. by providing domestic water of suitable quality or for groundwater recharge.

Legal regulations will be reviewed and, if necessary, adapted and used to establish the best possible conditions for the development and accelerated widespread implementation of efficient and sustainable water infrastructure (e.g. mandatory drainage plans for municipalities). Existing regulatory loopholes, such as in rainwater management (including hazard and risk maps for heavy rainfall), are eliminated. Research structures (known as living laboratories) must be developed that make it possible to apply innovative approaches to the implementation of water-smart cities (e.g. sponge cities, multifunctional land use in the event of heavy rainfall) and the use of new types of sanitation systems – to be applied in practice and on a large scale, and to create broad social and economic acceptance for them. Research in this area needs to take into account water quantities and different water qualities with a view to reducing risks in all areas (including for the environment and human health), paving the way for implementation in the long term. It will be based on the established structures of the German research landscape, as well as the ministerial research institutions, which already have extensive expertise in these areas. At the same time, efforts should be made to improve interministerial coordination of research activities. In view of the challenges resulting from the climate crisis, urban development funding will be an indispensable component for municipalities to better position themselves strategically. As a prerequisite for urban development funding, climate change mitigation and adaptation measures, for example by improving green infrastructure and, with the 2022 administrative agreement, also blue infrastructure, must be included as part of the overall measure. Measures for the development of green and blue infrastructure are also eligible for funding as a cross-cutting task in all programmes. In addition, climate change mitigation and climate adaptation measures must be incorporated into new or revised integrated urban development plans. In the case of urban renewal, green and blue measures are thus also addressed in particular – e.g. improvement of the green/blue infrastructure, soil unsealing, façade greening or creation/maintenance/expansion of green spaces, creation of infiltration and sponge areas. The administrative agreement is subject to ongoing development. This also aims to further strengthen the adaptation of towns and cities to climate change.

Based on an integrated risk-based approach, guidelines and regulations for critical infrastructure in the water sector must be drawn up and further developed and then implemented by the relevant bodies (authorities and operators). This will enable risks to be identified and assessed in their entirety and to be managed with appropriate measures. Research and development projects must identify options that help reduce dependence on crisis-prone supply chains for necessary input materials to ensure safe operation of wastewater treatment and water treatment plants for drinking water supply. In addition, in the public interest, measures must be assessed as to how the possible consequences of production stoppages due to crises can be better addressed in future for products that are needed for the safe operation of these plants (e.g. increased storage by operators and improved distribution organisation by federal states).

With high (IT) security standards that are continuously updated, the water industry will ensure that the IT infrastructure and physical systems for drinking water supply and wastewater disposal are effectively protected against manipulation and sabotage. In the area of IT security according to the BSI Critical Infrastructure Ordinance (BSI-KritisV), the aim is to expand application to include medium-sized suppliers (1,000 to 50,000 inhabitants supplied) as critical infrastructure.

When developing waterways, it is important to ensure that the objectives of the WFD are achieved. Transport aspects (including the importance of waterways for supply chains and public supply) need to be aligned with water management/environmental goals and the water resources available in the future. In the conflict between user interests and requirements for waterways, a higher level of acceptance for necessary infrastructure measures (e.g. among the public, environmental associations) must be achieved in the interest of sustainability and adaptation to changing climate conditions (e.g. through early participation, transparency and measures to mitigate environmentally adverse impacts). This will require an intensive dialogue with all stakeholders along waterways and with the public. The use of waterways as a transport route, combined with the reduction of ship emissions, is an important component for climate-friendly mobility.

The National Flood Protection Programme (NHWSP) – including dike relocations to reclaim natural retention areas like floodplains – must be further developed for reasons of precautionary flood risk management, and its financing must be secured for the long term. This gives rise not only to synergies[#] with nature conservation, water conservation and peatland protection, but also with activities involving climate adaptation, which are also embedded in the German Adaptation Strategy.

The basis for coastal protection and relevant adaptation measures are the general plans and regulations for coastal protection. In addition to technical coastal protection measures (development and implementation of innovative dike strategies), “soft” measures are also envisaged, including natural adaptation instruments such as the use of vegetated riparian buffer strips or sand spits, and zero-use or use-adapted riparian and coastal areas. A suitable combination of nature-based and technical coastal protection measures can promote dynamic coastal development processes. To adapt to climate change and the resulting sea level rise, a precautionary measurement[#] of at least 1.0 m (in relation to climate change) will be used in the future on the German North and Baltic Sea coasts when designing reinforcement measures for coastal protection structures. This precautionary measurement[#] will cover a period of 100 years in relation to the year 2000 or the current assessment date. Depending on the local conditions and the specific structure, the precautionary measurement can be implemented by different measures. The precautionary measurement# will be reviewed regularly or as required on the basis of new scientific findings, and adjusted if necessary. The GAK can be engaged to support, among other things, bank and flood protection structures, groynes and other coastal and flood protection measures by the federal government and federal states.

Finally, all infrastructure planning and measures, in addition to the implementation of the Flood Risk Management Directive, must take into account implementation of the EU Water Framework Directive and the Habitats Directive, which require good groundwater and surface water status and favourable conservation status for species and habitats in still and running waters. To improve the required coherence of the Natura 2000 network, the biotope network between federal states in particular must be expanded (especially streams, rivers and floodplains). The dismantling of structures and fortifications must also be planned and facilitated by laws. Extensive drainage systems must be evaluated for their suitability and, especially in peatland areas, must be designed in such a way to allow rewetting measures to the greatest possible extent. When granting new permits or modifying and adapting permits for water infrastructure or its uses – such as hydropower – the applicable water law and, where appropriate, other relevant areas of law, such as fisheries law, must therefore be applied with greater consistency. The necessary measures must be taken to mitigate the ecological impacts of hydropower plants pursuant to Sections 33-35 of the WHG. In the case of that permits have expired, the current legal situation dictates that an “extension” is dependent on the fulfilment of ecological requirements in individual cases.

II. 6. Link water, energy and substance cycles

Baseline

- Energy production from raw sludge (sewage gas) is experiencing an upward trend of 1-2% per year. The recovery of phosphorus contained in wastewater can reduce annual phosphorus mineral fertiliser imports by about half.
- The integration of a fourth purification stage increases energy requirements by an average of 5-30% but it also contributes to improved water quality in water bodies by eliminating trace substances.
- Energy supply, mainly for cooling purposes, currently accounts for just under half of water withdrawals in Germany. The restructuring of the energy system (phase-out of coal, promotion of renewables in the electricity and heat sectors, phase-out of nuclear energy) is expected to lead to a significant 50-60% reduction in cooling water withdrawals by 2030 and a 70-85% reduction by 2050.

What are the challenges?

Substances in wastewater can also be raw materials that should be used to promote circularity. Using water and its components with an awareness of circularity will lead to greater sustainability in the water sector. This applies both to water reuse if the quality is suitable for use and the environment, but also to the generation and consumption of energy in the water supply and wastewater disposal systems and the use of substances contained in wastewater, such as phosphorus and nitrogen.

Economical and efficient water use can be promoted by water recirculation, such as in various industrial uses (e.g. cooling and process water in steel production, industrial parks or mining) or also in technical aquaculture. The use of treated (municipal) wastewater, e.g. for agricultural irrigation, groundwater recharge or as domestic water for private and commercial use can, under certain circumstances, help conserve scarce freshwater and surface water resources and prevent potential conflicts of use. High environmental and health standards as well as additional costs and energy requirements for treatment and distribution must be the priority from a sustainability perspective and significant pollution levels must be avoided.

Unlike recirculating cooling and process water in the manufacturing industry, recirculation of used drinking water or the management of rainwater in buildings, cities, towns and municipalities is still rare. The reuse of used drinking water (grey water use with heat recovery) or the use of rainwater in buildings is still not very common, despite advanced technology being available. There is also scope for improving the use of these alternative water resources to water gardens, green roofs and façades. Strong support is required from the public sector for both. Intelligent systems are becoming increasingly important in the context of the climate crisis. To roll out model projects on a large scale, there is a need for stronger support from the public sector as well as changes to existing formal hurdles, such as the strict interpretation of the compulsory connection and use of central infrastructure systems.

The wastewater sector can contribute to climate change mitigation by harnessing other technical options for energy-saving measures and potential energy recovery. It can also compensate for potentially higher energy consumption through greater purification capabilities. The use of sewage gas to produce electricity is already established practice in many plants and is being supported within the framework of the Renewable Energy Sources Act (EEG). In many cases, however, operators complain about barriers to practical implementation that stand in the way of more widespread implementation. There is also still potential to be tapped in supplying heat to buildings or using sewage gas to generate process heat.

Closing substance cycles by introducing suitable and sustainable technologies and management strategies to recover nutrients is another challenge for wastewater management. Currently, the nutrients phosphorus and nitrogen present in wastewater go largely unused. These nutrients could be used, for example, to produce fertilisers or in industry. In Germany, phosphorus recovery from sewage sludge and sewage sludge incineration ash will become mandatory from 2029 as a result of the amendment to the Sewage Sludge Ordinance (AbfKlärV) that came into force in 2017. There is currently a lack of initiatives on recovery from the aqueous phase as there are also no corresponding requirements in water law. This will require considerable investment in recovery technologies over the next few years, which in many cases will necessitate the formation of new regional cooperation structures. The recovered phosphorus could then in part replace phosphorus from natural sources.

Vision – Water, energy and substance cycles in 2050

The water sector of the future is efficient, conserves resources and is sustainable in its use of nature and the environment, energy, raw materials and recyclables. The sustainable use of raw materials and the efficient and sustainable recovery or production/abstraction of energy, water and recyclables is ensured in closer cooperation with other sectors such as the waste, secondary raw materials and energy industries, fertiliser production (e.g. phosphate) and agriculture. Potential for reducing greenhouse gas emissions has been recognised and is harnessed.

The energy consumption of the systems for water supply and wastewater disposal has been optimised while complying with the relevant quality requirements and is generally covered by in-house production based on renewable energy sources and the use of energy potential from in-house processes (e.g. use of heat generated during purification processes in effluents). The resilience of critical infrastructure has been strengthened (e.g. for the scenario of a power outage) through this form of in-house production. The water and substance cycles in industrial production and technical aquaculture are largely closed.

The new EU Circular Economy Action Plan has been implemented: wastewater and wastewater components are used as a resource. Closed cycles are guaranteed and socially accepted along with the sale and reuse of raw materials. Innovative energy forms such as hydrogen are produced without interfering with other water uses. The sustainable use of water as a resource reduces the impact to a level compatible with nature. Water treatment is guided as much as possible by natural processes that are integrated into its overall approach to sustainable and environmentally compatible business practices.

What needs to be done?

There are currently a large number of research projects and initiatives on technical alternatives and legal foundations for the recovery of energy, water and recyclables, especially for wastewater systems and integration with other sectors (sector coupling).

To enable consistent recovery and circularity, as well as the availability of technological solutions it is crucial to have rigorous cross-sector legal requirements that do not hinder the proper and efficient use of recovered products that contain little or no pollutants. For example, legal requirements are needed for the use of products resulting from the recovery of phosphorous from wastewater and/or sewage sludge. To achieve an overall increase in the recovery of phosphorous from wastewater, a first step would be to establish corresponding requirements in water law. However, this must be coordinated with water, soil conservation, waste and fertiliser law to prevent contradictory developments at the interface between wastewater and sewage sludge. As well as the recovery and use of usable components from wastewater, it is also a question of linking the energy sector with other sectors with the goal of joint optimisation, based primarily on more widespread use of renewable energy sources and storage technologies, to compensate for fluctuations in the provision of electricity from renewable energy sources. Technological solutions are available for commerce, industrial production, residential

neighbourhoods and for supplying cites and towns with power and heat. The first step now is a comparative assessment of the current situation to create a strategically appropriate legal, economic and technical basis for further measures (e.g. help with sector coupling in the water sector). This includes regulations on sharing data and information on pollutant loads and operational data.

Wastewater plants, especially wastewater treatment plants, must be planned or upgraded together with the energy sector to optimise energy consumption and tap potential for energy production to allow this energy to be potentially fed into power grids, so that it is easier to adapt to the conditions of future energy systems. The legal frameworks for energy and taxes need to be reviewed and adapted if necessary in order to increase the investment options for municipal water supply and wastewater management bodies and companies when it comes to energy efficiency[#] and regenerative energy production.

The provisions in the EU Regulation on minimum requirements for water reuse will be implemented in order to ensure the hygienically safe and environmentally compatible use of treated wastewater for irrigation in agriculture with no negative impacts on health, also with regard to persistent trace substances. Corresponding provisions for other areas of application, for example in urban spaces, need to be developed where this makes environmental sense and is justifiable and where no threats to health are expected. This can best be avoided when used in industry. Implementing this Regulation will also help optimise nutrient cycles. In addition, legal requirements and guidelines for the use of treated wastewater will be drafted. Corresponding strategies must be given consideration in municipal urban land use planning and water supply plans. A decision about the viability of using processed wastewater should be taken with the additional aid of regional sustainability considerations (e.g. in water supply plans). Water demand will increase in several regions in Germany due to the production of hydrogen. General strategies will therefore be developed for the production of energy forms such as hydrogen that minimise the impacts on the water regime and prevent competition with other water uses. Strategies for thermal management of groundwater will be used for underground storage technologies that are required to shift to more renewables for heat and cooling supply, especially in urban areas. These will ensure that underground storage of heat and cold are only used where temperature changes do not have adverse impacts on other water uses such as the quality of groundwater as a drinking water source or groundwater as a habitat. To this end, thermal and ecological quality targets will be developed for groundwater. Building on these, the federal states should be required to draw up thermal management plans in densely populated urban areas in order to develop, identify and maintain adequate heat storage capacities in towns and cities. The goal is to ensure that every city has a water plan for thermal underground management in place and, where technically feasible and possible from a water management perspective, potential for the thermal storage of energy has been recognised and tapped. It is crucial to take the quality targets for groundwater set in advance into account in these plans. In this context, it is also important to look at the instrument of underground spatial planning.

The greenhouse gas emissions of the water infrastructure are recorded in national emissions inventories. They will be minimised to ensure that the water infrastructure makes the necessary contribution to greenhouse gas neutrality by 2045. To this end, research is required on quantifying greenhouse gas emissions and ways to reduce these emissions.

II. 7. Strengthen efficient administrations, improve data flows, optimise legal frameworks and secure financing

Baseline

- The water sector[#] in Germany has a many-layered organisational structure. Public water responsibilities are divided among the federal government, the federal states, districts and municipalities. The functions of the water sector are also carried out by various private and public companies and association structures (e.g. special purpose associations, special law associations, water and soil associations, water body maintenance associations).
- Around 250,000 qualified professionals were employed in various areas of the water sector in 2019. Of these, more than 60,000 will leave the sector by 2025 due to retirement.
- The enforcement of water regulations is the responsibility of the federal states and is carried out by authorities at federal state, district or municipal level. Responsibility for transport on federal waterways, including the associated enforcement, is the responsibility of the federal government. The federal government is also responsible for the restoration of ecological continuity at hydraulic complexes set up or operated by the state, and for the expansion of federal waterways where required to achieve the objectives of the Water Framework Directive. The conventional enforcement tasks (of the federal government and the federal states), which are highly dependent on certain conditions, often require very specialised technical and legal expertise and the ability to effectively integrate environmental aspects.
- Water administrations[#] and other environmental administrations and public institutions tasked with relevant water management duties are facing pressure to cut their spending and reduce bureaucracy on the one hand, even though almost all federal states have considerably reduced staff in the past decades. On the other hand, the range of tasks they are handling and the difficulty of the tasks are growing. Today's environmental problems are extremely complex and require ambitious solutions, improved tools and adequate personnel. However, finding staff is becoming increasingly difficult due to the major shortage in qualified professionals.
- The growth in data volumes and the resulting requirements for collecting, processing and sharing data, and the requirement of data quality and cross-cutting evaluation and usability, are also major challenges for water administrations. Technical and legal barriers are often a hindrance to seamless data and information exchange.
- The federal government's administrative data strategy is critical of the fact that data exchange between the federal, federal state and municipal levels only takes place sporadically and sometimes only on request. All federal ministries are required to make ongoing progress on linking and expanding efficient data infrastructure systems through goal-oriented cooperation that includes the federal states. The establishment of data partnerships to fulfil the state's mandate to provide services, also with actors outside the administration, complements this approach.
- Further improvement in international data exchange in line with the WMO long-term ambition in hydrology, the Global Climate Observing System and accelerated implementation of SDG 6 will also contribute to continental and global observations and predictions for the water cycle regarding quantity and quality of water resources.
- The competent authorities regularly stress that the current framework conditions (organisational, personnel, financial and regulatory) are inadequate for achieving the water goals and for tackling numerous new water management challenges, for example resulting from the climate crisis and biodiversity loss.
- To achieve the WFD management objectives in all water bodies, the LAWA estimates necessary additional costs in the coming years of approx. 35 billion euros in total.

- Annual investments of around 7.5 billion euros were recently made in water supply and wastewater disposal.
- Measures are being promoted via the GAK on semi-natural water body development, construction and expansion of wastewater treatment plants and construction of water reservoirs, as are a range of flood protection measures and investments in water-saving irrigation technologies.

What are the challenges?

Water management objectives are implemented by various administrative organisational bodies. Implementation thus primarily depends on how well the administrative or organisational structures in question function. In many cases, environmental administrations, including water management authorities, are now working at the limits of their capacity, as the German Advisory Council on the Environment (Sachverständigenrat für Umweltfragen, SRU) was able to document in many expert interviews. These administrations also acknowledge that they lack the capacity to rigorously fulfil all of their legally prescribed responsibilities. This has become clear from comments and feedback, especially from the federal states and municipalities, but also from industry players affected by lengthy approval and planning procedures, stating that administrations do not have enough well qualified staff, are facing a growing shortage of skilled professionals and do not have access to the technical and financial resources required to satisfy current requirements.

The conventional enforcement duties increasingly include tasks oriented towards environmental quality objectives. These require highly qualified administrations with the capacity for interdisciplinary work. Furthermore, administrations must have the authority and capability to develop strategic plans. Cooperative intermunicipal and multi-association projects are already common practice due to the overarching nature of the tasks handled by the water sector.

Workflows and communication processes will be fundamentally changed by digitalisation across administrations. The digital transformation is bringing about profound change in business and society, in work, consumption, cooperation and communication. A number of important plans and measures have already been implemented by the federal government as part of the 2020 agenda for digital government (Digitale Verwaltung 2020). Key strategic challenges for water data and environmental information include:

a. development of data management at federal and federal state levels with even better technical, organisational and content coordination
b. harmonisation of the existing data/technical information systems at federal, federal state and municipal levels, e.g. of the environmental data reporting apparatus within specialised networks (EU, European Environment Agency), and the provision of environmental data and information
c. reduction of technical, organisational and legal barriers to exchanging data and information in Germany, Europe and with United Nations organisations while meeting data protection requirements
d. protection of critical infrastructure against cyber and physical attacks
e. development of data on how smart devices or the use of the internet/digital services by private users (also data generated by private users in the hands of private companies) influences nature and the environment

The Directive on open data and the re-use of public sector information (Directive (EU) 2019/1024) is a first step in the right direction. The data relevant to water management must be incorporated into regulations on high-quality data sets as defined in this directive. The European Data Governance Act and the Data Act currently being drawn up represent further steps towards accessing into water data

outside of the public sector or within the public sector but excluded from reuse, for example due to business secrecy, copyright standards or statistical confidentiality.

Water is the link between the various sectors, for example health, agriculture, fishing and aquaculture, manufacturing, energy, infrastructure, environmental protection and nature conservation, spatial planning and regional development and between the responsible authorities. These act at different levels (municipal, regional, federal state, federal). Administrative structures must ensure, through a comprehensive approach, that authorities such as administrations for energy, transport and agriculture are able to handle water conservation responsibilities assigned to them.

Currently, the existing governance structures do not always make targeted and active use of the potential synergies arising from common goals in water conservation. This means financial and human resources are not used to their full potential. Streamlining, standardisation and digitalisation can help save these resources and should be therefore be used on a large scale.

The increasing complexity of water planning processes due to cross-cutting, overlapping implementation requirements and quality specifications may also overtax the capacities of some authorities in future. Certain future problems will no longer be solvable, e.g. within the scope of responsibility of individual municipalities. In fulfilling certain public service# functions, there is already a division of labour and cooperation between municipalities with the aim of greater efficiency. This intermunicipal cooperation should be expanded and strengthened. The legal and structural frameworks should be reviewed and adapted where necessary.

Further development of the legal framework is required in order to meet the water challenges described in this Water Strategy at national level and to some extent at European level.

Due to increasing demands on and complexity within the water sector, it is likely that the legally defined participatory processes will no longer be adequate or will start too late to serve the stakeholders and the general public. All interest groups must be included early on and as actively as possible in policymaking, planning and project decisions and must be able to support project implementation. Ensuring this is a challenge, also in light of current requirements coming from the European Court of Justice.

As the German Advisory Council on the Environment[25] has found, fees and charges currently only contribute a relatively small amount to financing environmental protection measures. In light of tight budgets and the increasing public sector responsibilities in environmental protection, requiring users and polluters to pay more for administrative costs can help relieve the financial burden and ensure that the state fulfils its duties adequately for the long term. It is possible and advantageous to charge the costs incurred to users, particularly where the costs of environmental protection services, such as wastewater disposal, can be directly allocated to the party responsible. Equally, charging users for environmental protection creates an incentive to change behaviour that should not be underestimated, whether in the context of providing public goods or helping prevent negative environmental effects, e.g. through the discharge of pollutants via wastewater (indirect discharge).

Vision – Administrations, data flows, legal frameworks and financing in 2050

The decision-making levels and administrative structures at federal, federal state, district and municipal level in the German water sector# have been established from an organisational, technical, staffing and financial perspective that enables new challenges to be tackled, for example the impacts of the climate crisis and the loss of biodiversity, but also demographic change and the balance between urban and rural areas. There is extensive cooperation within the administrative levels of the water

[25] See SRU (2007): Umweltverwaltungen unter Reformdruck: Herausforderungen, Strategien, Perspektiven.

sector and networked cooperation with other administrations whose activities can give rise to synergies and/or prevent conflicts with the water sector. This includes effective intermunicipal cooperation in the area of public water services.

An interconnected system of online applications and databases has been established to support complex processes in environmental protection documentation, notification and reporting obligations. This takes into account national obligations to the European Commission and the European Environment Agency, and monitoring requirements as part of intergovernmental partnerships (HELCOM, OSPAR, etc.). The interconnected system of online applications and databases has the aim of permanently reducing the administrative burden on companies and public authorities at all levels and ensuring a high level of protection for water bodies in Germany.

Integrated work methods have been adapted to the changed overall conditions and requirements. There is also intensive dialogue among the federal states on appropriate governance structures in joint working groups; this enables mutual learning.

The water sector and water authorities offer attractive professions, prestigious jobs and a range of opportunities for career development. Job openings in the sector are adequately filled with well qualified staff. Professionals in the sector have qualifications that keep pace with the latest developments in technology, digitalisation and new environmental requirements. Salaries are appropriate to the work. The selection of personnel has been adapted to the new challenges.

The legal framework specific to water is harmonised with other relevant areas of law (including chemicals law, pesticide and pharmaceutical law, energy law, nature conservation, spatial planning and construction law, climate change mitigation and climate adaptation law). Conflicting objectives have been minimised and tailored to the new challenges.

Synergies in legislation, planning, building and operation of water infrastructure enable effective administrative activities involving all relevant stakeholders and using modern forms of management and work organisation. The goal is to accelerate water infrastructure projects.

Financing that covers costs is ensured for water services (water supply and wastewater management) for the long term through adjusted charges, fees and pricing schemes that include the funding required for maintaining and modernising systems and infrastructure. The services performed by the competent authorities for public water supply and wastewater disposal to protect water resources and water bodies are appropriately accounted for. The possibilities offered by the digital transformation are used to differentiate tariffs based on demand.

In order to tackle the transformation of the water sector, sufficient funds are available in joint federal-federal state financing instruments to finance water management measures to be implemented by public agencies (water conservation, water body maintenance, flood and low water management). Charges linked to pressures put on water resources that create incentives to reduce pollution make an earmarked contribution to funding for programmes of measures, water-related climate adaptation, preservation of ecosystem services, conservation of species and habitats and water body development.

What needs to be done?

Active cooperation in and support for change processes in the water sector[#] by administrations require that they be sufficiently equipped with qualified personnel and, if needed, specially adapted administrative structures. At federal, federal state and municipal level, the water administrations should cooperate to develop and implement plans to enhance the skills of and train their personnel. Taking stock, together with associations and water service providers, of the existing training capacities and personnel needs with short, medium and long-term timelines is the next step. These will be

regularly updated, and the qualification requirements will be reviewed and adapted. The responsibilities of the Federal Waterways and Shipping Administration need to be enhanced with duties in the areas of hydroecology, climate change mitigation and adaptation to climate change.

Cooperation among all government levels is being improved. Intermunicipal cooperation must be further developed and considerably streamlined in order to increase the effectiveness of water supply, wastewater management, water body development and maintenance, and to ensure the economic efficiency of public services in rural regions for the long term. Here it is important to step up advice and support to municipalities on how to initiate and carry out cooperative projects. Further, it needs to be reviewed whether pooling technical expertise, for example by creating administration-specific competence centres, could reduce the local workload.

Strengthening administrations also means improving digital skills and taking advantage of the opportunities offered by digitalisation. Strengthening the digital skills of water administrations is thus essential for data quality and the quality of information made available through IT systems. The government's 2020 agenda for digital government (Digitale Verwaltung 2020), the Digital Strategy 2025 and the acts on e-government and online access (OZG) have laid foundations for streamlining and optimising administrative processes and creating seamless services for the public and companies. It is essential to develop this further. Clear standardisation and uniformity of IT processes in line with the one-for-all principle is supported. Municipalities should benefit from the impact of support and should be able to easily adopt solutions developed as part of the one-for-all principle.

For enforcement, this means, for example, making more capacities available for water-related legal processes in the future where practical and possible or (further) developing publicly accessible environmental information systems.

When it comes to collecting, managing and sharing water data, further harmonisation and standardisation processes need to be initiated in order to minimise, for example, losses due to conflicting data standards at the various administrative levels. Drawing up a plan to create a uniform legal basis for collecting and using water data (Water Data Strategy) in cooperation with the federal states and other water stakeholders can guide and frame this process. The harmonised digitalisation of data management and networking and the development and provision of web-based services for different users by administrations provide a key foundation for digitalisation of the water sector. They are also a prerequisite for improving early warning systems that requires a nationwide forecast and information system for the dangers and risks of extreme weather events (floods, heavy rainfall, droughts).

Climate change and its impacts on the water regime and water bodies potentially affect numerous adjacent communities and users of water bodies. Operational services can play an important part here for adaptation to climate change at an early stage. To implement the German Strategy for Adaptation to Climate Change regarding climate and water, a coordinated and integrated method is needed in order to transform climate change indicators and future climate predictions on hydrology, hydrodynamics, water quality, morphodynamics and shipping in watercourses, estuaries and oceans into more detailed, user-oriented data, and to provide advice to stakeholders.

Representatives of relevant interest areas and disciplines, e.g. for nature conservation and/or hydraulic plans and projects, need to be informed and involved in planning at an early stage. This is the only way to ensure that synergies are leveraged and an integrated approach to water systems is taken.

Regional participatory formats are an appropriate instrument to support the transformation of the water sector and in particular to ensure the acceptance and success of implementation processes.

These formats give participants (including landowners, water suppliers, municipalities, relevant associations and lower-level water, nature conservation, transport, agricultural and fisheries administrations) the opportunity to jointly engage in interdisciplinary discussions on the necessary regional duties in the water sector. These regional formats and spatial planning that takes greater account of water management aspects and issues can also help with the development of transparent, flexible and sustainable water resource management and serve to head off conflicts of use at an early stage.

The federal, federal state and municipal levels conduct ongoing reviews of the compatibility and the need for adaptation of existing structures in their areas of responsibility. An independent peer review of the responsibility, cooperation and decision-making structures in the water sector is also advisable to serve as a guide for the transformation process in this sector. It could take the form of a research project jointly commissioned by the federal government and federal states.

The Federal Water Act and other relevant provisions need to be reviewed and adapted as required in order to address the challenges identified in the Water Strategy (in particular the impacts of the climate crisis and loss of biodiversity). Additionally, current water law will be examined to see whether it reflects future challenges and developments at European Union level, for example the Green Deal and the Biodiversity Strategy for 2030. The aim is to improve coherence between different legal provisions by adapting the legislation for all relevant areas (nationally and at EU level) in order to prevent conflicting objectives in implementation.

Public procurement entities are required to increasingly prioritise products and services with the lowest possible impacts on water resources.

The existing organisational and regulatory frameworks, including financing instruments such as the GAK, will be evaluated to determine their future viability in order to ensure that the necessary duties can be carried out in all areas of the water sector. Current and imminent financing gaps need to be identified, and proposals developed to ensure that water sector responsibilities can be met in future. A federal programme of climate measures in water management and water body development will be drawn up as part of the Federal Environment Ministry's Action Plan on Nature-based Solutions for Biodiversity and Climate. The aim is to improve the water management conditions for nature-based solutions and to contribute to implementation of legally required EU measures for water conservation and water body development, and measures for adaptation to climate change. It is also important to avoid duplicate support structures for transparency and efficiency reasons.

II. 8. Intensify protection of marine areas (North and Baltic Seas) from pollutants from land

Baseline

- SDG 14 of the 2030 Agenda is to conserve and sustainably use the oceans, seas and marine resources for sustainable development. Currently, these are significantly polluted and in considerable danger due to human activity.
- The watercourses that drain into the North and Baltic Seas are a main input path[#] for nutrients coming from diffuse sources (e.g. agriculture) and point sources (e.g. wastewater treatment plants), and for pollutants and plastic waste (including microplastics) from industry, commerce and households.
- The federal states and the communities around watercourses use a regular monitoring programme to track the discharge of nutrients and pollutants. The data collected is used in the work under the regional marine protection conventions and the international river basin commissions. Similar monitoring is not yet in place for plastic pollution.

- Germany has met ambitious reduction targets for river-based nutrient inputs of 50% compared with 1985 levels. These targets originated from the International Conferences on the Protection of the North Sea in 1987 and 1990 and were adopted by HELCOM for the Baltic Sea. However, there is still a long way to go to achieve good status with regard to eutrophication in German marine waters. This is why measures are being taken to try and further reduce nutrient inputs by means of management plans under the WFD. The nitrogen inputs into surface waters in the German Baltic Sea catchment area (Warnow/Peene, Schlei/Trave and Oder river basins) were reduced in a comparison of the years from 1983 to 1987 and from 2012 to 2014 by 65% from 63,000 t/year to 22,200 t/year. Phosphorous inputs were reduced in the same time period by 78%, from 3,600 t/year to 800 t/year. Nutrient inputs into surface waters in the German North Sea catchment area (Elbe, Weser, Ems and Eider river basins) were reduced in a comparison of the years 1983 to 1987 and 2012 to 2014 by over 50% for nitrogen (from 804,038 t/year to 353,400 t/year) and by more than 70% for phosphorous (from 67,164 t/year to 17,540 t/year).
- The nine countries that border the Baltic Sea have determined the maximum allowable anthropogenic inputs of nitrogen and phosphorous into the Baltic Sea basin to achieve good environmental status of these waters with regard to eutrophication, although this limit does not automatically lead to achievement of good status. Building on this, they have defined a maximum allowable input ceiling in tonnes/year and a future reduction target. These target calculations take into account inputs via rivers and the air as well as inputs transported over long distances from other marine areas. They can be made more stringent if required in light of new scientific findings. The countries bordering the North Sea are working under OSPAR to establish similar targets.

- The new HELCOM Baltic Sea Action Plan (BSAP 2021-2030) contains concrete goals and the measures required to achieve them in the areas of *eutrophication*, *hazardous substances* (including marine litter), *shipping* (including underwater noise) and *biodiversity* in order to achieve good environmental status for all countries bordering the Baltic Sea.

- The strategic objective of the new OSPAR North-East Atlantic Environment Strategy (NEAS 2021-2030) is to tackle eutrophication by limiting inputs of nutrients and organic matter to levels that do not give rise to adverse effects on the marine environment. The specific measures for implementing this objective are currently being drawn up.
- The Ordinance for the Protection of Surface Waters (OGewV) sets nitrogen concentrations at the limnic-marine transition point at 2.8 mg/l TN for rivers flowing into the North Sea and 2.6 mg/l TN for rivers flowing into the Baltic Sea as the basis for management of the river basin districts. It is assumed that future compliance with these values can facilitate achievement of good status for the marine waters with regard to eutrophication. There are also current river-specific reference values for phosphorous (0.10-0.15 mg/l TP for rivers flowing into the Baltic Sea and 0.10-0.30 mg/l TP for rivers flowing into the North Sea).
- Of the 24 rivers flowing into the Baltic Sea in Germany, five attain the management target value for total nitrogen; three attain the river-specific reference value for total phosphorous. Of the nine rivers flowing into the North Sea analysed in the evaluation period 2015-2019, only the Rhine attained the target value for total nitrogen. The river-specific reference value for total phosphorous concentration was reached in the Rhine, Eider, Treene, Arlau, Miele and the Bongsieler Canal.
- There are currently no specific input target values or limit values at the limnic-marine transition point nationally or at EU level for pollutants that enter the seas via rivers. There is a lack of quantitative estimates of the reductions and related measures needed in river basins to help achieve good status for marine waters.

- Inputs of cadmium, lead and mercury via the rivers flowing into the North and Baltic Seas have sharply declined since the 1980s. The ambitious reduction targets for these three heavy metals of at least 50% and then later 70% compared with 1985 were key drivers in the process. These target values were laid down at the International Conference on the Protection of the North Sea in 1990 and confirmed in 1995. They were also taken up by HELCOM for the Baltic Sea. Although the quality objectives in the aqueous phase laid out in the EU Water Framework Directive are met for all three substances[#], this is not the case for Germany's marine waters, where these substances[#] accumulate in sediments and marine wildlife. As a result, it has not been possible to date to achieve good status regarding pollutant discharge into German marine waters.
- Three quarters of waste in the sea consists of plastic products produced and, in most cases, used on land. Plastic products degrade into tiny pieces in the environment – sometimes over centuries – and become secondary microplastics, which accumulate in sediments and in the water column and have harmful effects on marine biota. So-called primary microplastics, which are intentionally produced for a specific use, for example as an additive in cleaning products and in the medical sector, also reach the sea via rivers. One possible reason is that they cannot be completely removed by wastewater treatment plants. They can also find their way from production plants directly into water bodies through the air, e.g. as pellets. The current status assessment of Germany's North and Baltic Sea waters under the MSFD from 2018 found plastics (including microplastics) on the surface of marine waters, in the water column, in sediments and in marine wildlife.
- These reductions in all inputs described were not nearly enough to achieve good environmental status of marine waters as set out in the current provisions of OSPAR, HELCOM, the EU Marine Strategy Framework Directive, the EU Water Framework Directive and the EU Habitats Directive. Pollutants also continue to enter these waters. The environmental targets set by Germany to implement the MSFD include a further reduction in inputs of nutrients, pollutants and waste (with a focus on plastics) in particular via rivers, but also via the atmosphere.

What are the challenges?

The North and Baltic Seas are ecologically valuable and sensitive areas that are coming under increasing pressure from human use.

The wide range of uses include various forms of energy generation, resource extraction, shipping, fishing, water sports and beach tourism. Related construction measures in the sea (e.g. lowering the seabed) can also have major and permanent negative impacts on the ecosystem. This is compounded by the continuous pollution caused by the use of the sea, once common practice, to dump various types of waste. This marine pollution will be addressed by the future national marine strategy.

Pollution caused by land and sea uses is currently preventing the achievement of good environmental status in the North and Baltic Seas as laid down in the EU Marine Strategy Framework Directive – a goal that Germany actively supports.

Vision – Onshore marine protection in 2050

The many pollutants affecting the North and Baltic Seas, especially coming from the rivers that flow into them, are reduced to a minimum. The requirements of the EU Biodiversity Strategy for 2030, the MSFD, the WFD and the Habitats Directive as well as the OSPAR and HELCOM provisions for good status of marine waters are met.

What needs to be done?

It is important for the future national marine strategy to focus on protecting seas in their entirety with coordinated land-based and sea-based measures. Marine protection requirements must be integrated into other policy areas in a cross-sector approach to ensure that protection and use are brought into balance. This includes raising awareness of the effects of river-based and atmospheric inputs into seas and taking responsibility for reductions in the case of inland input sources.

In addition to this cooperation, clear goals and targets that enable gradual reduction of pollutant discharge from land are needed. The target values set for nitrogen at the limnic-marine transition point to date have proven to be a good tool for assessing the implementation and impact of inland measures to reduce nitrogen inputs and their impacts in the sea. Target values at the limnic-marine transition point should also be determined for total phosphorous and selected pollutants. These values are intended as a basis for determining onshore reduction requirements to achieve target values and facilitate appropriate measures in the river basin districts. A transparent, participatory process involving all inland and coastal states is planned. It is important to strive for an exchange of information and data, coordination of target values in the international river basin commissions and between these commissions and the regional marine protection commissions, as is a harmonised approach at EU level. The Federal Environment Ministry and UBA will support this work with a broad-based research project. The target values identified in the research project should be included in future in the Ordinance for the Protection of Surface Waters to lay out requirements for river management beneficial to marine protection. Similarly, target values must be defined for plastic inputs (including microplastics) in other research projects focused on marine waters.

In the context of the infringement procedure regarding the Nitrates Directive, a joint federal government and federal state monitoring programme related to the Fertiliser Application Ordinance is being set up and expanded that will monitor phosphorous inputs into watercourses, among other things. This should simultaneously be used to track the phosphorous discharged into the seas on an ongoing basis. This monitoring is intended to review whether the measures of the Fertiliser Application Ordinance are working. This also requires a significant increase in the measuring sites for phosphorous.

Discharge from upstream countries and the need to reduce this discharge must also be taken into account. In the medium term, the establishment of target values at the limnic-marine transition point should be regulated at EU level for all member states; values regulated in Germany alone are not binding for other countries. Pollutants discharged into seas need to be discussed more intensively in the international river basin commissions and marine protection conventions in order to make the approach of all countries as uniform as possible. With the EU's current zero pollution ambition in the context of the Green Deal, the chances are good for regulating and reducing substance inputs throughout the EU. The EU Biodiversity Strategy also offers very good support for this ambition.

The continuity of watercourses that is so crucial for migratory fish alternating between freshwater and salt water, including relevant coastal protection constructions, is addressed in sections II.3 and II.5.

II. 9. Raise awareness of water as a resource

Baseline

- 46% of people surveyed in Germany say that water quality in water bodies (pollution and hydromorphological modifications) is a fairly serious to very serious problem.
- 70% would like more information on the ecological impacts of water consumption and consider adequate information about water consumption to be the most effective measure to reduce these problems.

- Germany's water footprint is largely determined by the production of goods and imports from abroad: external water use accounts for just under 70% of the footprint.
- 62% of people surveyed in Germany say that changes in ecosystems are particularly alarming; 58% of respondents say that the climate crisis is particularly alarming.
- 85% of people in Germany are happy with the quality and price of drinking water.
- 90% of the population say they have no information at all about river basin management plans that have to be drawn up regularly under the EU Water Framework Directive.
- In 2012/2013, the European Right2Water initiative (officially called "Water and sanitation are a human right! Water is not a commodity but a public good!") collected more than 1.6 million signatures (with more than 1.2 million from Germany) for a petition calling for the supply of drinking water and the management of water resources to be exempt from internal market regulations and for the water sector to be kept off the agenda for deregulation.

What are the challenges?

The sustainable protection of water resources and water bodies and the forward-looking development and reorganisation of the water sector will require changes in many areas. These change processes require broad social acceptance, which must be actively sought.

Aquatic and water-dependant ecosystems – groundwater, springs, streams, rivers, lakes, seas, pond landscapes, bogs, floodplains, peatlands, forests – provide a wide range of services to people and society. They are recreational areas, habitats for flora and fauna and carbon sinks. They can provide natural protection against floods, contribute to improving water quality and, last but not least, form the basis for water supply. Forests play an important role as groundwater reservoirs. Water bodies and forests help regulate the climate (including preventing overheating in towns and cities and urban heat islands). Additionally, water bodies are also needed as transport routes, for irrigation of agricultural crops and for food production.

This view requires a general appreciation of the natural functioning of the water regime[#] and the important role healthy water bodies play in the natural balance, human well-being, health, the food supply and economic and social development as a whole. The use of the ecosystem services[#] mentioned above is something many people seem to take for granted.

A sufficient supply of high-quality, clean drinking water at any time is also perceived in Germany as an integral component of public services[#] and thus as something that is a given. In future, this will also include the supply of drinking water in public spaces (e.g. drinking water fountains). However, many people are not aware of the natural resources involved in these uses and the effort required to provide drinking water.

Many people generally understand the role their own behaviour and consumption play in water pollution – for instance through the use of products containing harmful substances (e.g. medicines, pesticides, cleaning products and chemicals, biocides, treated materials) or improper disposal (e.g. of medication in the toilet) and the use of available water resources, e.g. through the consumption of water-intensive manufactured goods like textiles. However, in many cases, there is a lack of transparent information about the level and possible impacts of individual own water consumption and of water consumption associated with the manufacture, use and disposal of products, and about other possible negative impacts on water bodies resulting from the use of products, for example pollutant discharge. There is often a lack of alternative goods produced with water-saving in mind, and of relevant information. In view of increasing pressure to use water resources, sustainable management must be promoted in all areas of use – not least to prevent possible conflicts of use. When it comes to providing relevant information, the water sector, and producers and sellers of products, have a responsibility in addition to state institutions. Potential complexity of calculating this information is taken into account and made transparent for consumers.

The full value of water must become more prominent in the minds of the public and policymakers. It is vital that water and water body ecosystem services# – for example as a habitat – and the services of drinking water supply and wastewater disposal – are made transparent for society, valued and appreciated. In the process, synergies with Germany's commitment in developing countries and emerging economies to achieve Sustainable Development Goal 6 on clean water and sanitation can be leveraged. The National Water Strategy must contribute to increasing knowledge about the importance of water in all its facets and actively raising public awareness to gain the necessary support for the required changes to how this resource is managed. This will also empower people to use water resources more responsibly and to take sustainable decisions.

Vision – Considerably increase appreciation for the value of water by 2050

The value of water and its importance as a public good (e.g. as food, a habitat and an economic factor) are firmly rooted in all areas of society. The right to water and free access to water are integral components of public services# at all levels. The state ensures that water is protected and it is responsible for the necessary public infrastructure.

Awareness of the value of water is embedded in all social groups and is evident in many facets of everyday life. Companies identify and account for their water footprint# and water risks in the production of goods and services; they report this information and take their responsibility seriously – also in production countries outside of Germany. The right information enables consumers to take the water footprint into account in their choices. Consumers can choose from a wide range of reasonably priced regional and seasonal foods and products that have been produced using environmentally friendly and water-efficient processes. And consumers appreciate this wide range. They rarely or never buy products produced under conditions that lead to high water consumption in areas suffering from water scarcity. This prompts a move away from water-intensive, non-sustainable production methods, or these methods become less relevant. The use of products with components that have negative impacts on hydroecology is avoided with a view to sustainability. There is an overall increase in understanding of how to deal with products containing pollutants. Retail, as a key sector, sells products that are produced in line with water conservation principles in most of its product range, and consumers can quickly identify and select these products using information about the ecological footprint, for example on ecolabels. Additional costs are reflected in consumer decisions and through possibly higher prices as a collective contribution to water conservation.

Consumers avoid recreational activities that lead to excessive water consumption in water-scarce locations. They are well informed about the risks of extreme weather events such as heavy rainfall, flooding and dry periods, and about the risks of consuming stagnant water. They are in a position to take their own precautions.

To avoid or resolve conflicts of use, the users, i.e. also the general population, are aware of the need for balanced water resource management. The public is aware of the various user interests, the goals of water body development and the requirements of a semi-natural water regime. The resulting decisions are presented transparently.

What needs to be done?

Information materials and educational programmes and advisory services on water appreciation and water use for people of different ages and professions will be created and interlinked with existing services. Since many water management and conservation decisions are made at municipal level, voluntary training needs to be organised for municipal decision-makers (in policymaking and administration) so they can gain comprehensive awareness and understanding of the interdependencies of water management.

Federal authorities responsible for water-related issues (including the Federal Environment Agency , the Federal Agency for Nature Conservation (BfN), the Federal Institute of Hydrology (BfG), the Federal Office for Agriculture and Food (BLE) with the Federal Information Centre for Agriculture (BZL) and the Federal Office of Civil Protection and Disaster Assistance (BBK)) will further develop and expand their relevant information and training activities. Key multipliers also include associations in the areas of water, nature conservation, environmental protection, leisure and sport.

Creating and linking learning centres where the importance of water can be experienced first-hand and where education and training is possible (e.g. training and exhibition sites on water and water body topics, experiential learning sites on and around water bodies, research and demonstration fields) is also an important component. This is associated with promoting appreciation for the value of the public services provided by the water sector.

A long-term water education and communication campaign (including at schools) is required to raise awareness among the general population and specific professional groups of the following:

a. knowledge about water infrastructure
b. knowledge about pollutants discharged into water bodies and the causes of this discharge, e.g. improper disposal of chemicals and pharmaceuticals
c. water bodies and biotopes dependent on water as habitats, improving the quality of life and recreation through intact water bodies and landscapes influenced by water
d. water use, water bodies, adaptation to the climate crisis, climate change mitigation
e. opportunities for participation in water management planning
f. the concept of the water footprint and water risks and ways they can be taken into account in production, global supply chains and in the consumption of products (e.g. using ecolabels that include criteria on quantitative and qualitative impacts of the product on water resources)
g. preference for seasonal and regional foods, ideally produced organically, for water conservation
h. individual precautions for buildings in the event of extreme events (e.g. protection against flooding during heavy rainfall, private cisterns for watering garden during dry periods)
i. economical use of water at home and in the garden
j. health and hygiene aspects of drinking water use (e.g. avoiding consumption of stagnant water)
k. sustainable, water-friendly tourism
l. raising awareness in the private sector of the importance of economical use of water resources and of producer responsibility along value chains, and attention to water risks
m. risk communication/increasing awareness of risks and conveying the need for suitable and targeted risk and crisis management, including establishing methodological expertise in water issues

This education and communication initiative must be geared towards a range of target groups (primarily children/young people, adults, industry experts and leaders, including in agriculture and forestry, producers, teachers, general and vocational training and local secondary multipliers and experts). The goal of communication measures is to increase social acceptance for the sustainable management of water and water bodies and to enhance appreciation of the services water provides, contribute to risk communication (high water levels, flooding, droughts), support precautionary measures (protection against natural hazards) and promote environmental education on water conservation. In the framework of education for sustainable development there should be a greater focus on water, especially aspects such as the concept of the water footprint.

Active participatory processes, such as citizen science instruments, will motivate the public to engage with water-related issues. Experiences of nature conservation, fishing and nature-compatible water associations in the area of citizen science will be drawn on.

In the domestic production sector, incentives will be created for production practices that use water economically and protect water bodies (e.g. with a Sustainable Water Award). Private and municipal companies will be expected, on a voluntary basis, to monitor their global production sites and supply and production chains for sustainability criteria, their water footprint and water risks and to publish the findings in sustainability reports. In addition, within the scope of their responsibility, they will be expected to contribute to ensuring efficient water use, reducing pollutant discharge and preventing conflicts of use. Consumers will be informed, by means of information materials and product labels (e.g. for textiles, medicines, cleaning agents, etc.), about how a product measures up in terms of criteria relevant to water and water bodies, such as the water footprint. The federal government's Sustainable Finance Strategy also aims to improve the transparency of water risks for investment decisions. When consumers are more aware and buy more products with a small water footprint, they make an important contribution to protecting water bodies and reducing water consumption. Water consumption should also be taken into account in the processing method. Information activities and measures geared towards target groups should put consumers in a position to make a sound choice.

II. 10. Work together to protect global water resources for the long term

Baseline

- According to United Nations projections, the world's population will grow to 9.7 billion by 2050 (and to 10.9 billion by 2100). At the same time, the lifestyles of many people are changing. Both of these trends lead to increased use of water resources. Water demand is set to rise by 55% by 2050.
- Already today, around 2 billion people live in regions with high water scarcity (SDG 6.4.2). Experts believe that this figure will increase sharply in the coming decades. The impacts of climate change are also affecting the availability of and demand for water. For example, there are changes in intensity and frequency of rainfall and increased evaporation rates with rising temperatures. Additionally, greater demand is expected for water for agricultural irrigation, cooling for industry and energy production. Beyond this, estimates suggest that by 2030, 700 million people around the world will be driven from their homes by extreme water scarcity.
- In 2050, approximately 70% of the world's population will live in cities and towns. Unless the resulting wastewater is adequately treated, this will place an extreme burden on groundwater and surface waters. According to UN estimates, over 80% of wastewater is still discharged into the environment without adequate treatment.
- SDG 6 of the 2030 Agenda seeks to ensure availability and sustainable management of water and sanitation for all. In addition to SDG 6, SDG 13 must also be taken into account when taking direct measures to combat climate change and its impacts in order to make water management and water infrastructure climate-resilient, facilitate adaptation to climate change and contribute to climate change mitigation.
- Long-term access to water supply, sanitation and hygiene will make a major contribution to enabling people to live healthy lives, creating opportunities and options for action and guaranteeing them participation in public services. United Nations surveys show that currently every third person globally (around 2 billion people), especially in low-income countries, has no guaranteed access to clean drinking water, and around half of the world's population (around 3.6 billion people) live without adequate sanitation.
- At the end of 2019, UN-Water concluded that the Sustainable Development Goal for water (SDG 6) of the 2030 Agenda will not be attainable unless the international community and UN

organisations significantly step up their efforts and cooperation among UN organisations is considerably improved, among other things.

- The institutional structures of the United Nations related to water are very fragmented. The functions and responsibilities in the area of water policy and management are distributed across 32 UN organisations, programmes and funds.
- Every year since 2011, the World Economic Forum has identified the global water crisis as one of the biggest risks for the economy, the environment and world peace. Losses in worker productivity due to illness caused by inadequate water supply and sanitation are as much as 5% of the gross domestic product in many countries. It is also estimated that 78% of global jobs depend on water, and around half of these to a very high degree.
- Germany's water footprint is largely determined by the production of goods and imports from abroad along global value chains: external water use accounts for just under 70% of the footprint.
- The 2030 Agenda's SDG 15 "Life on Land" calls for freshwater ecosystems to be conserved, restored and sustainably used. Water-based ecosystems form hotspots of biological diversity, although populations of freshwater species have decreased massively since 1970.

What are the challenges?

The global water cycle is a closed system, meaning that overall, the water resources on the planet remain the same. However, only a very small share of global (fresh)water resources (below 3%) is usable as a freshwater resource for abstracting drinking water or for other purposes. Global distribution is very uneven. Around one-third of the world's population live close to the coast. The population density in these regions is twice as high as the global average. Freshwater resources in these areas are at risk of salinisation due to their proximity to the sea. The reasons for this include overuse of groundwater aquifers, potentially resulting in salt water intrusion, and increased extreme weather events and rising sea levels due to climate change that lead to increased pollution of and pressure on groundwater in coastal areas. In view of the cross-sector importance of water, integrated, sustainable water management is crucial for sustainable development and alleviating global poverty. If the situation in agriculture and industry (including energy production) remains the same, water demand will increase sharply in the coming decades due to population growth, the impacts of the climate crisis, increasing electrification, changing lifestyles and consumption patterns and the associated economic development. To make water management sustainable, it will also be crucial to transform the agricultural and food systems. Agroecological approaches can help reduce the pressure on natural resources, making systems more sustainable. Beyond the sectors at the water-energy-food nexus, water also plays an essential role in health, education, gender equity, sustainable urban development, healthy ecosystems, biodiversity conservation and also peace and stability. Experts predict that the number of people living in regions with high water scarcity will rise sharply in the next decades to one third of the global population. The number of people driven from their homes by extreme water scarcity will also increase dramatically. In many cases, too much water is withdrawn from surface waters and groundwater. Water can cause conflicts in and between social groups and countries but it can also be a means of promoting understanding and cooperation.

At the same time, the available water resources will be strained by increased pollution of surface waters and groundwater, which will limit usable water resources and increase the effort and expense needed to supply safe drinking and domestic water. The declining status of water bodies hits developing countries and emerging economies particularly hard. Since the 1990s, water pollution has increased in almost all rivers in Africa, Asia and Latin America.

There is a growing danger that these pressures on water resources and water bodies can become the cause of conflicts within and between social groups and countries. However, they could also contribute to more understanding and cooperation and to preventing and solving conflicts. Sustainable use of

water resources and water ecosystems is a precondition for securing and improving people's living conditions. Water, in all its facets, is also a key component of liveable and resilient towns and cities, and this needs to be given greater consideration.

Already today, most cities, towns and rural regions lack adequate infrastructure, operating and financing mechanisms and resources to guarantee efficient and long-term sanitation and hygiene, and to ensure water and wastewater management for faeces and other wastewater to be safely transported, treated and, ideally, the substances they contain can be reused in a closed cycle. The water sector is facing a huge shortage of qualified professionals, in many places, resulting in delays to planning and implementation measures. It can be assumed, due to many factors, that this shortage will worsen. Examples of these factors include a failure to recruit and support young staff and an inadequate focus on education and training needs. This applies in particular to women, who are extremely under-represented in all areas of the water sector – not least due to traditional role models, a lack of training and support and an inadequate working environment.

In many places, the expansion of infrastructure is not keeping pace with population growth and increasing urbanisation. Globally, faeces and wastewater are still mostly discharged into the environment without adequate treatment. This leads to poor water status, health risks and increased emissions of the greenhouse gas methane. It also means that the valuable resources in faecal sludge and wastewater go unused. Even today, every third person worldwide has to drink impure water that poses a health risk. Around half of the world's population lives without adequate sanitation. Especially vulnerable people (e.g. children, women, people with disabilities, minorities, people living in poverty, fragility and in crisis situations, rural populations) are disproportionately hard hit. The quality and availability of water resources and access to drinking water, sanitation and hygiene are closely interlinked. In armed conflicts, water infrastructure like drinking water systems, wastewater treatment plants, dams and irrigation canals are often targeted to put pressure on civil society and policymakers. To achieve the relevant goals and targets of the 2030 Agenda for drinking water and sanitation (SDG 6.1 and 6.2), the pace of progress must be quadrupled, and for sustainable water management (SDG 6.5), the current pace of progress has to double by 2030.

Due to global economic interdependence, prosperity in Germany also depends on the availability and quality of water resources in other countries. At the same time, industrialised countries and their water footprint, i.e. their production and consumption patterns and lifestyles, are partly responsible for the overuse of water resources and the pollution of water bodies worldwide. As a result of global supply chains, these environmental impacts are often felt in places with weak environmental law and inadequate implementation of existing law, far out of sight of consumers.

Sustainable water resource management and healthy water bodies are also a prerequisite for functioning terrestrial and aquatic ecosystems, which are also of high economic significance. The annual value of the ecosystem services[#] they provide exceeds the annual global gross domestic product. For example, wetlands store more carbon than all other types of ecosystems. Despite this, such ecosystems and their biodiversity are, in quantitative terms, most affected by degradation and destruction (SDG indicators 6.6.1 and SDG 15.1.2). Intact water ecosystems are also an important component in preventing diseases in line with the One Health approach. This is based on the understanding that human, animal and environmental health are closely interlinked and relies on interdisciplinary and international cooperation.

UN Resolution 64/292 from 2010 recognised access to safe and clean drinking water and sanitation as a human right. In 2015, the UN General Assembly affirmed (Resolution 70/169) the human rights to water and sanitation as two separate human rights. Also in 2015, 193 UN member states committed to the goals of the 2030 Agenda, including SDG 6: to ensure availability and sustainable management of water and sanitation for all.

At the third session of the UN Environment Assembly in 2017, the UN member states adopted a resolution addressing water pollution to protect and restore water-based ecosystems.

According to UN analyses, SDG 6 of the 2030 Agenda is not achievable with current international efforts. To date, the UN development system has been unable to take measures sufficient to reverse this prognosis. According to a 2017 report commissioned by the UN Secretary-General, the large majority of the UN budget available for water issues goes to emergency and transitional development assistance (UNICEF, UNOPS, UNRWA, UNHCR). However, this area is still very underfunded in view of the high level of humanitarian needs around the world. The funds available to the United Nations for integrated water resource management, improvement of water use efficiency and long-term improvement of access to drinking water and sanitation are negligible in comparison. This makes it all the more urgent to tackle water-related challenges across sectors and to pool existing funding from a range of areas for joint solutions. The German government supports the work of UN organisations on water issues, especially in the contexts of crises, displacement and forced migration – primarily by supporting WASH projects, but also by supporting the efficient use of water in agriculture, especially via UNICEF and WFP.

The UN's institutional landscape is extremely fragmented when it comes to water, with very little overarching coordination and coherent direction in implementing the goals of the 2030 Agenda. The existing internal coordination mechanism of UN-Water only has a weak mandate and cannot intervene in the programme-based approach of the individual UN organisations.

Sustainable water management requires continuous gains in knowledge and a willingness to learn from experience. Understanding the complex processes in river-groundwater-ocean systems requires long-term strategies for data collection (e.g. on nutrients and pollutants, hydrology, morphology, sediments, biodiversity, water body uses), for the scientific assessment and interpretation of this data, as well as the transfer of findings in practice. The same applies to data on access to water supply, sanitation and hygiene systems and their condition, especially in households, schools and healthcare facilities. Cooperation and networks between researchers and actors beyond national borders are indispensable.

Vision – Global water resources in 2050

The long-term availability of water resources and the quality of surface waters and groundwater worldwide has been improved.

The safety of water resources and the protection of groundwater, surface waters and water-dependent ecosystems is ensured.

Water bodies are protected from harmful pollution, adverse changes and overuse. The conservation, restoration and sustainable management of ecosystems that are very important to the water regime and healthy water bodies (e.g. forests and wetlands) is ensured worldwide by multilateral, regional and bilateral agreements, national legislation and efficient implementation structures. Transboundary and international exchange of water data and information takes place worldwide and is assured by agreements and decisions.

The world's groundwater and surface waters have good status compared with an international evaluation baseline. Where this is not yet the case, the required political, institutional and financial framework conditions are established in order to achieve good status on an appropriate timeline. The necessary data is collected and administered in such a way that the status can be determined. Measuring networks and monitoring programmes reflecting the key parameters of the national and regional water regimes and the water body status have been implemented.

Water management, water uses and water infrastructure are resilient, for example thanks to cross-sector cooperation and increased implementation of nature-based solutions. For example, water-using sectors respond proactively to the impacts of the climate crisis and minimise damage related to those impacts. The water sector takes full advantage of its options for mitigating emissions of greenhouse gases into the atmosphere. Precautions are taken against other risks, such as pandemics and non-climate-related natural disasters, with forward-looking, risk-based planning and inclusive and integrated water management. Sustainable water management therefore also contributes to implementation of the Paris Agreement, the Global Biodiversity Framework and the One Health approach. The One Health approach takes a collective view of the health of humans, animals and the environment.

The economic and social impacts of the climate crisis through changes in the regional availability of water and the frequency and intensity of extreme events such as droughts and floods, and their significance for political conflicts and migration movements, are better understood and taken into account as a key factor in the development of policies and measures to prevent internal conflicts and conflicts between countries, and to tackle their impacts.

The targets of SDG 6, SDG 14, SDG 15 and other water-related targets of the 2030 Agenda have been implemented. Compliance with the goals and targets is ensured for the long term, for example through sustainable and fair operating and financing mechanisms, integrated and sustainable resource management and protected rights for local communities, vulnerable groups and minorities. Inequalities in access and supply have been resolved. The extensive links between water and other issues and targets are recognised, and their crucial importance is taken into account in sectoral planning. Ensuring access to water supply, sanitation and hygiene makes a major contribution to enabling people to live healthy lives, creating opportunities and options for action and guaranteeing participation in public services. The shortage of qualified professionals and the under-representation of women have been tackled through education and training and improved working conditions.

Water body pollution and overuse of these water bodies is in sharp decline thanks to regulation of water-relevant substances and their use under national legislation and international agreements and their resolute implementation, among other things. The cross-sector nature of the management and conservation of water bodies and water resources is reflected worldwide by integrated, sustainable water management. This involves close, efficient cooperation between ministries and specialist authorities in the various policy areas, the scientific community, the private sector and civil society at regional, national and local levels. There are established mechanisms to handle and reconcile conflicts of use. Governments, businesses and consumers (especially in industrialised countries) take account of the water footprint and water risks[#] (physical, regulatory and reputational) in production and supply chains in their decisions. This is supported by internationally agreed criteria and standards, and transparency regulations in individual countries, as well as by the commitment of companies beyond binding stipulations, for example in the water stewardship approach. Locally appropriate, adapted mechanisms are established globally for the sustainable financing of necessary investments in and expenses for the maintenance and operation of grey and green water infrastructure, water-based services, water management and conservation measures. These take into account the polluter pays principle as well as the special needs and rights of vulnerable groups, in keeping with the principle of leave no one behind. Implementation of efficient regulating mechanisms ensures sustainable and socially fair water use. This is complemented by fair, sustainable international financing mechanisms to support financially weak countries in ensuring security of supply and conservation of water resources. Financing mechanisms channel money from water users, the private sector and local finance markets into water management. This meets the need for additional funds for the provision and operation of the necessary infrastructure. When designing the mechanisms, the steering effects for effective, efficient and equitable water use are taken into account. Wherever possible and

expedient, finance flows are supported by capacity-building measures (recruiting and (further) training qualified staff, organisational development, support for political framework conditions such as financing and regulation) to add long-term value to investments, e.g. through operator partnerships to develop the know-how of water and wastewater companies in the sustainable operation of infrastructure. Multilateral structures to achieve the 2030 Agenda and handle future challenges are strengthened.

Structures and regulations exist – ideally agreed under international law – for cooperation among countries that share transboundary waters. These are based on the Convention on the Law of Non-Navigational Uses of International Watercourses or the Convention on the Protection and Use of Transboundary Watercourses and International Lakes. These structures have corresponding political mandates and sufficient capacities.

At multilateral level, mechanisms for cooperation are applied that can respond promptly, efficiently and as needed to international water and water body challenges. These mechanisms also support their member states as effectively as possible in handling these challenges.

At UN level, there is effective and efficient coordination of the (global, regional and country-specific) interventions of the various organisations and programmes active in the water sector. These organisations and programmes coordinate their areas of responsibility, complement each other's work and supplement each other's activities. Clear areas of responsibility are defined. They are geared to the goals of the relevant multilateral agreements (e.g. 2030 Agenda, Paris Agreement, Convention on Biological Diversity, Sendai Framework, New Urban Agenda for Sustainable Urban Development). Also at UN level, an intergovernmental mechanism has been established that enables the member states to regularly review the overall progress made on water goals and targets and how the UN system contributes to these, formulating policy guidelines in response.

What needs to be done?

Holistic approaches and strong international cooperation are required in order to realise the vision of good status for water bodies worldwide, resilient water infrastructure and supply services and global, sustainable use of our water resources. Germany supports the call of the EU Council to close loopholes in the water sector, including in financing, governance and capacity building, and to jointly use EU standards, know-how, experience and resources. UN-Water has proposed the SDG 6 Global Acceleration Framework for the water-related goals of the 2030 Agenda. It strives for harmonisation of the international community's efforts in five cross-cutting 'accelerators'. These are data and information, capacity development, innovation, governance at all levels and financing. The EU and its member states have committed in Council conclusions to support this framework through measures in the five accelerators. This framework will also be relevant beyond 2030.

The availability of reliable data on water pollution and water status, the links between land and water use and the impacts of the climate crisis is a basic requirement for targeted decision-making and measures. This requires appropriate capacities for the collection, management and analysis of relevant data, and robust cooperation among international organisations, at bilateral and multilateral levels and with the involvement of national authorities and research institutes. A status description and assessment of global freshwater resources (including groundwater and soil water) and ecosystems with comparable methods and criteria must be drawn up and regularly updated. The availability of targeted data products and evidence-based (climate) services and early warning systems to support decision-making in UN member states needs to be improved. Multi-stakeholder initiatives like the World Water Quality Alliance are particularly suitable for this. Additionally, scientific studies should be carried out for river-groundwater-ocean systems in an international framework with a view to integrated management of large water body systems and to improve conservation of water resources and ecosystems. The findings should then be incorporated into development and water-related

strategies. The data available on access to supply in households, schools and healthcare facilities needs to be further improved to facilitate targeted, evidence-based measures.

Decisions about the use of water bodies and resources are not taken solely by the authorities and bodies responsible for their conservation and management, but also by stakeholders in all sectors that use water bodies and resources (in particular energy, agriculture, aquaculture, industry, mining, transport, tourism and urban development). Decisions in other environmental policy areas (air quality control, waste management, climate change mitigation, climate adaptation, nature conservation) can also have impacts on water bodies and resources. Water policy goals can therefore only be achieved through cooperation and coordination across sectors and policy areas at national, bilateral, regional and multilateral levels. The corresponding mechanisms, structures and legal bases need to be created, further developed and strengthened. It is important here to ensure that these have a foundation in human rights and are transparent, facilitate participation, consider the interests and needs of especially vulnerable groups in a non-discriminatory manner, respect social aspects and curb future potential for conflict. Germany has an active role to play here in the relevant multilateral organisations and processes. Bilateral cooperation on water issues should therefore always draw on supporting guidance on how to establish and implement efficient regulation and governance systems in the context of integrated water resource management, and build on existing instruments, such as the OECD Water Governance Initiative (WGI). As part of the One Health approach, Germany will continue supporting the development of water, sanitation and hygiene (WASH) as a component of global pandemic prevention. It will also promote food security with sustainable agroecological approaches and the transfer of knowledge and technology, especially in small-scale agriculture.

In addition to bilateral cooperation with partner governments, the German government supports the work of UN organisations on water issues, especially in the contexts of crises, displacement and forced migration – primarily by supporting WASH projects, but also by supporting the efficient use of water in agriculture, especially via UNICEF and WFP.

In addition, the creation and support of transboundary cooperation mechanisms in river basins, lake catchment areas and aquifers and/or at regional level needs to be promoted. This can take the form of further support of UN member states for joining and implementing the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) and developing the capacities of mandated organisations like the river basin commissions.

Synergies between greenhouse gas mitigation and adaptation to the impacts of the climate crisis, for example ecosystem-based solutions, water reuse and increased water use efficiency in water-using sectors, must be more effectively leveraged. At the same time, it is important to minimise trade-offs between climate change mitigation and climate adaptation measures. These developments should be flanked and fostered by the establishment of targeted instruments for cooperation within the framework of multilateral mechanisms and conventions, and by the formation of cross-sector alliances and initiatives. These aspects are taken into consideration when establishing and updating ambitious climate and energy partnerships.

Partner governments and the operators of local water and wastewater plants should be supported with measures to cut GHG emissions in drinking water supply, sanitation and wastewater management. For example, increasing energy efficiency, optimising the operation of water and wastewater plants and developing and implementing targeted regulation. In many cases, highlighting and achieving additional benefits such as cost savings can act as an incentive. The implementation of technical innovations and the application of nature-based approaches and traditional and indigenous knowledge must receive targeted support.

Promotion of the expansion of urban and industrial wastewater management in developing countries and emerging economies, support for partner governments in the application of best available techniques and the establishment of suitable legal frameworks must be continued and stepped up. Related exchange between stakeholders from the government, industry and the scientific community on the practical application of new technologies and on shaping suitable governance and management structures needs to be supported.

In cooperation with the EU countries and other UN member states, decisions must be pursued to strengthen the multilateral mechanisms for achieving the water goals of the 2030 Agenda and future targets. Firstly, improved horizontal and vertical coordination must be sought between the various water-related organisations and programmes of the United Nations. This requires a strong mandate for an internal coordination mechanism within the UN system that is able to evaluate the activities and desired effects of the interventions of the various organisations and programmes overall and develop a basis for decision-making. Secondly, greater coherence in the decisions of the UN member states in the decision-making bodies of the various organisations and programmes is required to ensure that the scope of responsibility is clearly defined when setting targets and work programmes. This requires the establishment of regular monitoring and evaluation of the progress on target achievement and the contribution of the UN system, for example in the UN General Assembly or in the form of a regular high-level meeting of UN member states with a relevant mandate. Work with partner countries, civil society and other non-governmental organisations is needed with the aim of including water policy goals in the consultation and decision-making processes of multilateral conventions in other policy areas. This primarily applies to multilateral environmental conventions, but also to agreements in the agriculture, fishing, energy, mining and transport sectors. The aim is to agree on internationally comparable requirements to reduce pressures on water bodies, ensure sustainable use of water resources in the relevant sectors and create transparency surrounding the water footprint of goods and services and water risks along the production and supply chains.

III. Programme of water measures

The proposed measures summarised in the following overview are intended to operationalise the National Water Strategy. The programme of measures focuses on the time period up to 2030. Some of the measures are already being prepared, with most due to be started in the short term (by 2025). Some of the measures build on each other and, in some cases, will therefore only be initiated in the second half of the decade (medium/long term). The proposed measures explicitly address different levels (particularly the federal, federal state and municipal levels). Further coordination, discussion and agreement on priorities, responsibilities and financing will be necessary to implement these proposals. Measures within the remit of the federal ministries and higher federal authorities will be implemented within the framework of the financial and human resources available in the individual federal budget plans. The proposed measures draw, for example, on ideas arising from the National Water Dialogue and the citizens' dialogue on water conducted by the Federal Environment Ministry. During the process of drafting the National Water Strategy, many existing strategies related to water were analysed. The content of measures that were relevant to the strategic issues of the National Water Strategy have been included.

III. 1. Protect, restore and ensure a semi-natural water regime for the long term – prevent water scarcity and conflicting goals

Number	Measure	Links	Start date
1)	**Improve forecasting capabilities of water regime analyses** The competent higher federal authorities will present and implement a joint work programme for the development of a shared integrated range of publicly accessible data and services. The goal is to cooperate with the federal states to develop comprehensive, national forecasts of the available water resources. This will enable regional and supraregional analyses and allow suitable overarching measures to be formulated for ensuring a semi-natural, regional water regime, taking into account the water needs of the ecosystem. The forecasts will serve as the basis for assessing individual projects. This includes nationwide water regime modelling (with hydrogeological models), tied in with climate models as a basis for analysing medium- to long-term water resources and water needs in all regions of Germany. This work programme will also be supplemented and supported by suitable funding measures from the Federal Ministry of Education and Research (BMBF).	M 2 "Establish a low water level information system" M 3 "Define uniform parameters for low water levels and water shortage" M 4 "Establish groundwater real-time withdrawal monitoring" M 7 "Guiding principles for regional, semi-natural water regimes"	To start in the short term
2)	**Establish a low water level information system (Niedrigwasserinformationssystem, NIWIS) in cooperation with the federal states**	M 3 "Define uniform parameters for low water levels and water shortage" M 4 "Establish groundwater real-time withdrawal monitoring"	To start in the short term

	A national, user group-specific low water level information system (NIWIS) will be developed, set up and permanently operated at the Federal Institute of Hydrology. This will address the increasing need for sound, well-prepared data, information and analyses for the assessment and management of low water level events. The data, analysis and reporting system will serve as a central, publicly accessible data and information hub for the federal government, the federal states and other users and provide information for planning decisions, etc. NIWIS is intended to complement and support the platforms and portals that may already exist in the federal states, which are characterised by regional and local constraints coupled with appropriate spatial resolution.	M 7 “Guiding principles for regional, semi-natural water regimes” M 47 “Establish uniform nationwide guidelines for regional water supply plans” M 49 “Infrastructure spanning federal states and supraregional infrastructure”	
3)	**Define uniform parameters for low water levels and water shortage** The federal and federal state governments will work together to develop uniform national definitions of indicators and parameters for characterising low water levels, dry periods and drought. This will require a common understanding of how these data, methods and standards will be used (e.g. coordination of climate scenarios, forecast time periods, limit values, warning classes). Uniform parameters will provide the necessary basis for harmonising information, forecasting and warning systems. Taking regional differences into account, the parameters can be used to derive criteria or limit values to initiate measures.	M 2 “Establish a low water level information system” M 4 “Establish groundwater real-time withdrawal monitoring” M 7 “Guiding principles for regional, semi-natural water regimes” M 47 “Establish uniform nationwide guidelines for regional water supply plans” M 49 “Infrastructure spanning federal states and supraregional infrastructure”	To start in the short term
4)	**Establish groundwater real-time withdrawal monitoring** Together with the federal states, representative, quantitative real-time groundwater monitoring of the actual amounts of water withdrawn will be developed. This will form a basis for future risk-driven groundwater management.	M 57 “Further develop water law and regulations relevant to water in other legislation”	To start in the medium term
5)	**Create a water register and reduce exemptions from the permit requirement for groundwater withdrawals** The existing regulations on the water register in the Federal Water Act will be further developed to create a comprehensive, transparent water register for	M 57 “Further develop water law and regulations relevant to water in other legislation”	To start in the short term

	keeping track of all authorised, applied for and actual groundwater withdrawals. The existing exemptions from the permit requirement (Section 46(1) Federal Water Act) and the introduction of de minimis limits for the permit requirement will be reviewed.		
6)	**Develop a guideline for handling water scarcity** A nationally coordinated guideline, which will be developed together with the federal states and in dialogue with stakeholders, will create a uniform framework for setting priorities in local and regional decision-making. The aim, in particular, is to ensure that sufficient resources for drinking water supply are available at all times, as close to the location as possible. In addition, rules and criteria for transparent decision-making to define priority uses in the event of regional temporary water scarcity and dry soil will be developed. The special importance of supplying people with drinking water (drinking water supply as a priority) and other critical public services (e.g. food and health care) as well as the water needed for ecosystems and the economy will be taken into account. Initial recommendations for the participatory process will be developed in a research project.	M 1 “Improve forecasting capabilities of water regime analyses” M 47 “Establish uniform nationwide guidelines for regional water supply plans” M 48 “Create participation and mediation structures” M 54 “Increase water reuse”	To start in the short term
7)	**Guiding principles for regional, semi-natural water regimes** Guiding principles for regional, semi-natural water regimes are important as guidance and goals for implementation strategies, e.g. for regional water supply plans. A standard methodology to create specific guiding principles for regional, semi-natural water regimes will be developed in a project with the involvement of the federal states to ensure that the findings in all regions of Germany can be compared. This will contain proposals for categorising the semi-natural water regime by region based on different natural areas, describe the requirements profile for regional guiding principles and outline which hydrogeological, hydrological and soil-related data and modelling should be included. Case studies will be used to test whether the methodology can be applied and transferred elsewhere. A special focus will be the integration of low water	M 1 “Improve forecasting capabilities of water regime analyses”	To start in the short term

	aspects, such as how a semi-natural water regime can potentially mitigate low water levels.		
8)	**Integrate public water supply and water resource management interests better into the planning process** To ensure that public water supply and water resource management interests are adequately reflected in land development and spatial planning, in decisions about settlements and in the designation of new building areas, planning, building and water law will be reviewed for coherence and adapted where necessary.	M 9 “Improve integration of water planning into overall spatial planning”	To start in the short term
9)	**Improve integration of water planning into overall spatial planning** The relevant legal and scientific bases will be developed to improve the extent to which water planning is integrated into overall spatial planning (regional and urban land use planning) and thus how these issues are better asserted when balancing all spatial interests. The possibility of defining priority areas for groundwater recharge and future water supply (future water protection areas), both above and below ground, must also be considered in the process.	M 55 “Design water sector frameworks for new energy sources”	To start in the short term
10)	**Measures for the sustainable use of water quantities** To prevent the available water resources from being overused, specific technical solutions will be sought together with relevant associations and research institutes to reduce water consumption (demand management). The research findings will be used to develop, among other things, standards for efficient water use with state-of-the-art technology and to facilitate the production of water-saving products and applications.	M 4 “Establish groundwater real-time withdrawal monitoring” M 7 “Guiding principles for regional, semi-natural water regimes” M 16 “Agriculture and water sector[#] practitioners’ dialogue” M 17 “National practical handbook for water-optimised land use” M 55 “Design water sector frameworks for new energy sources”	To start in the short term
11)	**Further develop and introduce nationwide water withdrawal charges** Further development of water withdrawal charges (harmonisation and, if necessary, adoption of a federal regulation) will be reviewed. The revenue generated from these charges will be used to finance water management measures, e.g. to achieve the objectives of the Water Framework Directive (earmarking). The charges can also have a positive effect by encouraging people to use water as a resource more responsibly. A research project will		To start in the short term

	explore how “smart” water tariffs for domestic and drinking water could be used to influence developments.		
12)	**Improve soil conservation, soil hydrology and groundwater recharge** The Federal Soil Protection Act will be evaluated and adapted to meet the challenges of climate change mitigation, climate adaptation and biodiversity conservation. The different uses will be taken into account in the process. This will also include looking at the natural soil function with regard to soil hydrology, water retention over a large area and groundwater recharge.		To start in the short term
13)	**Semi-natural rainwater management** To make this possible, an amendment to Section 55(2) of the Federal Water Act, which does not give priority to infiltration, will be considered with the aim of prioritising infiltration where practical, proportionate and feasible. In the case of infiltration, the pollutant load of the rainwater must be taken into account to protect the groundwater from contamination in accordance with applicable technical regulations (e.g. DWA-A 138; DWA-M 102 to 104 and relevant DIN standards). This is part of implementing water-smart urban development. It can also prevent flood peaks in small streams if stream inflows are reduced.	M 19 “Develop and implement the guiding principle of the water-smart city”	To start in the short term
14)	**Requirements for rainwater removal on roads** The requirements and measures for rainwater removal on roads (e.g. Guidelines for Structural Engineering Measures on Roads in Water Protection Areas (RiStWag) and Guidelines for the Design of Roads – Drainage (RAS-Ew)), especially infiltration on green verges, will be reviewed for ecological aspects and their current implementation by the responsible authorities. With regard to infiltration, rainwater pollution should be taken into account to protect the groundwater from contamination. This serves to prevent groundwater and surface water pollution, as well as to avoid possible contamination of deeper soil layers. Furthermore, groundwater and surface water pollution by tyre abrasion and other contaminants caused by rainwater runoff from roads must be reduced to a large extent through legislation.		To start in the short term

15)	**Strengthen protection of peatlands** Comprehensive rewetting of peat soils must be ensured as part of the implementation of the federal government-federal state target agreement on climate change mitigation through peat soil conservation and the National Peatland Protection Strategy. It is vital here that enough water is available for rewetting measures. Drainage infrastructure in peatland areas must be dismantled or repurposed to enable a semi-natural landscape hydrology to be established and stabilised.	M 21 “Identify areas for floodplain development and water body development corridors and include them in planning” M 9 “Improve integration of water planning into overall spatial planning”	To start in the short term

III. 2. Ensure that land use in rural and urban areas is compatible with water bodies and adapted to the climate

Number	Measure	Links	Start date
16)	**Agriculture and water sector# practitioners’ dialogue** In dialogue between representatives from agriculture, water management and water conservation initiated jointly by the competent federal ministries, shared guiding principles for water-optimised agriculture will be developed with the involvement of existing networks and practitioners to protect water resources, also in light of the need for adaptation# to the climate crisis. Water-saving and water-efficient agricultural use and management will also focus on factors specific to a location such as soil quality, water supply, topography and climate.	M 17 “National practical handbook for water-optimised land use“ M 66 “Educational programmes and advisory services for agriculture and forestry”	To start in the short term
17)	**National practical handbook for water-optimised land use** A national practical handbook will be drawn up that summarises legal and subordinate regulations and identifies proven and climate-adapted examples of management methods with the goal of ensuring water-optimised land use adapted to natural groundwater levels and consistent implementation of legal provisions. The practical handbook will also be used for education and training in agriculture. It will be developed together with the Federal Information Centre for Agriculture and the Federal Environment Agency in dialogue with experts from agriculture and water management.	M 16 “Agriculture and water sector practitioners’ dialogue”	To start in the short term
18)	**Amend the Federal Forest Act to include water aspects** As part of the planned revision of the Federal Forest Act, a review will be conducted to determine to what extent water aspects related to forests and		To start in the short term

	forest management can be incorporated. The aim is for forests and forest management to make a greater contribution to maintaining and improving the water storage function and water retention capacity of forest soils, to mitigating the surface runoff of rainfall and to replenishing water stored in the soil and groundwater. In this context, the extent to which these goals can be supported by (public and private) incentives for water management ecosystem services provided by forests will also be explored.		
19)	**Develop and implement the guiding principle of the water-smart city** The federal government will further develop the guiding principle of the water-smart city in cooperation with the federal states (in this case the LAWA) and associations with a practical and feasible approach in order to bring together the various disciplinary perspectives on the issue and to strengthen the sustainable use of water in cities (use of process water and rainwater, infiltration, evaporation, storage; drought prevention as well as heavy rainfall management). The aspects of hydroecology and the experience of nature as well as the use of some wastewater flows for water-smart cities and urban vegetation, especially in dry regions, will be integrated. Similarly, water management interests and green-blue infrastructure will be strengthened as a planning and design element in new construction and redevelopment projects. The plan is to then incorporate the guiding principle of the water-smart city into the Federal Building Code (BGB). On the basis of the guiding principle, the federal government, in cooperation with the federal states and relevant associations, will derive measures to further develop legal regulations for water management (e.g. through an annex on rainwater in the Wastewater Ordinance, the prioritisation of decentralised rainwater management in new residential and commercial areas over discharge into sewers, with special consideration for heavy rainfall events) and to develop flood prevention measures as well as different ways to adapt to dry periods and heat in cities. The need for technical approaches, social acceptance and potential risks for the environment and human health will be further clarified and model recommendations drawn up, giving priority to nature-based solutions. The various areas such as municipal land management,	M 13 “Semi-natural rainwater management” M 20 “Reduce surface sealing – promote unsealing projects” M 47 “Establish uniform nationwide guidelines for regional water supply plans” M 51 “Establish a legal requirement to create and publish hazard and risk maps for protection against local flooding after heavy rainfall events” M 54 “Increase water reuse”	To start in the short term

	building and water law, financing and liability issues and existing technical rules need to be compiled, and adaptation needs identified. The federal government will support municipalities in preventing and managing heavy rainfall events and adapting to climate change. Through urban development funding, the federal government will also support municipalities that promote water-smart urban development and contribute measures to prevent and manage heavy rainfall events and adapt to the climate crisis. The establishment of municipal advisory structures (e.g. for climate adaptation or rainwater advisory centres) will be promoted. These advisory centres will be the main service and contact points for administrations, property management companies, property owners, planners and the public for questions about decentralised and sustainable rainwater management. Building on the process of implementing the White Paper on Urban Greenery, there are plans to develop an action plan for green-blue infrastructure and to include the measures of the National Water Strategy for implementing the guiding principle of water-smart urban development.		
20)	**Reduce surface sealing – promote unsealing projects** In a dialogue format involving relevant stakeholders (federal states, municipalities, industry, agriculture, associations, etc.), the aim is to examine how obstacles can be removed and, if necessary, how existing laws and funding instruments can be further developed to reduce soil sealing and significantly increase unsealing.	M 13 “Rainwater management” M 19 “Develop and implement the guiding principle of the water-smart city” M 51 “Establish a legal requirement to create and publish hazard and risk maps for protection against local flooding after heavy rainfall events” M 54 “Increase water reuse”	To start in the short term

III. 3. Further develop sustainable management of water bodies – achieve and preserve good status

Number	Measure	Links	Start date
21)	**Identify areas for floodplain development and water body development corridors and include them in planning** The area required for floodplain development and water body development corridors must be identified by the responsible water management and nature conservation administrations, taking into account sustainable water quantity	M 9 “Improve integration of water planning into overall spatial planning” M 23 “Measures to restore, protect, improve the ecological quality of and reconnect floodplains”	To start in the short- to medium term

	and sediment management and the requirements of nature conservation and water management. The improvements in ecosystem services associated with the additional space for rivers and floodplains and the impacts on current and future uses will be outlined. To ensure that areas for spatially significant water body development measures are secured as a precaution, the responsible water administration will inform regional planners of the necessary size of the corridors along the watercourses so that these can be taken into account in the planning process. Spatial planning and water management planning must be better coordinated. This applies to requirements related to both content and legal procedures for spatial planning and water management planning. The federal government will initiate a discussion with water sector and spatial planning experts at federal/federal state level to discuss possibilities for greater cooperation in the protection of the water regime, also with the help of best practice examples. For example, priority areas for water body development can be included in the spatial development plans for an entire federal state (except on federal waterways). This approach will first be examined more closely in simulations and pilot projects. In addition, based on the scientific foundations used to determine the land requirements, which are still to be developed, the opportunities and synergies of establishing a land target in environmental policy for the development of watercourses and floodplains must be discussed.	M 24 “Strengthen Germany’s Blue Belt programme”	
22)	**Implement quantitative sediment management** Sediment management plans will be drawn up for the river basins. These plans will outline solutions for sediment quality and quantity. Starting from sufficient knowledge of the river basin-related sediment regime, needs-based measures to improve sediment continuity or replacement measures to address inadequate quantities of sediment and their consequences, such as riverbed deepening and disconnected rivers and floodplains, will be assessed and planned.		To start in the medium term

23)	**Measures to restore, protect, improve the ecological quality of and reconnect floodplains** The immense potential of semi-natural rivers and floodplains to absorb and store carbon from the atmosphere will be used for nature-based climate action, climate adaptation and biodiversity conservation. Wherever possible, especially in protected areas, the aim is to preserve or restore rivers and floodplains to a semi-natural state. Nature conservation, climate change mitigation and adaptation to climate change (flood protection) must always be considered in tandem and taken into account in the implementation of measures together with existing uses of water bodies, such as shipping and recreational use. Reclaiming natural retention areas and changes in land use are particularly significant in this context.	M 6 “Develop guidelines for handling water scarcity“ M 9 “Improve integration of water planning into overall spatial planning” M 21 “Identify areas for floodplain development and water body development corridors and include them in planning” M 24 “Strengthen Germany’s Blue Belt programme”	To start in the short term
24)	**Strengthen Germany’s Blue Belt programme** Activities under Germany’s Blue Belt programme must be strengthened and linked to water conservation measures in order to create a biotope network of national significance along the federal waterways and their floodplains. The potential for and challenges of the integration of open space and water body development will be investigated along riparian zones in settlements. It is important to ensure that synergies are created with the biotope network plans for nature conservation and with the objectives of the Habitats Directive for water-dependent habitat types, biotopes and species.	M 21 “Identify areas for floodplain development and water body development corridors and include them in planning” M 23 “Measures to restore, protect, improve the ecological quality of and reconnect floodplains”	To start in the short term

III. 4. Mitigate risks caused by pollutants

Number	Measure	Links	Start date
25)	**Continue the trace substance dialogue and further develop content** The German Centre for Micropollutants (SZB) established in 2021 as part of the Federal Environment Agency will continue its scientific follow-up on the work done in the trace substance dialogue (e.g. selection of relevant substances, identifying reduction measures along the value and use chains, raising awareness and setting priorities) and will advise stakeholders and the Federal Environment Ministry. The trace substance dialogue should take into account the goals of the zero pollution action plan. This trace substance dialogue will	M 26 “Support and implement the zero pollution action plan”	To start in the short term

	also be supplemented and supported by suitable measures funded by the Federal Ministry of Education and Research.		
26)	**Support and implement the zero pollution action plan** At EU level, Germany is working to further develop implementation of the European framework requirements for water and marine conservation (Water Framework Directive, Marine Strategy Framework Directive) with emission- and substance-related regulations (e.g. Directive 2010/75/EU on industrial emissions, Directive 91/271/EEC concerning urban waste-water treatment, the EU Biocide Directive 528/2012, Regulation (EC) No 726/2004 on medicinal products, Regulation (EC) No 1107/2009 on plant protection products, Regulation (EC) No 850/2004 on persistent organic pollutants, and the REACH Regulation (EC) No 1907/2006) and to improve the preconditions for cross-sector coherent implementation (e.g. prioritisation, data management).	M 25 “Continue the trace substance dialogue and further develop content”	To start in the medium term
27)	**Strengthen chemicals management – restrict the use of relevant pollutants to essential applications that still need to be defined** A list of substances that exceed a relevant hazard level or pose a relevant risk to water bodies and drinking water abstraction will be developed as part of the continuation and further development of the trace substance dialogue. The use of these pollutants must be limited to essential uses yet to be defined, where unacceptable risks can be eliminated. The federal government will push for corresponding measures at EU level as well.		To start in the short term
28)	**Establish further environmental quality standards in water policy** Germany will advocate for the establishment of environmental quality standards for other priority hazardous substances (e.g. active pharmaceutical ingredients) at EU level (update of the Directive on environmental quality standards in the area of water policy).	M 26 “Support and implement the zero pollution action plan”	To start in the short term
29)	**Introduce a limit value for human and veterinary medicinal products in the Groundwater Ordinance** A limit value must be introduced in the Groundwater Ordinance (Grundwasserverordnung) for medicinal products in groundwater. This would lead to more regular testing of groundwater for medicinal products; high concentrations could be detected early on and causes could be systematically identified and contained.		To start in the medium term

30)	**EU restriction on microplastic particles in cosmetics and detergents** Germany supports a European restriction on microplastic particles that have been intentionally added to cosmetics, textiles and detergents.		To start in the short term
31)	**Promote decontamination of polluted sediments in water body systems** Polluted sediments must be prevented from remobilising or, in special cases, removed from water bodies and deposited/disposed of on land in order to help restore water bodies as semi-natural and climate-resilient ecosystems. This will contribute to achieving good ecological and chemical status of water bodies under the Water Framework Directive and to achieving the objectives of the Marine Strategy Framework Directive by reducing or eliminating pollutant discharge from rivers. Sediment contamination from other pollutant discharge must be reduced or stopped. To achieve this aim, the close interrelationships between sediment regime and sediment quality in and around rivers and estuaries also needs to be better understood. Measures of supraregional importance for decontaminating polluted sediments must be identified and prioritised. This can be based, for example, on existing sediment management plans for the Rhine and the Elbe rivers. Polluted sediments along the identified priority river sections must be decontaminated in cooperation between the federal government (Federal Waterways and Shipping Administration) and the federal states (within the scope of their respective areas of responsibility).		To start in the short term To start in the medium term
32)	**National substances database** A national database will be established on the basis of standardised methods for monitoring substances and substance groups[#], taking into account existing databases. Nutrients in the relevant media – including sewage sludge and wastewater – will also be recorded. Data on the geohydraulic and erosion-relevant properties of soil layers will be made available in a nationwide database as a basis for assessing possible pollutant discharge into groundwater and possible measures to protect groundwater and soils. The two databases	M 25 “Continue the trace substance dialogue and further develop content” M 26 “Support and implement the zero pollution action plan”	To start in the medium term

	will create a better knowledge base for scientists, practitioners and the public and will support enforcement.		
33)	**Create a research and demonstration field for the risks of pollutant discharge into water bodies** The establishment of an early warning system will be assessed for use in the field, following the example of the Danish system (PLAP, Pesticide Leaching Assessment Programme). This will provide scientifically sound and independent data on the environmental behaviour of substances (pesticides and other substance groups) under real conditions in the field. This data will be taken into account in substance regulations and will help prevent possible damage and expensive decontamination measures.		To start in the medium term
34)	**Develop Best Available Techniques reference documents (BREFs) on the law governing incidents** Best available techniques must be used to prevent pollutant discharge into water bodies due to damage and incidents (major accidents). To this end, relevant BREFs or corresponding sections in BREFs, e.g. on fire-fighting water retention, must be developed.		To start in the medium term
35)	**Develop and implement a risk-based approach for the catchment areas of withdrawal points for drinking water abstraction** In line with the new EU Drinking Water Directive, a fully risk-based approach to safe drinking water will be implemented to protect drinking water resources and reduce the amount of treatment required to produce drinking water. Appropriate measures (risk management) must be developed and implemented on the basis of an assessment of the catchment areas and the potential risks to drinking water quality. This risk-based approach will span the entire catchment area supply chain, including the removal, treatment, storage and distribution of water.		To start in the short term
36)	**Fourth purification stage** More water purification plants will be retrofitted, where necessary, with a fourth purification stage using the guidance on setting priorities developed in the trace substance dialogue. In addition, wastewater treatment should be evaluated at specific locations known to be hotspots (e.g. hospitals). Sufficient	M 37 “Regulate producer responsibility”	To start in the short term

	financing instruments must be available to the federal states and municipalities for this purpose. To this end, an EU regulation on producer responsibility should also be pursued. The goal is fair cost distribution.		
37)	**Regulate producer responsibility** National, European and international producers or distributors of substances or products on the German market that result in water pollution must make a greater contribution to preventing and eliminating the substances and the damage they cause to water bodies as part of extended producer responsibility that creates incentives for measures to reduce pollution by trace substances and pollutants along the entire value chain. Possible instruments are the enforcement of best available techniques, exclusion of certain applications, take-back or disposal obligations as well as contributions of producers and distributors to the proportionate financing of measures. For reasons of effectiveness and to avoid putting Germany at a competitive disadvantage, a suitable approach will be pursued at EU level.		To start in the short term
38)	**Assess the impact of the measures of the Fertiliser Application Ordinance on implementation of the Nitrates Directive based on impact monitoring and, if necessary, develop them further** The measures of the Fertiliser Application Ordinance to implement the Nitrates Directive need to be assessed for their effectiveness as part of comprehensive monitoring to be set up nationally. This will be supported by a digital nutrient origin system. The legal prerequisites will be created by amending the Fertiliser Act and introducing a Monitoring Ordinance. Depending on the results of monitoring, supplementary measures will be reviewed.		To start in the short term
39)	**Adjust livestock numbers to the amount of land available** The aim is to help livestock farmers make livestock farming more humane for animals and better for the environment. The development in livestock numbers must be compatible with the amount of land available and aligned with the objectives of climate change mitigation, nature conservation, water conservation and emissions control.		To start in the short term

40)	**Identify microbiological threats to human health (pandemic prevention)** Establishing wastewater monitoring will enable early detection of health risks to the population from human pathogenic viruses (e.g. SARS-CoV-2). For SARS-CoV-2, an indicator was already implemented ("viral load in wastewater") in the pandemic radar established under the new Infection Protection Act (Infektionsschutzgesetz). Possibly extending the scope to other pathogens and antimicrobial resistances as well as pollutants must be assessed within the framework of wastewater-based epidemiology.		To start in the short term

III. 5. Further develop water infrastructure adapted to the climate – protect against extreme events and ensure supply

Number	Measure	Links	Start date
41)	**Develop uniform national conceptual guidelines for the future design of water infrastructure** Uniform nationwide conceptual guidelines will be developed to support administrations and infrastructure operators in the long-term, cross-sector design of infrastructure. The guidelines will provide information on how to take into account climate resilience, resource conservation, sector coupling and multifunctionality in the design of infrastructure (broken down by water management infrastructure sectors), following an integrated risk-based approach. They will serve as a guide to promote multifunctionality (e.g. unsealing, climate adaptation, local recreation, etc.) and the resilience of future investments, prioritising nature-based solutions as much as possible. The guidelines also need to contain information on variant analysis and practical examples. In terms of efficient use of funds, these guidelines will provide guidance on aligning existing and/or new funding programmes and investment planning.	M 13 "Semi-natural rainwater management" M 14 "Requirements for rainwater removal on roads" M 19 "Develop and implement the guiding principle of the water-smart city" M 44 "Adapt (technical) water regulations to climate change"	To start in the medium term

42)	**Develop climate adaptation targets for water infrastructure** Measurable (i.e. verifiable in terms of quantity or quality) climate adaptation targets for water infrastructure will be identified as a contribution to the further development of the German Strategy for Adaptation to Climate Change and reviewed for their informative value, applicability and data availability.	M 44 “Adapt (technical) water regulations to climate change”	To start in the short term
43)	**Identify and assess potential synergies of flood and low water risk management, especially with regard to storage management** Taking into account the impacts of the climate crisis, a changing precipitation regime, but also changing runoff conditions and events, synergies between flood and low water risk management, especially with regard to storage management, will be investigated and solutions developed in cooperation with the federal states and the relevant associations. If necessary, this can lead to the development of guidelines, which may also include criteria for prioritising competing uses, for dam management, including minimum water flows. The aim is to look at general possibilities for adaptation (e.g. structural modifications or technical solutions to control levels) both for existing and new reservoirs.	M 41 “Develop uniform national conceptual guidelines for the future design of water infrastructure“ M 42 “Develop climate adaptation targets for water infrastructure” M 44 “Adapt (technical) water regulations to climate change”	To start in the medium term
44)	**Adapt (technical) water regulations to climate change** The impacts of the climate crisis and the climate-adapted design of water infrastructure will be taken into account in existing subordinate regulations, standards, guidelines and provisions, e.g. for rainwater retention areas, infiltration facilities, structural flood protection, dams, etc. The water sector bodies and associations will review the standards and technical rules as part of regular revision cycles and adapt them to meet the challenges of the climate crisis, as well as transparently communicate the relevance of the individual standards for climate adaptation, e.g. the climate rating in the German Association for Water, Wastewater and Waste guidance documents.	M 41 “Develop uniform national conceptual guidelines for the future design of water infrastructure“ M 57 “Further develop water law and regulations relevant to water in other legislation”	To start in the short term
45)	**Establish and further develop security standards in the water sector** The existing standards for IT security and the physical security of facilities in the water sector will be continuously updated. This way, the water sector can		To start in the short term

	ensure that the (IT) infrastructure for drinking water supply and wastewater disposal is effectively protected against manipulation and sabotage. The degree to which the safe operation of wastewater treatment and water treatment plants for drinking water supply is dependent on crisis-prone supply chains for the necessary input materials must be reduced. In the area of IT security according to the BSI Critical Infrastructure Ordinance, the aim must be to expand application to include medium-sized suppliers as critical infrastructure.		
46)	**Minimise hydropower impacts on water bodies** The operation of hydroelectric power plants is a factor in why the management objectives[#] set out in the EU Water Framework Directive have not yet been achieved in Germany. Together with the federal states, possible measures in the area of hydropower will be assessed that would contribute to improving the ecological situation of watercourses in Germany, particularly with regard to achieving the objectives of the WFD. Special attention will be paid in the process to ecological continuity for organisms and sediments, including fish protection. This will include steps to consistently implement the legal requirements (Sections 33ff Federal Water Act) – especially for existing hydropower uses – regarding enforcement and dismantling plants. An incentive for the implementation of measures could be funding from the federal states for the ecological remediation and dismantling of hydropower plants, which can also be granted to the private sector.		To start in the short term
47)	**Establish uniform nationwide guidelines for regional water supply plans** A uniform nationwide framework will be developed together with the federal states to support them in drawing up regional water supply plans at the level of the federal state or catchment area. These water supply plans are intended to make the use of local water resources (groundwater and surface waters) sustainable and prevent their overuse. They must be developed with the participation of stakeholders from water management, agriculture and forestry, aquaculture, beverage and food production, industry as well as nature conservation and environmental protection associations. These plans will form the basis for planning regional grey and green water infrastructure systems (water retention, groundwater recharge, interconnected supply areas, long-	Based on M 1 “Improve forecasting capabilities of water regime analyses”	To start in the short term

	distance water supplies, reservoirs). Alternative water resources, such as process water and rainwater as well as measures to reduce consumption and demand, will also be evaluated. The water supply plans will transparently outline the links to other regional or federal state-wide planning, such as for handling ecological minimum flow and low water levels. In these water supply plans, future developments of water resources and water demand will be compared and, for example, demographic changes and climate change impacts on regional water management as well as supraregional interfaces factored in. The plans will consider different scenarios and take into account situations of prolonged periods of drought and water scarcity. They will also consider potential synergies with energy supply (shared use of storage infrastructure) and effects on the flow of surface waters and options for water reuse. A review will also be conducted to determine whether water supply plans should be required by law.		
48)	**Create participation and mediation structures – use recommendations for regional water distribution** The establishment of participation and mediation structures (e.g. water councils) will be examined, which, with the involvement of all competent authorities (municipal, federal state, federal), will support implementation of national requirements for water use, recommend regional water distribution and, most importantly, advocate for the acceptance and success of these requirements, thus helping to accelerate procedures. In these forms of participation, the focus will be on striking a balance between water management interests, including drinking water supply, and the interests of agriculture and forestry, industry, property owners, fisheries and aquaculture, inland shipping, recreational use (water sports) and nature conservation. The recommendations developed through participation will be incorporated into the preparation of regional water use plans and support the creation and establishment of regional land use and development plans as well as water protection areas and management requirements for the protection of local water resources. These forms of participation need to be explicitly mandated and enshrined in the water laws of the federal states.	M 47 “Establish uniform nationwide guidelines for regional water supply plans”	To start in the short term

	In addition, a research project will analyse existing experiences with regional participation structures and supplement them with case studies in areas affected by dry periods and land use conflicts in order to identify factors for success and expectations of regional forms of participation.		
49)	**Infrastructure spanning federal states and supraregional infrastructure** The water use plans will serve as the basis for identifying needs for infrastructure spanning federal states and supraregional infrastructure throughout the country. It can then be assessed whether the necessary areas for infrastructure spanning federal states and supraregional infrastructure – such as long-distance water pipeline corridors – can be included in the federal state plans and in a federal spatial development plan.	Depends on M 47 "Establish uniform nationwide guidelines for regional water supply plans" Supported by M 1 "Improve forecasting capabilities of water regime analyses"	To start in the medium term
50)	**Strengthen flood and coastal protection for the long term and make it viable for the future** **a)** The National Flood Protection Programme – including dike relocations to reclaim natural retention areas like floodplains – will be further developed and its financing secured for the long term. The preventive and supraregional flood protection measures of the NHWSP require long planning, approval and implementation timeframes due to their size and complexity. Secure long-term financing is therefore required, as well as needs-based financing, for successful, rapid implementation of the measures. The NHWSP gives rise not only to synergies[#] with nature conservation, but also with activities involving adaptation to the climate crisis that are also embedded in the framework of the German Adaptation Strategy. **b)** As sea levels rise and storm surges become higher as a result, Germany's coastal regions are exposed to an increased risk of flooding. To have the	M 24 "Strengthen Germany's Blue Belt programme"	To start in the medium term

	capacity to alleviate the considerably increased hydrological loads, the protective dikes along the coast must be reinforced to meet the challenges of the future as "climate dikes"[26]. Furthermore, innovative dike solutions and water management measures in inland areas must continue to be developed in the future. Besides the absolutely indispensable technical coastal protection measures, nature-based solutions (e.g. restoration of coastal habitats, use of riparian vegetation or sand spits) will be increasingly used in the future. This also applies to the long-term protection of the Halligen islands as a cultural heritage and nature conservation site. Suitable ecosystem-based approaches to adapt to the climate crisis will above all help coastal regions to sustainably adapt to the impacts of the climate crisis for the long term. At the same time, these approaches will support the conservation of coastal species and habitats. To tackle the challenges mentioned above, it will be necessary to set appropriate priorities in future.		
51)	**Establish a legal requirement to create and publish hazard and risk maps for protection against local flooding after heavy rainfall events** Flood risks due to more frequent heavy rainfall events must be considered more intensively and taken into account in planning. The requirement to create and publish hazard and risk maps for protection against local flooding after heavy rainfall events will be stipulated in water law. More use must be made of the possibilities for publication that already exist in the federal states as a result of implementation of the INSPIRE Directive. On the basis of criteria already used in part by the federal states to create heavy rainfall maps, uniform national criteria and methodologies for these maps will be developed and made available in a guideline. The runoff patterns of small catchment areas (< 10 km^2) must be taken into account. Compatibility with the LAWA strategy for effective heavy rainfall management must be ensured.	M 13 "Semi-natural rainwater management" M 19 "Develop and implement the guiding principle of the water-smart city"	To start in the short term

[26] See also: https://www.nlwkn.niedersachsen.de/jb2021/Niedersaechsischer_Klimadeich/klimawandel-und-kustenschutz-ein-entscheidender-meter-mehr-niedersachsischer-klimadeich-und-verdopplung-des-vorsorgemasses-201169.html

	The maps will serve as the basis for municipal planning. They will provide data on risks to planners, property owners and rescue workers and therefore contribute to more effective precautionary measures to tackle the impacts of climate change. They must be seen as a supplement to the already existing flood hazard and risk maps (see Section 74 Federal Water Act). A requirement for consideration in the approval of building projects (responsibility of the federal states, Model Building Regulation (BauO)) will be established to ensure that the knowledge gained with the maps is incorporated into the relevant planning and approval decisions.		

18 ## III. 6. Link water, energy and substance cycles

Number	Measure	Links	Start date
52)	**Review existing legal frameworks/remove barriers to investment for investments in public services** The legal frameworks for energy and taxes need to be reviewed and adapted if necessary in order to increase the investment options for municipal water supply and wastewater management companies when it comes to energy efficiency# and regenerative energy production.	Section II 7, Strengthen efficient administrations	To start in the short term
53)	**Develop guidance on coupling the energy and water sectors** The aim of coupling the energy/water sectors is to integrate the water, energy and waste management sectors and optimise them in a joint integrated approach. This integrated view of the sectors will make it possible to design a better and more efficient overall system. On the basis of existing research findings and pilot projects, guidance will be developed for infrastructure operators (showing what is feasible) to support the creation of water and wastewater systems that are sector coupled, climate neutral and resource efficient. It will cover technical, legal, financial and organisational aspects and outline the pros and cons of sector coupling.	M 52 “Review existing legal frameworks/remove barriers to investment”	To start in the medium term
54)	**Increase water reuse**		To start in the short term

	For the reuse of wastewater, the European requirements (Regulation (EU) 2020/741 on minimum requirements for water reuse) must be rapidly and fully transposed into German law. Water reuse will also become relevant as a climate adaptation measure, particularly in towns, cities and regions with long dry periods in summer. Based on analyses of potential, guidelines for other uses of treated wastewater (in addition to the implementation of EU Regulation 2020/741) from wastewater treatment plants and domestic wastewater will be developed. Furthermore, guidelines will be developed for taking the reuse and multiple uses of water into account, which should be considered particularly in municipal urban land use planning and in water supply plans for urban districts and industrial facilities.		
55)	**Design water sector frameworks for new energy sources** Requirements, technical instructions and evaluation processes will be drawn up for the production of innovative energy sources like hydrogen or the geothermal use of groundwater (heating/cooling). In some cases, further research will be necessary. The aim is to assess and minimise impacts on the water regime and water ecology and to prevent competition with other water uses. It will also be important to look at the instrument of underground spatial planning.	M 9 “Improve integration of water planning into overall spatial planning”	To start in the medium term
56)	**Promote recovery of nutrients from wastewater and sewage sludge** The Sewage Sludge Ordinance will be evaluated in particular with regard to the implementation of disposal strategies in the municipalities and the promotion of innovative technologies for the recovery of phosphorus from sewage sludge and sewage sludge ash. The introduction of additional requirements under wastewater law to improve nutrient recovery and for effective downstream phosphorus recovery from sewage sludge/sewage sludge incineration ash will be investigated.		

III. 7. Strengthen efficient administrations, improve data flows, optimise legal frameworks and secure financing

Number	Measure	Links	Start date

57)	**Further develop water law and regulations relevant to water in other legislation** In order to address the challenges identified in the Water Strategy (in particular the impacts of the climate crisis and loss of biodiversity), the Federal Water Act and other relevant provisions will be reviewed and adapted if necessary. This includes the following in particular: • Review exemptions for water withdrawals (Section 46 Federal Water Act) • Assess further development/harmonisation of water withdrawal charges and the possibility of federal regulation • Introduce a publicly accessible register of actual water withdrawals • Assess the need for permits for new drainage systems • Create and publish hazard and risk maps for protection against local flooding after heavy rainfall events • Consider more restrictive regulations in areas with increased flood risk, also for risk areas outside floodplains (Section 78 b Federal Water Act) • Consider a legal regulation to provisionally secure floodplains automatically upon publication of the flood hazard maps • Consider building regulations and building planning law to give greater consideration to flood prevention and general water management issues related to climate adaptation (e.g. mandatory contribution to water management planning) • Consider establishment of absolute building bans in specific hazard areas (e.g. floodplain drainage areas with very high intensities, flow velocities and/or flow depths) • Review Section 55(2) of the Federal Water Act with regard prioritising decentralised management, e.g. through infiltration of rainwater with low levels of pollution or use prior to discharge via sewers • Consider the introduction of a protected area category in the Federal Water Act for water body development	Link to other measures with proposed changes to the law	To start in the short term

	• Review the Waste Water Ordinance with regard to trace substances and explore the possibility of a general requirement for the use of water-saving processes • Amend the Waste Water Charges Act (AbwAG) with the aim of improving water conservation • Amend the Federal Soil Protection Act • Evaluate the Sewage Sludge Ordinance and review supplementary water law requirements for nutrient recovery • Adapt the legal framework with a view to the future to strengthen resilient infrastructure (e.g. CRITIS Act, precautionary and emergency preparedness laws (esp. Emergency Preparedness (Water) Act), Federal Water Act)) • Furthermore, various adjustments are necessary in the subordinate regulations, e.g. Guidelines for Structural Engineering Measures on Roads in Water Protection Areas, Guidelines for the Design of Roads – Drainage, etc.		
58)	**Further develop intermunicipal cooperation** Intermunicipal cooperation must be further developed and streamlined in order to increase the effectiveness of water supply, wastewater management, water body development and maintenance, and to ensure the economic efficiency of public services in rural regions for the long term. This will include improving the general conditions for cooperation, e.g. by strengthening advisory services and support to local authorities, fully taking advantage of EU legal scope, making efforts to expand this scope and establishing legal certainty. In addition, intermunicipal cooperation must be facilitated in specific areas where it can assume a key role in creating sustainable structures that are financed on a long-term basis (e.g. possibility of a start-up premium/start-up financing).		To start in the short term
59)	**Make administrations more robust in terms of staffing and organisation** A joint national systematic survey of personnel needs in administrations and specialised offices of the water sector[#] (federal government and federal states), including necessary qualifications, needs to be the basis for personnel		To start in the short term

	recruitment and development planning. This work should also take into account the requirements and possibilities of digitalising water technology (Water 4.0) and water administration. Further, it needs to be reviewed whether pooling technical expertise, for example by creating administration-specific competence centres, could reduce local workload.		
60)	**Launch a federal programme of climate measures in water management and water body development** A federal programme of climate measures in water management and water body development[#] will be launched as part of the Action Plan on Nature-based Solutions for Biodiversity and Climate. If the federal government and the federal states agree on a solution for joint funding for climate change mitigation and adaptation, the funding elements of the federal programme should be included.		To start in the short term
61)	**Create a framework for collecting, storing and using water data** A legal and technical framework for data management and the improvement of data exchange between different sectors will be developed (e.g. to improve forecasting capability for high and low water levels, drought). In addition, the development and provision of web-based services for different user groups will be strengthened and the knowledge base on water quality in Germany ("digital mapping") will be expanded with validated data.		To start in the short term
62)	**Strengthen water aspects in public procurement** Public procurement at federal level must be geared to sustainable water use and water conservation (e.g. water footprint, Blue Angel).	M 72 "Operationalise the water footprint and information on the water footprint for consumers"	To start in the medium term

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III. 8. Intensify protection of marine areas (North and Baltic Seas) from pollutants from land

Number	Measure	Links	Start date
63)	**Create the basis for greater reduction of onshore pollution discharged into marine waters** Reference values must be determined for total phosphorous, selected pollutants and plastic waste including microplastics at the interface between inland and marine waters (the limnic-marine transition point). These form the basis for measures to reduce discharge into marine waters from river basins and aim to achieve good environmental status for marine waters. The findings will later be incorporated into an amendment to the Surface Waters Ordinance. It is important to strive for an exchange of information and data, coordination of reference values in the international river basin commissions and between these commissions and the regional marine protection commissions, as is a harmonised approach at EU level.		To start in the short term

III. 9. Raise awareness of water as a resource

Number	Measure	Links	Start date
64)	**Water communication strategy** Design and implementation of a 10-year communication strategy for water as an issue, which is operationalised through different, target group-specific information and communication measures. Target groups for the different measures are children/youth, adults, farmers, fishermen and -women and traders as well as multipliers and local experts. The individual information and communication measures will be designed, for example, to promote social acceptance of sustainable management of water resources and water bodies, including adaptation to the consequences of the climate crisis and climate change mitigation, as well as appreciation of water management services, to contribute to risk communication (flooding, floods, drought, nutrient input and pollutant discharge, drinking water hygiene), to support individual precautions (protection against natural hazards, sustainable use of chemicals)		To start in the short term

	and to promote education in water conservation. The communication strategy will include a water award (Sustainable Water Award) for companies (industry, skilled trades, agriculture, horticulture, etc.), which will be presented on the basis of a competition for innovative approaches and processes for the economical and particularly efficient use of water. By the end of 2028, the information and communication measures will also serve to implement the United Nations Decade on Water.		
65)	**Training programme for municipal decision-makers** Training and education opportunities must be established for municipal decision-makers (municipal policymakers, administrations). The training should cover planning aspects as well as ecological and technical issues. Since many water management and conservation decisions are made at municipal level, this target group needs to gain comprehensive awareness and understanding of the interdependencies and risks of water management. Policymakers who understand their own scope for action are better able to leverage it in decision-making.	M 69 "Establish a network of experiential learning and educational sites focused on water issues"	To start in the short term
66)	**Incorporate water issues into educational programmes and advisory services for experts and managers in agriculture and forestry** Joint identification of needs, design and implementation of educational programmes and advisory services on water by experts from water management, agriculture and forestry as well as nature conservation from the federal government (BLE with BZL and BZfE, UBA, BfN), the relevant associations and the federal states with the aim of establishing water-conserving and multifunctional management of agricultural and forestry land.	M 16 "Agriculture and water sector practitioners' dialogue" M 17 "National practical handbook for water-optimised land use"	To start in the short term
67)	**Educational programmes and advisory services for people working in medical, nursing and pharmaceutical professions** Joint design and implementation of educational programmes and advisory services on water issues by experts from water management, health care and education as well as the relevant associations. These educational programmes dealing with water issues must be integrated into education already at universities, technical colleges and vocational schools.		To start in the short term

68)	**Train those responsible for water body maintenance to develop a culture of integrated water body maintenance** Water body maintenance inevitably causes interventions in water and water-dependent habitats. Depending on the intensity, duration and timing of the intervention, ecological developments may be interrupted, counteracted, fostered or hindered. At the same time, water body maintenance measures can specifically support the interests of nature conservation and water conservation, e.g. reduction of pollutant discharge from adjacent areas, increase in the potential for self-purification. Further training and education for water management professionals, which should lead to certified qualifications, must be used to work towards ecologically oriented water body maintenance that balances water management interests and the interests of agriculture and forestry, fisheries and aquaculture, nature conservation and the transport requirements of federal waterways.	Link to section II. 3 “Further develop sustainable management of water bodies” M 9 “Improve integration of water planning into overall spatial planning” M 21 “Identify areas for floodplain development and water body development corridors and include them in planning”	To start in the medium term
69)	**Establish a network of experiential learning and educational sites focused on water issues** As part of a project in cooperation with potential network partners and the federal states, a strategy will be developed and coordinated to set up a nationwide network of educational institutions and exhibition spaces as well as experiential learning and educational sites focused on water issues. In a second step, an office will be set up to support strategy implementation. The members of the network will provide general education about water from pre-school age to adulthood and promote the attractiveness of the sector-specific job profiles by providing information and advice to attract young people. The network will also provide advice on creating educational programmes. The aim is to create new programmes or materials wherever the existing network has gaps in content or geographic coverage.	M 64 “Water communication strategy” M 65 “Training programme for municipal decision-makers” M 66 “Educational programmes and advisory services for agriculture and forestry”	To start in the short term
70)	**Use citizen science for supplementary monitoring** Development and implementation of citizen science projects and tools, as well as corresponding capacity building as a new way of involving local communities in water conservation to supplement official monitoring. The aim is to encourage local residents to engage with water issues.	M 64 “Water communication strategy” M 69 “Establish a network of experiential learning and educational sites focused on water issues”	To start in the short term

		M 73 “Strengthen water issues in school education”	
71)	**Create a research and demonstration field for innovative water and wastewater technologies** The goal is to create a permanent demonstration site for innovative water and wastewater technologies under real-life conditions and with intensive scientific involvement, in combination with a centre for education and training. The research and demonstration field will establish a platform for start-ups and scientific cooperation aimed at helping innovative developments make the transition to practical application. The education and training component, also for experts from other countries, is intended to help new strategies spread internationally, which is also an important prerequisite for future cooperation and exports.	Link to section II. 5 “Further develop water infrastructure”	To start in the short term
72)	**Operationalise the water footprint and information on the water footprint for consumers** Further development of the water footprint concept aims to derive national resource indicators, taking supply chains into account in the water footprint and to provide product-related data on water use (broken down into green/blue/grey water or weighted for water scarcity) for relevant products and services as a standardised label. Other concepts, e.g. for water risks, will be reviewed with regard to possible operationalisation. This information will be compiled in such a way that it serves to raise awareness among the general public and can be used as guidance for consumer decisions, e.g. individual calculations of the water footprint[#] for selected products. Furthermore, targeted information will be provided for schools and consumers as well as for special user groups such as hotels, restaurants and public procurement.	M 64 “Water communication strategy” M 73 “Strengthen water issues in school education”	To start in the short term
73)	**Strengthen water issues in school education** The subject of water is already part of the content of school education. A gap analysis in curricula will be used to determine which water-related subjects	M 70 “Use citizen science for supplementary monitoring“	To start in the short term, continuous

	should be highlighted more in the classroom (e.g. water footprint, water risks, trace substances, proper handling of drinking water). Lesson units, teaching and learning formats, educational programmes and materials must be developed for the identified subjects and made available to schools and other educational institutions. Schools must be given access to the network of experiential learning and educational sites.	M 72" Operationalise the water footprint and information on the water footprint for consumers"	
74)	**Include water aspects in corporate sustainability reporting** a) Include water aspects in corporate sustainability reporting following the revision of the EU provisions for sustainability reporting and develop methods to assess water risks for companies and to measure the impact of corporate activities on water bodies, among other things, with the aim of ensuring transparent management of water resources and improved information for financial market players for their investment decisions (German Sustainable Finance Strategy). b) The sustainability reports of municipal companies must be supplemented with information on water use, its impacts and water-related risks. This should be done as part of the revision of EU requirements for sustainability reporting. It will be necessary to develop methods for municipal companies to assess water risks with a view to increasing transparency in the use of water resources and assessing impacts on water bodies. The improved information will help municipal companies and municipal policymakers in their investment decisions.	M 72 "Operationalise the water footprint and information on the water footprint for consumers"	To start in the short term

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III. 10. Work together to protect global water resources for the long term

Number	Measure	Links	Start date
75)	**Cooperate internationally to implement sustainable water resource management** Germany will support the establishment of structures and capacities for continuously collecting and using hydrological and meteorological data in partner countries. Germany will advise these partner countries and mandated		To start in the short term

	intergovernmental organisations on transboundary river basin cooperation, on joint data management and knowledge transfer activities and on cooperative use of planning and financing mechanisms. Germany will support governments and other relevant intergovernmental, state and non-state actors in establishing the necessary frameworks and implementing resource-efficient water use, sustainable water services for all (especially vulnerable groups), and integrated water management that takes into account climate and ecosystem concerns, sustainable land use, economic development, regional integration, water as a resource for peace and potential conflicts of use. Germany will also support related multilateral initiatives.		
76)	**Strengthen multilateral mechanisms to achieve the water goals of the 2030 Agenda** Germany is engaged in strategic dialogue with the EU and UN member states on the creation of an intergovernmental mechanism under the United Nations that will enable regular exchange on the implementation of the water goals of the 2030 Agenda and future global goals and targets. Germany will also advocate strengthening the mandate and the operation of UN-Water as a mechanism for coordinating the UN organisations and programmes active in water-related areas. Germany supports a coherent and synergistic UN approach to the 2030 Agenda and follow-on goals and targets with other water-related international agreements, such as the Paris Agreement, the Ramsar Convention, the Convention on Biological Diversity and the Convention to Combat Desertification.		To start in the short term
77)	**Support prevention of water pollution and overuse as well as protection and restoration of water-based ecosystems and their biodiversity** Germany is actively involved in bilateral and multilateral initiatives for regular assessments of the status of global freshwater resources (Global Water Quality Assessment) and for the establishment of data products and services related to water quantity and quality for UN member states. Germany supports the creation of scientific knowledge as well as specific tools for water resource management, which will help to understand the relationships between water resources, aquatic and terrestrial ecosystems, including sustainable land use, and human use for water and sanitation, as well as in industry, commerce,		To start in the short term

	energy production and transport. Partner governments of emerging economies and developing countries will be supported in the creation and implementation of regulations to protect water bodies, to involve and cooperate with industry and commerce, e.g. in the stewardship approach, and to apply the best available techniques (BAT) of urban sanitation and industrial wastewater management. International exchange between administrations, industry and science to achieve SDG 6 and SDG 15 and in the use of new environmental and climate-friendly technologies will be promoted.		
78)	**Support for respecting the human right to water and sanitation** Germany is committed to improving coordinated access to drinking water, sanitation and hygiene in the contexts of development cooperation, transitional development assistance and humanitarian aid, at bilateral and multilateral level and also in cooperation with civil society actors. In line with the overarching principle of the 2030 Agenda “Leave no one behind” (LNOB), particular attention will be paid to poor and vulnerable population groups. To this end, water/wastewater will be taken into account as an important issue in the promotion of municipal partnerships, and the potential of operator partnerships will be systematically used in the context of development cooperation.		To start in the short term

27 Glossary[27]

Term	Definition
Adaptation	Initiatives and measures with the aim of reducing the sensitivity of natural and human systems to actual or expected impacts (due to changes in legislative frameworks, society or the climate, obsolete structures or technologies). Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned.[28]
Cross-media	Perspective that integrates various media, for example the environmental media of water, climate, air and soil.
Ecosystem services	Services, benefits or advantages supplied to people by ecosystems. Examples of ecosystem services include the supply of water that can be used for irrigation and drinking through natural filtering of rainwater, the supply of medicinal and mineral water, the reproduction of fish stocks as a source of food and the provision of an appealing environment for recreation, leisure and aesthetic enrichment. In contrast to the term ecosystem function, the term ecosystem service takes an anthropocentric perspective and refers to the benefits of the ecosystem for people.[29] Ecosystem functions are the ecosystem processes behind ecosystem services.[30]
Efficiency	Rational use of resources with an integrated and cross-media# approach that does not focus on single resources.
Grey water	Wastewater from baths, showers or washing machines with low pathogen levels and no faecal contamination that can be treated and reused as process water.
Incentives	The link between motives (in the sense of needs) and motivation that conditions behaviour. Public financial incentives to promote sustainable# water uses# can include charges, taxes and funding programmes; there are also other non-financial incentives such as public recognition of activities, for example awards.[31]
Input path	There are both point source and diffuse input paths. Point source input paths: wastewater treatment plants, direct industrial discharge, other types of direct discharge (e.g. mining). Diffuse input paths: erosion, surface runoff from paved and unpaved surfaces, drainage channels, overflow of combined waste and stormwater, rainwater channels, off-grid households, groundwater, atmospheric deposition.[32]
Land take	Daily expansion of settlement and transport areas (indicator 11.1a of the German National Sustainable Development Strategy) reported annually by the Federal Statistical Office (Destatis) in its land use statistics.
Landscape features	Characteristics of natural space or landscape, for example topography, climate, geology, soil composition or land use.
Management	Sustainable and value-creating administration and use of resources following the principle of economy. Significance in relation to water: the management of all artificial and natural water cycles and subprocesses respecting three essential goals: the long-term conservation of water as a habitat and as a key element of habitats; the preservation of water in its various facets as a resource for current and future generations; the identification of options for long-term economic and social development that is compatible with nature.[33]
Multi-barrier principle	Also called the multiple barrier system or multi-barrier approach. It is a principle applied in environmental technologies with multiple successively tiered safety barriers for the defined assets.[34]
Nature-based solutions	Nature-based solutions are measures that are inspired and supported by nature. They are cost-effective and have environmental, social and economic advantages. They also help strengthen the resilience of ecosystems. Nature-based solutions benefit biodiversity and support the provision of a range of ecosystem services.[35]

[27] The terms marked with # in this document are explained in the glossary.
[28] According to: IPCC (2007): Climate change 2007. Synthesebericht, https://www.umweltbundesamt.de/service/glossar/a (27 April 2021).
[29] BfN (2015): Gewässer und Auen – Nutzen für die Gesellschaft, https://www.bfn.de/fileadmin/BfN/wasser/Dokumente/BR-gepr-Gesell_Nutz_Gewaes_Auen_barrierefre.pdf (2 June 2020).
[30] Based on: Biologie-Seite (2020): Ökosystemdienstleistung, https://www.biologie-seite.de/Biologie/%C3%96kosystemdienstleistung (27 April 2021).
[31] https://wirtschaftslexikon.gabler.de/definition/anreiz-29046.
[32] https://www.umweltbundesamt.de/themen/wasser/fluesse/nutzung-belastungen/stoffeintraege-in-gewaesser#stoffeintrage-deutschlandweit-quantifizieren-modellieren.
[33] Based on: UBA (2018): Nachhaltige Wasserwirtschaft, https://www.umweltbundesamt.de/themen/wasser/wasser-bewirtschaften/nachhaltige-wasserwirtschaft#textpart-1 (2 June 2020); and Educalingo: Management, https://www.feda.bio/en/about-faktencheck-artenvielfalt/topic-areas/soil-biodiversity/ (27 April 2021).
[34] https://www.dvgw.de/medien/dvgw/wasser/management/1011castell_multibarriere.pdf (27 April 2021).
[35] European Commission (2021): Nature-based solutions, https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en (27 April 2021). European Commission (2021): Nature-based solutions, https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_enhttps://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions_en (27 April 2021).

Networked infrastructure	Structurally or functionally linked facilities and installations of a material nature. Networking can mitigate certain risks or weaknesses of the various parts of the infrastructure system (e.g. digital monitoring, combined drinking water supply systems) but can also give rise to additional risks (e.g. in the event of power outage or the spread of pathogens or invasive species in ecosystems).
Particles	Substances in water that can be separated or filtered out of the water using partially standardised analysis processes. Depending on the analysis process, these particles can be differentiated by origin and size (for example soil particles, i.e. minerals or organic substances, macroplastic particles, microplastic particles, nanoparticles).
Pathogen	General overarching term used for disease agents that can cause infections or infectious diseases in humans. These can be cellular or subcellular vectors such as viruses, viroids, bacteria, parasites, fungi, protists or other infectious organisms.[36]
Pollutant discharge	Discharge of nutrients, harmful substances and trace substances through various input paths# or transport paths into surface waters, groundwater, seas and oceans.
Polluter pays principle	In environmental law, the polluter pays principle is a basic concept of environmental protection that requires the polluter to bear the costs of preventing, eliminating or offsetting environmental damage.[37]
Precautionary measurement	The precautionary measurement plays a role in the height of coastal protection infrastructure relative to average high tide levels. In light of the climate crisis and the associated rise in sea level, a higher precautionary measurement will ensure adequate coastal protection along the German North and Baltic Sea coasts.[38]
Precautionary principle	The precautionary principle goes beyond simply averting negative impacts and focuses on mitigating risks to people and the environment, keeping pace with scientific findings and technical progress. The two dimensions of the precautionary principle are risk# prevention and resource conservation. Risk prevention means taking precautions when there is incomplete knowledge or uncertainty about the type, extent, probability and/or causality of environmental damage and dangers in order to avoid these from the outset. Resource conservation means using natural resources like water, soil and air carefully in order to ensure their long-term availability for the benefit of future generations.[39]
Process water	Process water is hygienically safe water that can be used in households, companies and industrial enterprises when water does not necessarily have to meet quality standards for drinking water.
Public services	Ensuring general public access to essential goods and services in accordance with the needs of the public, guided by defined quality standards at socially acceptable prices. The goods and services defined as essential vary over time and are determined by policymakers.[40]
Rainwater	Rainwater and other types of precipitation that run off built-up or paved surfaces.
Relevant trace substances	Trace substances that have adverse impacts on aquatic ecosystems even in very low concentrations and/or that have a negative effect on drinking water abstraction from raw water. In the aquatic environment they lead to what are known as micropollutants. In some cases they are regulated as priority substances or river basin-specific pollutants.
Risk	Risk describes the combination of the likelihood that something will occur and the extent of damage it could cause.[41]
Safe by design	Safe by design refers to the safe development of products, materials and processes so that they pose no risks to people and the environment. This is achieved by considering safety in the development of every product and process.
Semi-natural (state)	According to the definition in Section 6 of the Federal Water Act, a semi-natural state is not the equivalent of a natural state. It is differentiated as follows in Section 6(2): "Water bodies in a natural or semi-natural# condition should be preserved in this status..." It further stipulates that natural water bodies that have been artificially developed should be returned to a semi-natural#

[36] Based on: Infektionsschutzgesetz Bundesrepublik Deutschland, vertreten durch die Bundesministerin der Justiz und für Verbraucherschutz (ed.): Gesetze im Internet, https://www.gesetze-im-internet.de/ifsg (27 April 2021); and: Lexikon der Biologie (Spektrum: Pathogens Lexikon der Biologie, https://www.spektrum.de/lexikon/biologie/keim/35714 (2 June 2020)).
[37] Based on: Glossar Spurenstoffdialog des Bundes; Ergebnispapier Phase 2 (2019); and: Emde & Emde (1996): Umweltorientiertes Handeln in Kreditinstituten. ed. Dt. Sparkassenverband. Wissenschaft für die Praxis, Volume 10, p. 24.
[38] see Ministerium für Energiewende, Klimaschutz, Umwelt und Natur des Landes Schleswig-Holstein, „Generalplan Küstenschutz des Landes Schleswig-Holstein – Fortschreibung 2022", Kapitel 2.2 „Anpassung an den Klimawandel", p. 21 ff., available at: https://www.schleswig-holstein.de/DE/fachinhalte/K/kuestenschutz/generalplanKuestenschutz.html; Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz (NLWKN), „Klimawandel: NLWKN sieht Küstenschutzstrategie des Landes durch IPCC-Bericht bestätigt", available at: https://www.nlwkn.niedersachsen.de/startseite/aktuelles/presse_und_offentlichkeitsarbeit/pressemitteilungen/klimawandel-nlwkn-sieht-kustenschutzstrategie-des-landes-durch-ipcc-bericht-bestatigt-203257.html; NLWKN, "Klimawandel und Küstenschutz: Ein entscheidender Meter mehr", available at: https://www.nlwkn.niedersachsen.de/jb2021/Niedersaechsischer_Klimadeich/klimawandel-und-kustenschutz-ein-entscheidender-meter-mehr-niedersachsischer-klimadeich-und-verdopplung-des-vorsorgemasses-201169.html
[39] Based on: Glossar Spurenstoffdialog des Bundes; Ergebnispapier Phase 2 (2019); and: Emde & Emde (1996): Umweltorientiertes Handeln in Kreditinstituten. ed. Dt. Sparkassenverband. Wissenschaft für die Praxis, Volume 10, p. 24.
[40] Gabler Wirtschaftslexikon: Daseinsvorsorge, https://wirtschaftslexikon.gabler.de/definition/daseinsvorsorge-28469 (27 April 2021).
[41] Based on: Glossar Spurenstoffdialog des Bundes; Ergebnispapier Phase 2 (2019).

	state, except where this runs counter to overriding public interests. In addition to public welfare, high value is attached to the conservation of water bodies as an integral part of the natural environment, which is cited as the first principle of management.[42]
Semi-natural processes (for drinking water purification)	This describes a process of purifying raw water that does not involve continuously adding chemical substances for purification. Physical processes are prioritised, e.g. physical deacidification or filtration systems to remove particles, iron and manganese. Bank filtrations and artificial groundwater recharge by means of slow sand filters precede actual drinking water purification.
Soil biodiversity	Soil biodiversity plays a crucial role in providing many key ecosystem services such as water purification, soil fertility and carbon storage. Soil is home to a large variety of organisms – from micro- to macroorganisms and from terrestrial to aquatic organisms.[43]
Substance	A chemical element and its compounds as found in nature or obtained via a production process, including active decomposition products (relevant metabolites), the additives necessary to maintain its stability (attendant and carrier substances) and the contaminants (with the exception of solvents) generated by the process used and by combined and repeated application that can be separated from the substance or material without impairing its stability or changing its composition.[44]
Substance groups	Substance groups contain substances with similar material or structural properties: • group of substances with similar properties, for example persistent, toxic, bioaccumulative or endocrine substance • group of substances with structural similarities (having similar molecular structures) These have certain similar substructures, e.g. functional groups. One example of a group of similar substances is polycyclic aromatic hydrocarbons.[45]
Sustainability	Sustainability means that each generation solves its own problems and does not impose them on future generations.[46] This involves • the use of renewable resources such as water, forests and fish stocks does not exceed what can be regenerated • non-renewable resources like minerals and petroleum are only depleted to the extent that they can be replenished (e.g. renewable alternatives) • the air, water and soil are not polluted with more harmful substances than can be processed by their natural capacity for self-purification[47] Building on the Brundtland Report by the World Commission on Environment and Development, the German Bundestag's Study Commission on the Protection of Humanity and the Environment described sustainable development as the concept of long-term, future-proof development of the economic, environmental and social dimensions of human existence.[48] Since 2016 and for a period of 15 years (up to 2030), the 2030 Agenda, with its 17 Sustainable Development Goals (SDGs), has been the policy focus of the United Nations, intended to safeguard sustainable development at economic, social and environmental levels.[49]
Synergy	The interplay of various forces (sectors) to form an overall output. This overall output is often expected to exceed the sum of the individual outputs. Synergy emerges, for example, in complex issues or problems when multiple people (from various disciplines) who have different information work together on the issue. Barriers to synergy include tense relationships between group members, conformity and too many group members.[50]
Trace substances	Substances present in water in very low concentrations. Trace substances originate from a range of areas and products, e.g. biocides, human and veterinary medicinal products, pesticides, industrial chemicals, hygiene products and detergents.

[42] SZDK/Schenk (2019): 53. EL August 2019, Federal Water Act Section 6 No. 9, 10.
[43] https://www.feda.bio/de/was-ist-der-faktencheck-artenvielfalt/themenbereiche/bodenbiodiversitaet/
[44] Sonderforschungsgruppe Institutionenanalyse – sofia (2007): Glossar – Zusammenstellung der wesentlichen Begriffe im REACh-System, https://www.reach-helpdesk.info/fileadmin/reach/dokumente/REACHGlossar.pdf (27 April 2021).
[45] UBA (2015): Stoffgruppen,https://www.umweltbundesamt.de/themen/chemikalien/chemikalien-reach/stoffgruppen (27 April 2021).
UBA (2015): Stoffgruppen,https://www.umweltbundesamt.de/themen/chemikalien/chemikalien-reach/stoffgruppen (27 April 2021).
[46] According to: German government (2013): National Sustainable Development Strategy, https://www.umweltbundesamt.de/service/glossar/n (27 April 2021).
[47] Emde, Roth-Emde (1996) Umweltpolitik in der Bundesrepublik, In: Umweltorientiertes Handeln in Kreditinstituten, ed.: Wissenschaftsförderung der Sparkassenorganisation e. V.: Wissenschaft für die Praxis. Department 3, Volume 10, p. 25. Sparkassen Verlag
[48] Wikipedia (2020): Drei-Säulen-Modell (Nachhaltigkeit), https://de.wikipedia.org/wiki/Drei-S%C3%A4ulen-Modell_(Nachhaltigkeit) (02.06.2020); cited: Abschlussbericht der Enquete-Kommission „Schutz des Menschen und der Umwelt – Ziele und Rahmenbedingungen einer nachhaltig zukunftsverträglichen Entwicklung", Deutscher Bundestag: Printed paper 13/11200, 26 June 1998, p. 218.
[49] Wikipedia (2020): Ziele für nachhaltige Entwicklung, https://de.wikipedia.org/wiki/Ziele_f%C3%BCr_nachhaltige_Entwicklung (2 June 2020); cited: Rio+20 outcome document "The future we want" (A/RES/66/288).
[50] Gabler Wirtschaftslexikon: Synergie, https://wirtschaftslexikon.gabler.de/definition/synergie-47512 (2 June 2020), amended.

Value chain	All activities (value creation and resource consumption) necessary to bring a product from design to the various production and processing phases, to the end consumer and finally to disposal after use.[51]
Water body development	The semi-natural# restoration of water bodies as functional, intact ecosystems, the inclusion of floodplains as natural retention areas and the associated implementation of forward-looking flood protection. Also includes the integration of other issues in the public interest like various uses, nature conservation, recreation, leisure time and the aesthetics of water body landscapes.[52]
Water body maintenance	Cultivation and development of water bodies with the aim of preserving and improving the function they serve for water management and the natural environment as well as their navigability. Maintenance is regulated by the Federal Water Act and water acts at federal state level. Water body maintenance must be in line with the management objectives of the EU WFD (see Sections 27 to 31 of the Federal Water Act) and must not endanger achievement of these objectives.[53]
Water footprint	In contrast to direct water consumption, the water footprint also includes indirectly used water. The amount of water "hidden" in products is often termed virtual water. The water footprint is the entire amount of water used by countries, companies or consumers.[54]
Water infrastructure	All long-lived facilities and installations of a material nature that enable any type of use of water or other resources connected to water (e.g. energy, fish) or ecosystem services#, or facilities and installations dependent on or that can be heavily impacted by water. In the context of the water dialogue, the term is used very broadly and includes, for example, human-made infrastructure, sometimes termed "grey" infrastructure (e.g. dams, canals and drainage networks, wastewater treatment plants, irrigation facilities, dikes, measurement systems, digital infrastructure such as networks and data centres) and natural infrastructure, sometimes termed "green" or "blue" infrastructure (e.g. rivers, lakes, wetlands, floodplains, groundwater bodies, groundwater infiltration areas).
Water regime	A part of the natural system focused on quantities of water in its various states and spaces. Water regime describes the interplay of individual water cycle variables and their amounts. It is influenced by the energy cycle. According to the general water balance equation, the main components of the water regime are precipitation, evaporation, runoff and change in storage. Important specifications of the water regime include: a) landscape hydrology: this means that the water regime components correspond regionally to semi-natural landscape features#; b) soil hydrology; and c) local hydrology.[55] Sustainable use of water resources protects the functions of the water regime that are required for people and the environment, and for nature and landscape conservation. With regard to the water regime, the Federal Water Act stipulates that water is to be used economically, the functionality of the water regime is to be preserved and an increase in or acceleration of water runoff must be prevented, as must impairments of onshore water-dependent ecosystems and wetlands.[56]
Water risks	The term water risks is used in particular in the context of corporate risk analyses and is usually divided into three related categories: • physical – not enough water, too much water, unusable water or inaccessible water • regulatory – changing, ineffective or poorly implemented public water policy and/or regulations • reputational risk – stakeholders have the impression that water is not being used sustainably or responsibly
Water sector	The entirety of the institutions and activities for water supply[57], wastewater management and regulation of the water regime.[58]

[51] Wuppertal Institut für Klima, Umwelt, Energie GmbH (ed.) (2009): Kaskadennutzung von nachwachsenden Rohstoffen: Ein Konzept zur Verbesserung der Rohstoffeffizienz und Optimierung der Landnutzung, https://epub.wupperinst.org/frontdoor/deliver/index/docId/3303/file/WP180.pdf (27 April 2021).
[52] LAWA (2006). Leitlinien zur Gewässerentwicklung – Ziele und Strategien, https://www.umweltministerkonferenz.de/umlbeschluesse/umlaufBericht2006_30.pdf (27 April 2021).
[53] Based on: Section 39 of the Federal Water Act.
[54] Umweltbundesamt (2018): Wasserfußabdruck, https://www.umweltbundesamt.de/themen/wasser/wasser-bewirtschaften/wasserfussabdruck#was-ist-der-wasserfussabdruck
[55] Based on: Spektrum: Wasserhaushalt. Lexikon der Geowissenschaften, https://www.spektrum.de/lexikon/geowissenschaften/wasserhaushalt/17995 (27 April 2021).
Federal Water Act of 31 July 2009 (Federal Law Gazette [BGBl.] I p. 2585) last amended by Article 2 of the Act of 4 December 2018 (Federal Law Gazette I p. 2254), Sections 5 and 6.
[57] E.g. UBA (2020): Wasserwirtschaft, https://www.umweltbundesamt.de/daten/wasser/wasserwirtschaft (27 April 2021).
[58] Based on: Duden: Wasserwirtschaft, https://www.duden.de/rechtschreibung/Wasserwirtschaft (27 April 2021).

Water uses	Services for households, public facilities or economic activities such as withdrawal, impoundment, storage, treatment and distribution of water from a water body; collection and treatment of wastewater in treatment plants that is subsequently channelled into surface waters, shipping, fisheries, flood protection, hydropower, the energy sector, industrial and commercial use including bottling, tourism, sports and recreation, etc., and other activities with an impact on the status of a water body, to include uses beyond the definition in the Federal Water Act. This Act defines water uses as all water services and other activities with impacts on the status of a water body that are significant in terms of the management objectives of Sections 27 to 31, 44 and 47. Water services include the following services for households, public facilities or economic activities of every kind: • withdrawal, impoundment, storage, treatment and distribution of water from a water body • collection and treatment of wastewater in treatment plants that is subsequently channelled into surface waters