Die
Bundesregierung

Second Progress Report on the

German Strategy for Adaptation to Climate Change (DAS)

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A. The German Adaptation Strategy (DAS): objectives, principles and processes

Climate change is one of the greatest challenges of the 21st century. The effects of climate change can already be felt in Germany and will intensify in future. Between 1881 and 2019, the average air temperature in Germany rose by 1.6˚ Celsius. Climate change has serious adverse impacts on the health and prosperity of people living in Germany. Heatwaves, flooding and heavy rainfall events, etc. cause premature deaths, as well as damage to agriculture and forestry, buildings and infrastructure, and industry and the economy; climate change can also trigger dynamic adaptation processes in ecosystems, such as the displacement of plant and animal species. Timely and far-sighted adaptation to the impacts of climate change is becoming increasingly important in order to minimise these risks and damage and avoid higher remedial and adaptation costs in future.

In response to the challenges posed by climate change, the federal government has adopted the German Strategy for Adaptation to Climate Change (DAS). The aim is to ensure that the existing objectives in the various sectoral policy fields can be achieved under the new conditions created by climate change. The German Adaptation Strategy provides a policy framework for Germany's adaptation to climate change and facilitates a cross-sectoral approach by the federal government.

In Germany, climate change adaptation is an ongoing long-term task and is addressed within an institutional and methodological framework agreed at political level. Scientific research programmes and processes for participation and consultation have been set up, along with a continuous reporting system.

Adaptation to climate change is based on the precautionary principle: the aim is to prevent or minimise damage to people and the environment and build the capacities of state and non-state actors alike to handle the impacts of climate change. The coronavirus pandemic, which we have been experiencing globally since early 2020, is an example of the effects of ambitious precautionary policies. The same urgency and necessity prevail in relation to climate change adaptation as well.

- The coronavirus pandemic and climate change demonstrate, with increasing clarity, the interconnectedness and vulnerability of all spheres of life and the economy in Germany.
- It is therefore becoming increasingly important, now and in future, to build resilience to climate impacts and other crises through preparedness over the long term and crisis management in the short term. This enhanced resilience will also contribute to achieving other important objectives that society has set itself, such as global and national sustainable development goals, greenhouse gas neutrality and the halting of biodiversity loss through enhanced protection of nature and the environment. For that reason, it is important to rely on nature-based solutions wherever possible, primarily because they offer great benefits from a precautionary perspective, but also because they safeguard basic, robust health and provisioning services, thus maintaining the functionality of the system as a whole even when individual elements are temporarily unavailable.

A.1. The DAS: principles and objectives

The long-term objective of the German Strategy for Adaptation to Climate Change (DAS) is to reduce the vulnerability of natural, social and economic systems to the impacts of climate change and to improve the adaptive capacity of these systems and take advantage of any opportunities at the same time. In order to identify action options, 15 fields of action are considered; these are (in alphabetic order): agriculture; bio-

logical diversity; the building sector; energy industry; financial services industry and insurance; fishery; forestry and forest management; human health; soil; tourism; trade and industry; transport and transport infrastructure; water regime; flood management and coastal protection; and cross-sectional topics: spatial, regional and physical development planning, and civil protection and emergency preparedness.

The work is supported and approved at federal government level under the auspices of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) within the Interministerial Working Group on Adaptation to Climate Change (IMAA). The IMAA is made up of representatives from nearly all the federal ministries, who coordinate activities and continuously set new goals to establish the conditions for climate change adaptation in Germany. The structures for cooperation have proved their worth. In addition, the Conference of Environment Ministers of the Federation and the *Länder* (UMK) has established the Standing Committee on Adaptation to Climate Change Impacts (StA AFK) as part of the Federation-*Länder* Working Group on Climate, Energy, Mobility and Sustainability (BLAG KliNa). The Standing Committee[1] is the main coordination mechanism for cooperation with the *Länder* and is the forum through which strategies and measures adopted by the *Land* administrations feed into work on the DAS.

The following principles, set forth in the DAS, were devised to provide guidance for the further development of the adaptation process and federal government action:

- openness and cooperation;
- approach based on knowledge, flexibility and the precautionary principle;
- subsidiarity, self-provision, adaptive capacity and proportionality;
- integrated approach and consideration of climate change impacts in plans and decisions;
- acting in the face of uncertainty;
- international responsibilities.

Key outcomes and updates of the DAS are approved by Cabinet decision and published as IMAA reports (e.g. progress reports).

A.2. The DAS reporting cycle

Based on the methodologies agreed in the IMAA, a reporting system has been established for the process of planning climate change adaptation in Germany. The process can be divided into four phases based on the adaptation policy cycle[2]:

1. **Understand and describe climate change**: The **Monitoring Report**[3] provides an overview of the observed impacts of climate change and the adaptation measures already introduced in Germany. This provides a compact overview of the changes that can already be observed as a result of climate change using measured data.
2. **Identify climate impacts and characterise vulnerabilities**: The **climate impact and vulnerability analysis** (KWVA)[4] identifies which fields of action and regions are particularly at risk from climate

[1] For further information on the precise composition of the IMAA and StA AFK, see Bundesregierung (2015).
[2] For further information on the model for the adaptation policy cycle, see: Vetter A., Chrischilles E., Eisenack K., Kind C., Mahrenholz P., Pechan A. (2017): Anpassung an den Klimawandel als neues Politikfeld. In: Brasseur G., Jacob D., Schuck-Zöller S. (eds.) Klimawandel in Deutschland. Springer Spektrum, Berlin, Heidelberg.
[3] For further information on the monitoring report and methodology, see: Konstanze Schönthaler, Stefan von Andrian-Werburg: Evaluierung der DAS – Berichterstattung und Schließung von Indikatorenlücken. UBA Climate Change 13/2015.
[4] Further information on the methodology can be found in: Leitfaden für Klimawirkungs- und Vulnerabilitätsanalysen (UBA 2017), which provides guidance and methodological recommendations on conducting regional and national climate impact and vulnerability analyses and draws attention to other helpful material and information.

change and where there is a need for action. Reference periods are: the present, near future (2031-2060) and distant future (2071-2100). The KWVA was developed for the first time in 2015.

3. **Develop and implement measures**: The **Adaptation Action Plans** (APAs) specify the current and future measures taken at the federal level to adapt to climate change. Among other things, they are based on the scientific findings and results of the KWVA. The APAs underpin the DAS by defining specific activities at the federal level and identify links with other national strategy processes. The APAs describe the measures to be implemented by the ministries within their respective spheres of responsibility.
4. **Evaluation – observe, assess and develop adaptation**: The strategy process and implementation of the DAS are evaluated on a regular basis. The first external evaluation was conducted in 2018. **Evaluation of the DAS** is performed in accordance with a methodology approved by the IMAA[5]. The results of the evaluation were published as a scientific report in November 2019[6] and also underwent a review by the ministries; details of this review are included in this Progress Report. The **Progress Reports** set out practical steps for the further development and implementation of the German Adaptation Strategy. The present report continues the process of outlining the framework for action on climate change adaptation in Germany.

The **Monitoring Report** is currently updated every four years; the climate impact and vulnerability analysis is updated every six years. The evaluation is conducted at four-yearly intervals. The DAS was updated in the 2015 and 2020 Progress Reports and approved by the Cabinet. Together with the Progress Reports, the measures identified in the Action Plans are currently updated every four years (on the future interaction between the various elements, see Chapter C).

[5] For further information on the methodology for the evaluation, see: Christian Kind, Theresa Kaiser, Hansjörg Gaus: Methodik für die Evaluation der Deutschen Anpassungsstrategie an den Klimawandel (also available in English: Methodology for the Evaluation of the German Adaptation Strategy), https://www.umweltbundesamt.de/publikationen/methodik-fuer-die-evaluation-der-deutschen https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/methodology_for_the_evaluation_of_the_german_adaptation_strategy.pdf

[6] https://www.umweltbundesamt.de/publikationen/politikanalyse-zur-evaluation-der-deutschen

Figure 1: The DAS reporting system. Source: Federal Environment Agency (UBA), authors' own presentation.

Deutsch	**Englisch**
Fortschrittsberichte der DAS	DAS Progress Reports
Berichtswesen der DAS	The DAS reporting system
Monitoring Klimawandel; Folgen des Klimawandels; Fortschritt beim Anpassungsprozess	Monitoring Climate change; climate change impacts; progress on adaptation
Klimawirkungs- und Vulnerabilitätsanalyse Anfälligkeit gegenüber den Folgen des Klimawandels	Climate impact and vulnerability analysis Vulnerability to climate change impacts
Aktionspläne Vereinbarung und Priorisierung geeigneter Massnahmen und Instrumente	Action Plans Agreeing and prioritising appropriate measures and mechanisms
Umsetzung von Anpassungsmassnahmen	Implementing adaptation measures
Evaluierung Prozess und Umsetzung (Output)	Evaluation Process and implementation (output)

A.3. The DAS, APA and Progress Report in review

The German Adaptation Strategy (DAS) was adopted by the federal government in 2008. In order to flesh out the objectives laid down in the German Adaptation Strategy, the Federal Cabinet subsequently adopted the first Adaptation Action Plan (APA I)[7] in 2011. The APA I underpins the German Adaptation Strategy with specific activities to be carried out by the federal government and identifies links with other national strategic processes. In December 2015, the federal government adopted the first DAS Progress Report[8] and the second Adaptation Action Plan (APA II).

[7] Bundesregierung (2011).
[8] Bundesregierung (2015).

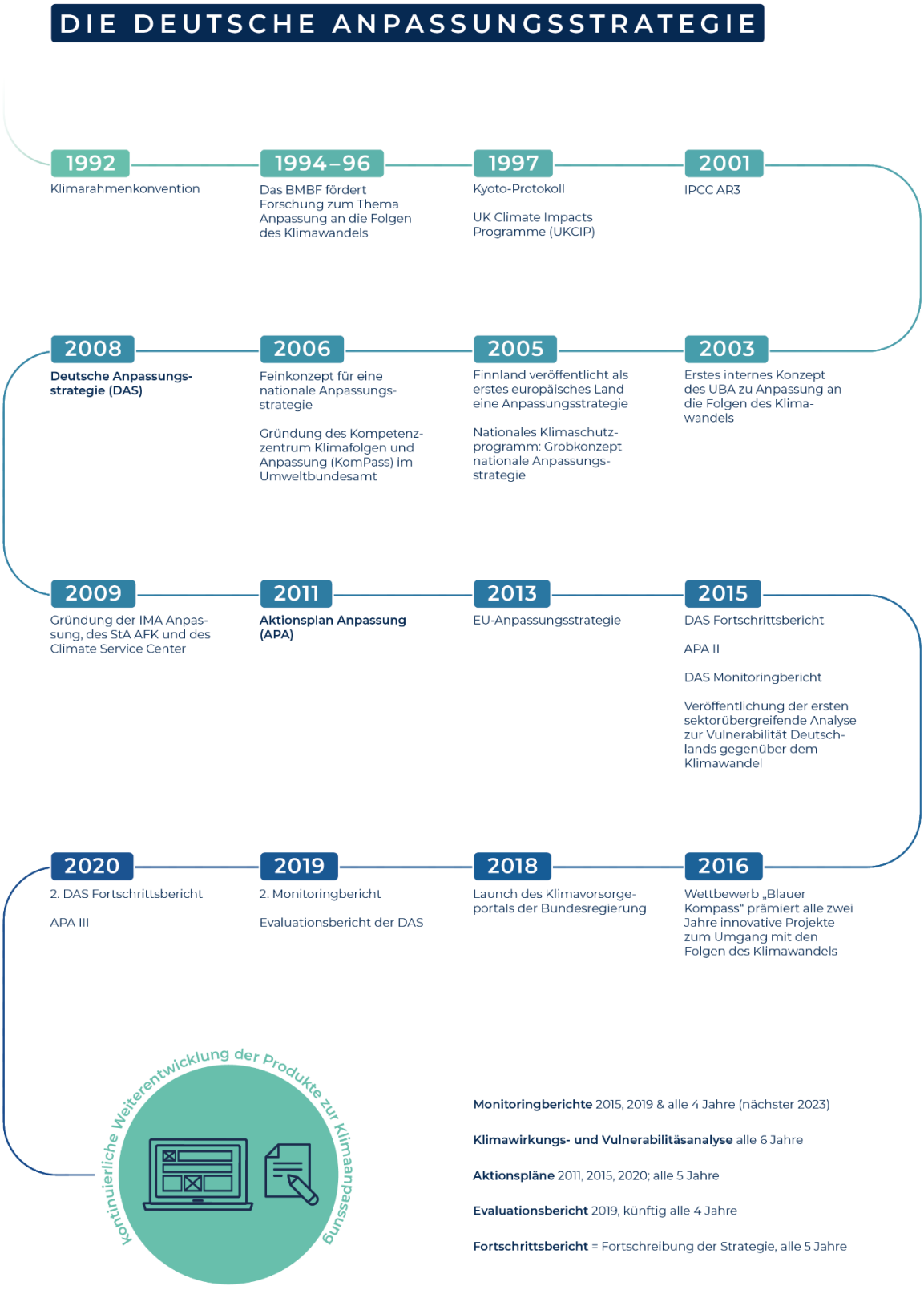

Figure 2: A chronology of the adaptation strategy, action plan and progress report. Source: Federal Environment Agency (UBA), authors' own presentation.

Deutsch	**Englisch**
Die Deutsche Anpassungsstrategie	The German Adaptation Strategy (DAS)
1992 Klimarahmenkonvention	1992 United Nations Framework Convention on Climate Change
1994-96 Das BMBF fördert Forschung zum Thema Anpassung an die Folgen des Klimawandels	1994-96 The German Research Ministry (BMBF) funds research on adaptation to climate change impacts
1997 Kyoto-Protokoll UK Climate Impacts Programme (UKCIP)	1997 Kyoto Protocol UK Climate Impacts Programme (UKCIP)
2001 IPCC AR3	2001 IPCC AR3
2003 Erstes internes Konzept des UBA zu Anpassung an die Folgen des Klimawandels	2003 First internal concept paper by the German Federal Environment Agency (UBA) on adaptation to climate change impacts
2005 Finnland veröffentlicht als erstes europäisches Land eine Anpassungsstrategie Nationales Klimaschutzprogramm; Grobkonzept nationale Anpassungsstrategie	2005 Finland is the first European country to publish an adaptation strategy Germany adopts the National Climate Protection Programme; broad concept for a national adaptation strategy
2006 Feinkonzept für eine nationale Anpassungsstrategie Gründung des Kompetenzzentrum Klimafolgen und Anpassung (KomPass) im Umweltbundesamt	2006 Detailed concept for a national adaptation strategy Establishment of the KomPass Competence Centre on Climate Impacts and Adaptation at the UBA
2008 Deutsche Anpassungsstrategie (DAS)	2008 German Strategy for Adaptation to Climate Change
2009 Gründung der IMA-Anpassung, des Sta AFK und des Climate Service Center	2009 Establishment of the Interministerial Working Group on Adaptation to Climate Change (IMAA), the Standing Committee on Adaptation to Climate Change Impacts (StA AFK) and the Climate Service Center
2011 Aktionsplan Anpassung (APA)	2011 Adaptation Action Plan (APA)
2013 EU-Anpassungsstrategie	2013 EU Adaptation Strategy
2015 DAS Fortschrittsbericht APA II DAS Monitoringbericht Veröffentlichung der ersten sektorübergreifenden Analyse zur Vulnerabilität Deutschlands gegenüber dem Klimawandel	2015 DAS Progress Report APA II DAS Monitoring Report Publication of first cross-sectoral analysis on Germany's vulnerability to climate change
2016	2016

Wettbewerb „Blauer Kompass“ prämiert alle zwei Jahre innovative Projekte zum Umgang mit den Folgen des Klimawandels	Biennial “Blue Compass” competition honours innovative adaptation projects
2018 Launch des Klimavorsorgeportals der Bundesregierung	2018 Launch of the German government’s Climate Preparedness Portal
2019 2. Monitoringbericht Evaluationsbericht der DAS	2019 2nd Monitoring Report DAS Evaluation Report
2020 2. DAS Fortschrittsbericht APA III	2020 2nd DAS Progress Report APA III
Monitoringberichte 2015, 2019 & alle 4 Jahre (nächster 2023)	Monitoring Reports 2015, 2019 and every four years thereafter (next one due in 2023)
Klimawirkungs- und Vulnerabilitätsanalyse alle 6 Jahre	Climate impact and vulnerability analysis every six years
Aktionspläne 2011, 2015, 2020; alle 5 Jahre	Action Plans 2011, 2015, 2020; every five years thereafter
Evaluationsbericht 2019; künftig alle 4 Jahre	Evaluation Report 2019; every four years thereafter
Fortschrittsbericht = Fortschreibung der Strategie, alle 5 Jahre	Progress Report = Strategy update, every five years
Kontinuierliche Weiterentwicklung der Produkte zur Klimaanpassung	Continuous development of adaptation products

A.4. European Union and international integration

In Germany, policy-making on climate change adaptation is embedded in strategic processes dealing with this topic at the European and international levels. Germany contributes actively to the work being undertaken at both levels and is represented in various bodies and institutions.

Adaptation to climate change is a prominent topic on the European agenda. In its Communication on the European Green Deal, the European Commission states that it will “adopt a new, more ambitious EU strategy on adaptation to climate change”. A public consultation on a blueprint for the new EU Adaptation Strategy took place in spring and summer 2020. The Commission currently aims to publish its communication on the Strategy in 2021.

The European Climate Law not only addresses the topic of climate change mitigation but also deals with adaptation. The initial proposal states that: “The relevant Union institutions and the Member States shall ensure continuous progress in enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change.” To that end, “Member States shall develop and implement adaptation strategies and plans …”. Reports on progress made by the EU as a whole and at the national level will be submitted regularly and assessed by the Commission.

In February 2020, the Commission published a revised proposal for an Implementing Act on reporting on national adaptation action and launched a public consultation. The proposal fulfils the reporting requirements of the Governance Regulation (Annex VIII, Part 1, p. 69) and the United Nations Framework Convention on Climate Change (UNFCCC). Key aspects to be covered in reporting, according to these provisions,

include the main purposes and objectives of, and the institutional arrangements for, adaptation measures, climate change projections, adaptive capacity, adaptation plans and strategies, monitoring and evaluation frameworks and progress on implementation. Following the consultation, the Climate Change Committee will adopt a decision on the draft Implementing Act. The *Länder* were informed about the current consultation procedure by the German Standing Committee on Adaptation to Climate Change Impacts.

The Paris Agreement gives equal importance to adaptation and mitigation as the pillars of international climate policy. The Agreement sets a global goal on adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. Chapter D of the Progress Report considers Germany's international climate policy commitments in more detail.

Various multilateral frameworks established by the United Nations are also relevant to climate change adaptation. The Sendai Framework for Disaster Risk Reduction (SFDRR) and the Sustainable Development Goals (SDGs), both adopted in 2015, underline the importance of climate change adaptation. Adaptation has also gained importance in the context of other multilateral agreements and international organisations, such as the Organisation for Economic Co-operation and Development (OECD) and the G7 and G20 meetings.

B. Current findings and results

B.1. Monitoring: climatic changes, impacts and adaptation responses

The German Adaptation Strategy's monitoring system ensures that, in all the DAS fields of action, the impacts of climate change and adaptations to it are kept under continuous review. The second DAS Monitoring Report was published by the Interministerial Working Group on Adaptation to Climate Change in November 2019.[9] The report is based on the DAS monitoring indicators, which draw on measured data series.[10] In the 2019 DAS Monitoring Report it was not yet possible to systematically consider the data from 2018 and 2019 – years that were extremely hot and dry – because the analysis of statistically sound, nationwide data involves some delay. Rather than presenting the latest up-to-date developments, ongoing DAS monitoring focuses on systematic observation of climate impacts and adaptation, on the basis of statistically well-founded time series. Nevertheless, an initial estimate of developments in 2018/19 is provided in the monitoring texts where this is already possible.

New and revised indicators

The 2019 DAS Monitoring Report contains revised DAS indicators for the fields of human health, the water regime and water management, the building sector, and transport and transport infrastructure. As a result of these revised indicators, DAS monitoring in the period covered by the report is more strongly geared to the guiding priorities of the 2015 vulnerability analysis. For example, heavy rainfall events in residential areas and such events affecting road transport are now covered, as is damage to roads as a consequence of unusual weather conditions and climatic events. A new DAS monitoring indicator on heat-related deaths means that statements can now be made about the country as a whole. The data in the 2015 Monitoring Report were based merely on a regional case study.

The revision of the DAS monitoring indicators for the action area of the water regime and water management involved close collaboration with the German Working Group on Water Issues of the Federal States and the Federal Government (LAWA). The technical basis of the DAS monitoring indicators is worked out by experts from the federal government and the *Länder* in a working group of the LAWA climate change committee (LAWA AK). As a result of this work, the DAS monitoring indicators for the water regime and water management are now partially underpinned by data with full spatial coverage that is submitted by government agencies in the *Länder*. The aim is to develop a consistent and coordinated indicator system for water resources management that is agreed by the federal government and the *Länder*. This system will be used both for the federal government's climate impact reporting as part of DAS monitoring and for the specific reporting systems of the *Länder*.

[9] https://www.umweltbundesamt.de/en/publikationen/2019-monitoring-report During preparations for the updating, the technical principles on which the DAS monitoring system is based were reviewed, new findings were incorporated and the DAS monitoring system was continuously developed. In order to consider the latest state of knowledge and set the correct thematic priorities, experts from government agencies at national and federal state (*Länder*) level, associations and scientific institutions were involved.

[10] The DAS monitoring indicators summarise developments at national level. In order to make the selection, cause-and-effect relationships and their contribution to the adaptation process were discussed and evaluated with experts. The issues described are ones for which scientific findings indicate that changes – identified by the selected indicators – are to be expected in the course of climate change or for which the described measures strengthen the adaptation process.

Following the revision, the DAS monitoring system involves a total of 105 indicators. Fifty-six indicators characterise impacts of climate change (impact indicators), while 44 relate to activities and conditions that support the adaptation process (response indicators). In addition, there are five monitoring indicators which span a number of action areas; they capture the German government's overarching activities that support the process of adaptation to climate change.

Current findings on climatic changes and climate impacts

The 2014-2017 reporting period was characterised by a series of very warm years with extended droughts and violent downpours of heavy rain, the consequences of which included floods in the spring and summer of 2016 and 2017. The indicators reveal both continuous changes and an increasing frequency of extreme climatic events.[11] By way of example, there follows discussion of indicators that provide particularly meaningful insight into the priority action areas identified in the 2015 vulnerability analysis.

Increasing heat exposure

The summers of 2003, 2018 and 2019 were the warmest since meteorological records began. The annual air temperature as an aggregated mean for Germany was determined statistically to have risen by 1.5°C between 1881 and 2018 (linear trend). This exceeds by 0.3°C the rise found in 2013. Over the past forty years, there is evidence of a trend towards increasing heat extremes. In particular, the number of "hot days" on which the highest measured temperature is 30°C or more has risen significantly.[12] This corroborates a key finding of the 2015 vulnerability analysis, which identified the increase in heat exposure as the clearest and most pronounced climate signal. Hot spells are associated with health problems.

Nationwide data show that in the summer of 2003 there were around 7,500 more deaths in Germany than would have been expected in the absence of a heatwave. In 2006 and again in 2015 there were around 6,000 excess deaths.[13] Apart from preventive measures to protect human health, adaptation is also needed at planning and construction levels in order to reduce heat stress, especially in urban contexts.[14] Between 2012 and 2016 the proportion of respondents in a representative population survey who thought that their physical wellbeing or health would in future be severely or very severely impaired by heatwaves rose from just under a third to fifty percent.[15] The proportion who expect a future increase in heat stress to have a severe or very severe impact on their performance at work has also increased significantly (from approx. 25% of respondents in 2012 to 45% in 2016).[16]

[11] All the presentations of results in this section are based on the 2019 DAS Monitoring Report. The indicator labels in the DAS Monitoring Report use a standardised system. The first letters refer to the action area to which the indicator is assigned. The abbreviation after the first dash is either I = Impact, for impact indicators, or R = Response for indicators that depict adaptations. The number after the second dash designates the indicator's position in the particular action area. The references that follow give the titles and labels of the DAS monitoring indicators.

[12] Heat exposure (GE-I-1)

[13] Heat-related mortalities (GE-I-2)

[14] Heat stress in urban environments (BAU-I-1), Summer-related heat island effect (BAU-I-2), Recreation areas (BAU-R-1), Specific energy consumption for space-heating by private households (BAU-R-3), Priority and restricted areas for special climate functions (RO-R-4)

[15] Public awareness of health problems due to heatwaves (GE-I-1). The DAS monitoring system includes other findings of the representative environmental awareness studies that are regularly conducted by UBA and BMU.

[16] Heat-related loss in performance (IG-I-1)

It is noticeable that this heightened perception of risk is being reflected in steps taken to adapt to increased heat exposure. Thus during the reporting period there was a significant increase in the use of warning and information services, as the indicator on use of the DWD's heat warning services shows.[17]

Adverse effects on water usage owing to increased warming and more frequent summer droughts

The data on groundwater levels selected from nationwide statistics indicate that, by comparison with the long-term mean, the frequency of months with below-average low groundwater levels has been increasing significantly.[18] In particular, successive precipitation shortfalls in several consecutive years have led to reductions in groundwater levels or reduced spring discharge. Strikingly low groundwater levels and low spring discharge occurred in particular between 2013 and 2017.[19] Because of the pronounced dry period, the data for 2018 suggest a similar and possibly even more extreme situation. The time series beginning in the 1960s for the mean runoff at gauges distributed across 80 river catchments in Germany indicates distinct fluctuations between the years. During the summer season, the mean runoff drops significantly, indicating a decrease in water availability during the summer.[20] The difficult situation with regard to soil water supply,[21] as reported in 2015, is continuing. Agricultural management techniques must be adapted to boost the soil's humus content and water supply, in order to be better prepared for drought periods.

Damage from heavy rain and flash floods in urban areas

For the first time, data on heavy rain events in residential areas have been collected and included in the 2019 DAS Monitoring Report.[22] This aligns the DAS monitoring process more closely with the findings of the vulnerability analysis, which in 2015 identified heavy rain and flash floods in urban areas as a key action point. Precaution against losses from heavy rain and flash floods in urban areas is recorded in the DAS monitoring system in the form of data on the density of extended insurance cover for damage from natural hazards. The figures show that although the insurance density has increased significantly in recent years, for the country as a whole it is still relatively low at 43% for building insurance and 24% for contents insurance.

Floodwater and river flooding

For neither the summer nor the winter season does the occurrence of floodwater days show any significant trend for the time series to date.[23] The emergence of floodwater is always related to specific combinations of weather conditions which have so far not occurred systematically or repeatedly. An example of these weather conditions is the Vb (or 5B) weather type which led to the flooding of the

[17] Usage of warning and information services (HUE-2), Heat warning service (GE-R-1), Information on pollen (GE-R-3), Information on how to act in a disaster situation (BS-R-1)

[18] Groundwater level (WW-I-1). The groundwater measuring points and gauges on watercourses that were selected are as far as possible ones that are unaffected by anthropogenic influences. This is important, because it is often difficult to draw a distinction between climate impacts and impacts arising from changes in use or farming/management practices. The greater the extent to which sysems are influenced by humans, the more this applies.

[19] Because of the pronounced dry period, the data for 2018 can be expected to show that the situation is similar or probably even more extreme.

[20] Average flow level (WW-I-2)

[21] Soil moisture levels in farmland soil (BO-I-1)

[22] BAU-I-4. Because the indicator is being included for the first time, it is not possible to comment on the trend.

[23] WW-I-3

River Elbe in 2002 and to other floods. As yet no trend has been identified in the distribution of flood-water days over the hydrological winter and summer seasons. However, flooding is affected by numerous other circumstances in addition to climate change.

Sea-level rise and the risk of storm surges

The levels of the North Sea and Baltic Sea recorded by the DAS monitoring process in 2019 indicate a rise in sea levels that is in most cases statistically significant.[24] The rise in water levels as a result of storm surges is largely attributable to the rise in sea level.[25] This poses a gradually increasing threat to coastal regions, especially estuaries and low-lying coastal plains.

Changes in species composition and natural development phases as a result of a gradual temperature rise

Rising temperatures also affect natural systems. In consequence, the duration of the growing period has increased further since the 2015 DAS Monitoring Report.[26] For example, the characteristic development phases of wild plants (such as emergence of leaves, development of flower buds or fruit, leaf fall) in spring, summer and early autumn are starting earlier, while the stages that occur at the height of autumn, in late autumn and in winter are starting later than before. The changes in seasonal weather phases can have both positive and negative effects on agriculture. An earlier onset of apple blossom, for example, involves a greater risk of late frost damage which can result in crop losses.[27]

The greater frequency of warm and dry years is also having a distinct impact on ecosystems on which humans have little direct effect. For example, the proportion of beech trees in naturally warm and dry woodland reserves has decreased by comparison with species better adapted to drought.[28] The current condition of woodlands and forests and any changes in them since the last National Forest Inventory of 2012 will not be available for consideration until after the next National Forest Inventory in 2022 and will thus be included only in the third monitoring report. The ongoing warming is also resulting in significantly increased water temperatures in lakes[29] and in the North Sea.[30]

Even if annual mean temperatures are steadily rising, long, cold winters continue to affect ecosystems. This is illustrated by changes in bird species communities.[31] Since 1990 the composition of bird species has been shifting in favour of thermophilic species. Between 2009/10 and 2012/13 there was a series of hard winters that caused a decline in the numbers of many breeding birds. These hard winters particularly affected species which had migrated to Germany from more southerly climate zones.

[24] WW-I-8
[25] WW-I-9
[26] In the 1951-1980 reference period the growing period lasted 222 days; in 2015 the DAS Monitoring Report noted that it had lengthened to 230 days (1983-2012). In the 30-year period currently under consideration (1988-2017) the figure is 232 days. For further information see the indicator “Phenological changes in wild plant species (BD-I-1)”
[27] Agrophenological phase shifts (LW-I-1)
[28] Tree species composition in designated forest nature reserves (FW-I-1)
[29] Water temperature of standing waters (case study) (WW-I-5)
[30] Water temperature in the sea (WW-I-7)
[31] Community temperature index for bird species (BD-I-2)

Between 2000 and 2017, the impacts of climate change were increasingly taken into account in landscape management planning and in other specific fields of planning, such as the designation of land for preventive flood protection.[32]

[32] Priority and restricted areas for (preventive) flood control (RO-R-3)

B.2. Vulnerability assessment

A key document on which the need for action in relation to climate change adaptation and the third Adaptation Action Plan (APA III) are based is the German government's vulnerability analysis. The last vulnerability analysis was published in 2015. It is updated every six years, with each analysis applying to two DAS reporting cycles (see also Section A.2). The next vulnerability analysis will be published in 2021.[33] The main findings of the 2015 vulnerability analysis, which have already been described in detail in the 2015 progress report, continue to guide actions. They are therefore set out below (see the section headed "2015 vulnerability analysis", which is italicised for clarity). Selected up-to-date scientific findings on climatic changes, climate impacts and Germany's vulnerability to the consequences of climate change are also described in this chapter. The emphasis here is on the increased risk that results from the accelerated rise in sea level (IPCC Special Report on the Ocean and Cryosphere 2019), and on recent information on damage potentials and on the consequences of worldwide climate change for the Germany economy. This information, which supplements the 2015 vulnerability analysis, has been obtained from research projects during the past reporting period. The most important findings from the German government's risk analysis for civil protection purposes on the subject of drought are also set out.

2015 vulnerability analysis

"The 2015 vulnerability analysis identifies six spatial foci of the consequences of climate change that apply across all action areas:

1. *Damage caused by rising heat stress in agglomerations*
    - *Particularly affected action areas: Human health and the building sector*
    - *Spatial focus: Conurbations in warm regions, which will expand further in future;*
2. *Adverse effects on water usage owing to increased warming and more frequent summer droughts*
    - *Particularly affected action areas: Soil, agriculture, forests and the forestry industry, and the energy industry*
    - *Spatial focus: Regions with a warm and relatively dry climate in East Germany and the Rhine catchment area;*
3. *Damage to buildings and infrastructure from heavy rain and flash floods in urban areas*
    - *Particularly affected action areas: The water regime and water management, coastal and marine protection, the building sector, transport and transport infrastructure, industry and commerce*
    - *Spatial focus: Conurbations in the north-west German plain, the Mittelgebirge and south-west Germany;*
4. *Damage to buildings and infrastructure as a result of river flooding*
    - *Particularly affected action areas: The water regime and water management, the building sector, transport and transport infrastructure, industry and commerce*

[33] The findings of the updated climate impact and vulnerability analysis (KWVA) are due to be scientifically published in 2021 and then incorporated into the updating of the DAS. In 2018, as a first step towards the 2021 KWVA, the network of government agencies dealing with adaptation to climate change selected 105 climate impacts. Two-thirds of these 105 climate impacts had already been considered in the 2015 vulnerability analysis and are therefore being continuously updated. One-third of the climate impacts are new. The majority of the climate impacts can be assigned to the six focal areas of the 2015 vulnerability analysis. New issues in the 2021 KWVA include the impacts of UV radiation and of climatic changes outside Europe on human health, the environment and material assets; economic relationships are also covered.

- *Spatial focus: Conurbations in the river valleys of the north German plain, and also the catchment areas of the Rhine and Danube;*

5. *Damage to coasts as a result of sea-level rise (more significant in the distant future), the associated increase in wave action and the heightened risk of storm surges*
    - *Particularly affected action areas: Coastal and marine protection, the building sector, transport and transport infrastructure, industry and commerce*
    - *Spatial focus: Coasts;*
6. *Changes in species composition and natural development phases as a result of a gradual temperature rise*
    - *Particularly affected action areas: Human health, soil, biological diversity, agriculture, forestry and forest management, fisheries*
    - *Spatial focus: Oceans and rural areas.*

The 2015 vulnerability analysis shows that the increase in heat stress is the clearest and strongest climate signal, with considerable impacts on health and infrastructure, especially in densely populated urban areas. At the same time, forestry, agriculture and the water regime are particularly under threat from increasing warming and in future from aridity. The most vulnerable regions of Germany from the point of view of climate change are areas with structural deficits that are located in regions with a warm climate and are therefore most severely affected by heat and aridity. Other regions that are vulnerable in the face of the expected increases in heavy rain in summer and in winter precipitation are structurally weak conurbations in which a large proportion of their area is at risk of flooding. This flooding may be triggered not only by high river levels but also by heavy rain or flash floods. In the long term the gradual temperature increase will pose a particular risk both to coastal regions and to species and habitats that are tied to unique and sensitive regions, such as the high mountains and the mudflats of the Wadden Sea.

Action areas with a large number of similar climate impacts were combined in the vulnerability analysis into six clusters whose climate impacts frequently also coincide spatially. The APA III continues to be based on the climate impacts of each cluster, and the measures and instruments are ordered in the same way.

*The **'water' cluster** includes the three action fields that are concerned with the management of water and aquatic ecosystems and that together are of major importance for many of the other DAS action areas: 'the water regime, water management', 'coastal and marine protection' and 'fisheries'. 'The water regime, water management' is the action area with by far the most interrelationships with other action areas. The impacts emanating from this action area predominate in these relationships, so that changes in the water regime often have cascading impacts on other action areas.*

*The **'land' cluster** comprises the closely interlinked action areas of 'soil', 'agriculture', 'forestry and forest management' and 'biological diversity'. The action areas of 'soil' and 'biological diversity' have numerous links with other action areas outside this cluster: soil, because it is an important factor in location and production, and biological diversity, because it is affected by many of the ways in which ecosystems are used, such as by agriculture and forestry, by fisheries or by tourism. The action area of 'biological diversity' of course covers aquatic ecosystems as well as terrestrial ones.*

*The three DAS action areas that are particularly dependent on long-lasting, built infrastructure are combined in the **'infrastructure' cluster**: 'the building sector', 'the energy industry' and 'transport and*

transport infrastructure'. In consequence, these action areas are heavily interlinked. In addition, they all have numerous interactions with the 'business' cluster.

*The **'business' cluster** comprises the DAS action areas that cover production and service enterprises and that involve mainly the private sector: 'industry and commerce', 'the tourism industry' and 'the financial services industry'.*

*The **'health' cluster** involves the action area of 'human health'. This cluster is key to the reasoning behind adaptation measures in Germany, because climate impacts in other action areas very often have a direct or indirect effect on human health. For example, extreme weather events can cause accidents and other health problems through damage to infrastructure.*

*The **'spatial planning and civil protection'** cluster combines two cross-sectoral action areas: 'spatial, regional and physical development planning' and 'civil protection'. Both action areas are only indirectly affected by the consequences of climate change. In 2015 the Vulnerability Network therefore reviewed these action areas in terms of their scope for maintaining or increasing adaptation capacity. The 'civil protection' action area is responsible for protection of the population and hence has many interfaces with other areas (such as infrastructure). The 'spatial, regional and physical development planning' action area plays a key part in the other clusters' proactive adaptation to climate change.'*

Increased risk as a result of accelerated sea-level rise

Recent scientific studies and in particular the IPCC Special Report on the Ocean and Cryosphere of September 2019[34] show that sea-level rise is accelerating faster than was assumed just a few years ago.[35] In particular, there is a risk that if the CO_2 content of the atmosphere continues to increase unchecked, the intensified melting of the great ice sheets which has already been observed over the past 20 years will speed up global sea-level rise. In this scenario, known as the RCP 8.5 scenario, the likely range (17th – 83rd percentile) of mean global sea-level rise by the end of the 21st century is 61 – 110 cm; in the longer term, a rise of several metres could occur by 2300.[36] The regional relative sea-level rise in the North Sea and the Baltic can deviate from the global value, mainly as a result of post-glacial vertical land movements. Observations over several decades reveal rising extreme water levels at many places on the North Sea and the Baltic. This trend can be explained by the long-term rise in sea level.[37]

Sea-level rise, together with higher water levels during storm surges and the associated intensification of wave action in coastal areas, places greater strain on coastal protection systems.[38] This increases the risk of flooding in the hinterland and amplifies coastal protection requirements. Another consequence of sea-level rise and the possible increase in high water levels is that the drainage systems in low-lying marshy areas on the German North Sea coast may be overwhelmed.

As the sea level rises, the vulnerability of the flat coastal regions will increase. This means that there is an increased risk of permanent flooding of land at sea level as it becomes difficult for fresh water to

[34] See the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC); IPCC 2019.
[35] Grinsted et al. 2015, Hansen et al. 2016, IPCC 2019, Klein et al. 2018
[36] IPCC 2019, Figure SPM.1
[37] Weisse et al. (2014)
[38] LAWA (2017); Storch et al. (2018)

flow into the sea. Valuable physiographic areas such as the Wadden Sea are also in jeopardy.[39] In addition, sea-level rise and the higher storm surges that accompany it are likely to pose a particular risk to loose-material coasts on the North Sea and the Baltic.[40] The effects of the higher sea level are not confined to coastal protection, which in Germany is the responsibility of the federal states *(Länder*): they also impact on other sectors such as water management, agriculture, fisheries and biological diversity. For example, restrictions on shipping and ports could affect transport and logistics throughout Germany.

On the German North Sea coast the rate of sea-level rise is likely to be faster than the rate at which the Wadden Sea can keep pace through additional deposition of sediment.[41] In consequence it is likely that the Wadden Sea will shortly face irreversible change, transforming from an area dominated by mudflats to a lagoon-like system, with enormous impacts on the ecosystem.[42]

The coastal areas on the German North Sea and the Baltic are in the main safeguarded by "hard" coastal protection measures such as dykes and barriers. Other options for protecting people and property are also available: they include flood-proof building methods and land reclamation. Of increasing importance are near-natural solutions such as beach nourishment or the creation of coastal areas that are periodically flooded. In the face of accelerated sea-level rise, the choice of appropriate coastal protection measures should depend both on the particular subjects of protection in the region or locality and on long-term sustainability.

Because of the high risks, the delay in effecting a response and the irreversibility of the rise, it is essential – despite the existing uncertainties – that the future sea-level rise is given appropriate consideration in planning processes now. The federal government and the *Länder* will simultaneously take action against global warming with ambitious climate change mitigation measures and adapt to unavoidable climatic changes and climate change impacts. The federal government supports the work of the *Länder* in the field of proactive coastal protection.

Accelerated sea-level rise is of importance not only for Germany's coastal areas but also worldwide. It particularly affects densely populated regions and cities close to the coast. The existence of small island states can be at risk. In consequence, the UN Security Council addressed the consequences of climate change in 2020: it considered accelerated sea-level rise to be one of the main risks.

2018 risk analysis for civil protection purposes on the subject of drought

In 2018 the working group of the German government's executive agencies produced a report for the Federal Ministry of the Interior (BMI) on the effects of an extreme drought lasting for several years (BT printed matter 19/9521). The interdepartmental risk analysis for civil protection purposes, which was coordinated by the Federal Office of Civil Protection and Disaster Assistance (BBK), involved the specialist bodies of the working group of dam operators providing drinking water (ATT) plus the German Working Group on Water Issues of the Federal States and the Federal Government (LAWA), the German

[39] Hofstede (2014), MELUND (2015)
[40] Buth et al. (2015)
[41] Wachler et al. (2018)
[42] Becherer et al. (2018)

Technical and Scientific Association for Gas and Water (DVGW) and the German Association for Water, Wastewater and Waste (DWA).

The BMI's risk analysis for civil protection purposes is produced annually. It serves partly to give proactive consideration to risks where the management of their consequences might place particular demands on the federal government as a result of its legal responsibilities, including its obligations under Germany's Basic Law. The risk analysis uses a scenario to determine both the probability of occurrence and the magnitude of damage to people and their livelihoods. Its other purpose is to provide information as a basis for risk assessments at political and administrative level.

The risk analysis on the subject of drought focuses on a scenario in which the whole of Germany is affected by a drought that lasts for six years, accompanied in the summer of the final year of the scenario by a heatwave and in the winter by a cold wave. It addresses possible impacts on the energy supply, the environment, food, transport and the economy.

The risk analysis places special emphasis on the (drinking) water supply. For example, the scenario considers the fact that it may at times not be possible to maintain the piped supply of drinking water.

Low river water levels may reduce the capacity of thermal power plants that use river water for cooling; they may also have impacts ranging from minor failures resulting in delays in the delivery of freight to a temporary total collapse of the transport of goods on inland waterways. Throughout the scenario period there is an increased risk of forest fires, power cuts and significant harvest reductions (up to 60% of an average harvest), as well as a shortage of food for flora and fauna.

In terms of the classification system that the BBK uses for its risk analyses, the occurrence of an extreme drought is classed as "likely to a limited extent", meaning that such an event is expected to occur once every 100 to 1,000 years. However, in view of the consequences that are already observable in Germany during prolonged dry periods, it is to be assumed that, because of climate change, the impacts of drought described in the risk analysis will occur more frequently. In some cases they will be amplified by other consequences of climate change.

Increasing potential for damage as a result of climate change

Identifying damage as a result of climate change is a complex issue. Nevertheless, it is particularly important, because the potential for damage resulting from climate impacts can be high. A precautionary damage-reduction approach in areas such as construction or land use is often worthwhile, in both the public and the private sectors. The federal government and the *Länder* are therefore addressing this issue. Results are now available from the study "Assessment of risks associated with climate change: Damage potentials and the economic impact of climate change and adaptation measures", which involved the damage modelling network of public authorities. In view of the importance of the issue, other studies using various methodological approaches are currently being produced by other stakeholders at federal government and *Länder* level; they will provide a clearer picture of the situation as the DAS is updated.

The following key areas are used as examples in the study: heavy rain, storm surges, heat-related deaths (heat deaths) and human performance; the impact of adaptation measures is also assessed. The climate impacts that are considered were selected on the basis of the six overarching and spatial

priorities of the German government's 2015 vulnerability analysis and of the climate impacts which can be quantitively measured by existing data and methods. For example, the damage potential of river flooding could not be considered in this study. River flooding is already causing significant damage. The 100-year-return-period flooding of the Elbe in 2002 resulted in damage totalling around 11 billion euros.[43]

The modelling performed in the study shows that the selected climate impacts are likely to lead to increasing damage.[44] The analysis indicated that these damage potentials could be significantly reduced through suitable preventive measures (see Figure 3).

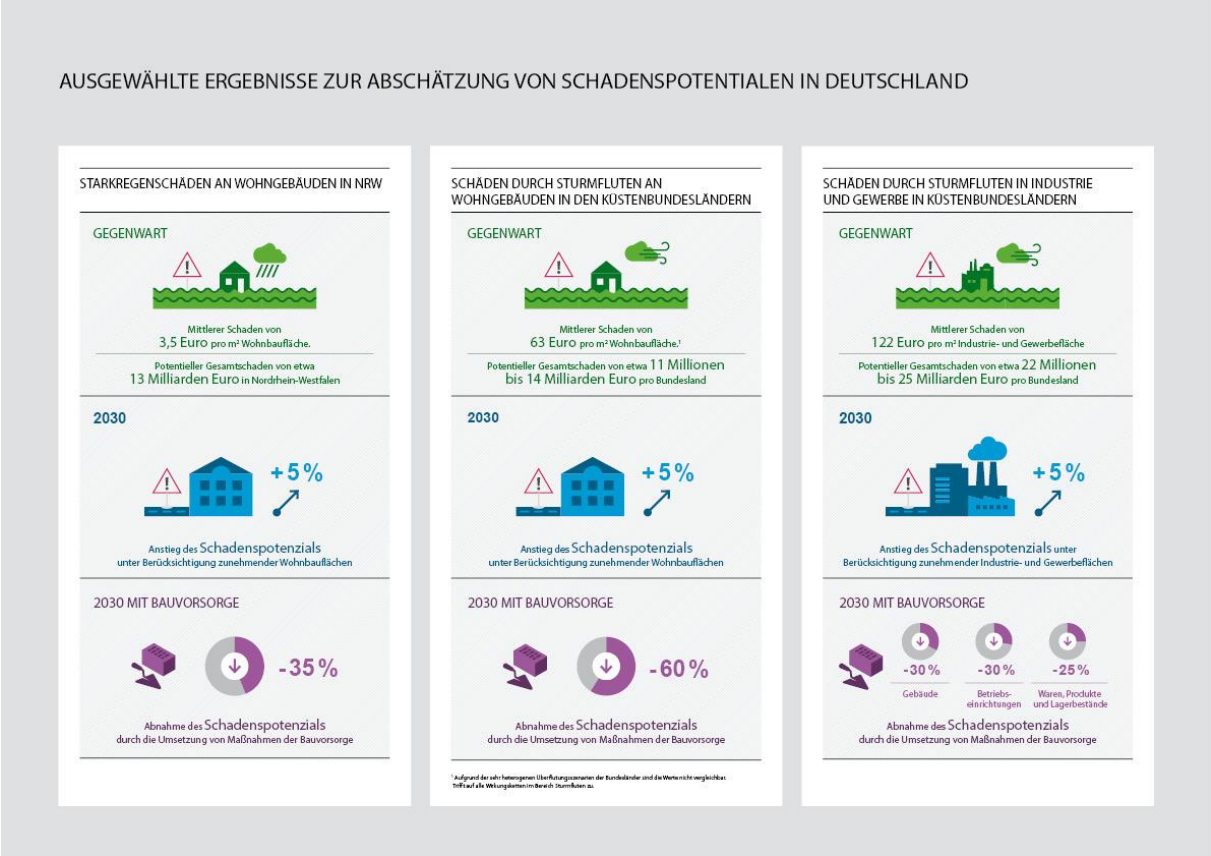

Figure 3: Schematic representation of the damage potential of selected climate impacts for the present, by 2030 and by 2030 with building precautions. Source: based on Bubeck et al. (2019)[45]

[43] This figure includes damage to residential buildings, household effects, commercial businesses, infrastructure (municipal, state, other ownership) and agriculture and forestry, plus the costs of preventive measures and civil protection, see Bundestag printed matter 18/1403 of 13.05.2014, the German government's response to the minor interpellation on adaptation to the impacts of climate change in Germany.

[44] Detailed information on the methodology and the underlying data and models can be found in the final report of the project "Cooperation between public authorities on climate change and adaptation", pp. 116ff. (see Bubeck et al. 2019).

[45] The potential damage from heavy rain and storm surges was calculated as follows: wherever possible, the change in potential damage as a result of the expected climatic and socioeconomic changes and the damage-reduction effect of adaptation measures were considered. Possible adaptation measures in the field of preventive behaviour and building precautions (e.g. sealing walls and doors, use of mobile water barriers) were depicted by adapting the damage models. This involved using "damage mitigation factors" which were calculated from the levels of actual damage identified in surveys.

SELECTED FINDINGS FROM THE ESTIMATE OF DAMAGE POTENTIAL IN GERMANY		
DAMAGE BY HEAVY RAIN TO RESIDENTIAL BUILDINGS IN NORTH-RHINE/WESTPHALIA	DAMAGE BY STORM SURGES TO RESIDENTIAL BUILDINGS IN GERMANY'S COASTAL STATES	DAMAGE BY STORM SURGES TO INDUSTRY AND COMMERCE IN GERMANY'S COASTAL STATES
PRESENT	PRESENT	PRESENT
Average damage of €3.5 per m^2 of residential area	Average damage of €63 per m^2 of residential area[1]	Average damage of €122 per m^2 of industrial & commercial area
Potential total damage of around €13 billion in North-Rhine/Westphalia	Potential total damage of between about €11 million and €14 billion per federal state	Potential total damage of between about €22 million and €25 billion per federal state
2030	2030	2030
Increase in damage potential considering increase in residential area	Increase in damage potential considering increase in residential area	Increase in damage potential considering increase in industrial & commercial area
2030 WITH BUILDING PRECAUTIONS	2030 WITH BUILDING PRECAUTIONS	2030 WITH BUILDING PRECAUTIONS
Reduction in damage potential as a result of implementation of building precaution measures	Reduction in damage potential as a result of implementation of building precaution measures	Reduction in damage potential as a result of implementation of building precaution measures
	[1]Because of highly varied flood scenarios in the various states, the values are not comparable. This applies to all impact chains involving storm surges.	

The methodology and results in detail

Storm surges

To identify damage as a result of flooding caused by **storm surges**, the following procedure was used: the spatial extent of a flood, possible flood depths and the associated probability of occurrence were obtained from the available flood risk maps produced by the *Länder* during the first assessment cycle of the EU Floods Directive. In accordance with the Directive, scenarios with different probabilities of occurrence were described. The extreme scenario in line with the Floods Directive is the occurrence of a storm surge without flood protection measures: this thus represents a worst-case scenario. In the model chain that was used, the impact of climate change on the storm surge risk can be depicted partly via changes in flood areas and depths and partly via changes in probabilities of occurrence. Using the available data it was only possible to depict climate change via changing probabilities of future occurrence. The flood areas remain unchanged. Because the probability of occurrence of particular water levels is increasing over time, events that are now defined as once-in-a-century ones will become significantly more frequent by the end of this century. The consideration of floods as a result of storm surges in the extreme scenario thus gains importance.

The example of the impacts of *storm surges on residential buildings* highlights the fact that even simple measures – such as the installation of non-return flaps or the sealing of house walls – can reduce potential damage. The calculated levels of damage (see diagram above) relate to the extreme scenarios that assume the widespread failure of flood protection measures – for the flood areas to be identified

under the Floods Directive (extreme event).[46] If no adaptation measures are put in place, the potential damage as a result of frequent events is in the region of tens of millions of euros for most of the coastal states, while the damage caused by a medium event can be as high as 260 million euros in a single case. In the unlikely case of an extreme event without protection measures, the maximum damage potential for a single state was put at up to 14 billion euros. Because of the very different flood scenarios in different states, the values are not comparable. The average damage for the extreme scenario without protection measures is €63 per square metre of built-up residential area in the flood risk area (in accordance with the Floods Directive). Because of expanding residential areas, the present damage potential in the extreme scenario without protection measures would rise by around 5% by 2030. An increase in building precautions could effect a significant reduction of around 60% in the present damage potential and the elevated rate of that potential in future.

The estimated costs of damage arising from the *impacts of storm surges on industry and commerce* are in a somewhat higher range than the cost of damage to residential buildings (see diagram above). The average level of damage to industrial and commercial buildings, plant and equipment and to goods, products and stocks was put at €122 per square metre of industrial and commercial sites. However, this covers only direct damage: it ignores loss and damage as a result of business interruption and other indirect damage caused by issues such as supply shortages and the disruption of value chains. Because of expanding industrial and commercial sites, the present damage potential in the extreme scenario without protection measures would rise by around 5% by 2030. If the likelihood of storm surges increases, the damage potential could increase further. Optimal building precautions, including measures to prevent the contamination of water, could significantly reduce the damage potential in the extreme scenario without protection measures – by around 30% in relation to damage to buildings, plant and equipment and 25% in relation to goods, products and stocks.

Heavy rain

It can be assumed that heavy rain will increase in both frequency and intensity, with an attendant increase in the damage potential – although it was not possible to capture the influence of climate change for this climate impact.

Damage from flooding as a result of heavy rain was calculated by extracting the flood-exposed values from the fixed asset figures and other statistical data on individual sectors of the economy and locating them spatially with the help of land cover maps. The subsequent appraisal of the level of damage in the different scenarios was based on the recorded damage by extreme heavy rain events in the past, because adequate depiction of the influence of climate change on heavy rain events is not yet possible. An example that was used was the heavy rain event in Münster on 28 July 2014, for which insured damage to property amounted to around 71 million euros (GDV 2015).[47] Damage modelling was used to perform the calculations.

As mentioned above in connection with storm surges, the level of damage depends on the sectors being considered – in this case residential buildings. For this reason, sector-specific input data and

[46] It should be borne in mind that the level of damage was extrapolated to apply to the entire area of a federal state. However, the events often apply only locally.

[47] GDV 2015: Naturgefahrenreport 2015 – Die Schaden-Chronik der deutschen Versicherer in Zahlen, Stimmen und Ereignissen [Natural hazard report 2015 – The German insurers' damage chronicle in figures, voices and events], p. 15.

damage models were used. Because no comprehensive risk maps are available for heavy rain, the potential damage was calculated on the basis of case studies from North-Rhine/Westphalia (NRW) and transferred to the entire area of that state.

For North-Rhine/Westphalia, case studies indicate that the current event-dependent potential for damage to residential buildings by heavy rain amounts to around 13 billion euros.[48] This corresponds to average damage of €3.5 per square metre of residential area. Because of expanding residential areas, this damage potential would rise by around 5% by 2030. Very good building precautions – such as sealing basements, preventing backflow and installing water barriers – could achieve a significant reduction of around 35% in the damage potential by comparison with average precautions. In contrast to the situation with regard to watercourse discharge, it is not possible to assign a probability of occurrence to surface runoff from heavy rain.

Heat-related deaths

Heat-related deaths were assessed using a statistically based heat mortality function. This made it possible to calculate the additional percentage of heat-related deaths within the total mortality in the population. The "apparent temperature" was derived from the air temperature and humidity and used as the climatic stress factor for human health.[49] The results indicate a significant increase in the number of heat-related deaths as a percentage of all deaths. 2018 was the warmest year in Germany since regular records began in 1881 (DWD 2020). Figure 4 shows that in some parts of Germany – mainly in the east and south-west of the country – there were more than 30 days on which the thermometer rose to 30°C or higher. A higher percentage of heat-related deaths was therefore to be expected in 2018. The Robert Koch Institute (RKI) calculated that there were around 1,200 heat-related deaths in the two *Länder* of Berlin and Hesse in the summer of 2018.[50, 51]

[48] The following input parameters were used for the modelling of potential damage to residential buildings by heavy rain that is presented here: climatic exposure (maps of flooding as a result of heavy rain from selected case studies), sensitivity (especially built-up area as a land-use type in the ATKIS basic digital landscape model of the Federal Agency for Cartography and Geodesy BKG) and the damage function (FLEMOps model – Flood Loss Estimation MOdel for the Private Sector), adapted to heavy rain (Thieken et al. 2008). Detailed information on the methodology and the underlying data and models can be found in the above-mentioned final report, pp. 41ff. (see Bubeck et al. 2019).

[49] The following input parameters were used for the modelling of damage to human health and performance that is presented here: climatic exposure (apparent temperature according to Steadman 1979), sensitivity (sensitivity of the population to thermal stress) and the damage function (temperature/mortality function according to Kendrovski et al. 2017). Detailed information on the methodology and the underlying data and models can be found in the final report of the project "Behördenkooperation Klimawandel und -anpassung" [Cooperation between public authorities on climate change and adaptation], pp. 116ff. (see Bubeck et al. 2019). The modelling of the percentage of total mortality represented by heat-related deaths shows a robust rise in all model calculations for the IPCC climate scenarios RCP 4.5 and RCP 8.5.

[50] An der Heiden, M., Buchholz, U., Uphoff, H. (2019): Schätzung der Zahl hitzebedingter Sterbefälle und Betrachtung der Exzess-Mortalität; Berlin und Hessen, Sommer 2018 [Estimate of the number of heat-related deaths and consideration of the excess mortality; Berlin and Hesse, summer 2018]. Epidemiologisches Bulletin · 23:193-202 · DOI 10.25646/6178

[51] The model of Bubeck et al. and the estimate of the RKI (An der Heiden et al.) use different calculation methods.

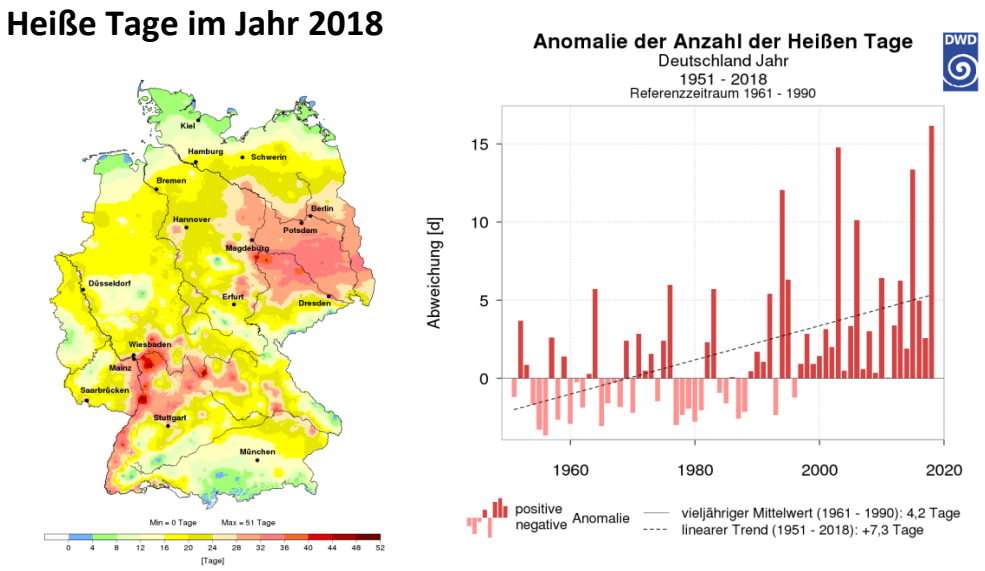

Figure 4: Left: the number of hot days (maximum temperature ≥ 30°C) in 2018, right: the anomaly of the number of hot days in Germany by comparison with the reference period of 1961-1990. Source: DWD 2020

Heiße Tage im Jahr 2018	Hot days in 2018
Abweichung [d]	Deviation [d]
Min = 0 Tage	Min. = 0 days
Max = 51 Tage	Max. = 51 days
[Tage]	[days]
Anomalie der Anzahl der Heißen Tage	Anomaly of the number of hot days
Deutschland Jahr	in Germany for the years
Referenzzeitraum	Reference period
positive	positive
negative	negative
Anomalie	anomaly
vieljähriger Mittelwert 4,2 Tage	multi-year mean 4.2 days
linearer Trend +7,3 Tage	linear trend +7.3 days

On the basis of the modelling for the two IPCC climate scenarios RCP 4.5 and RCP 8.5 that were considered, it is estimated that by the middle of this century the percentage of all deaths that are classed as *heat-related deaths* could quadruple by comparison with a scenario without climate change. By the end of this century there is even the possibility of a six- to twelve-fold increase. [52] However, the extent to which the increasing stress as a result of climate change could be offset by behavioural changes among the population or by appropriate adaptation measures has not been taken into account.

Heat stress also impairs *human performance in the workplace.* The modelling described below considers only indoor offices, where air conditioning is possible. The methodology was unable to cover outdoor workplaces, even though they will be severely affected by heat stress. To depict the effect in indoor spaces, the energy expenditure on cooling and the associated costs of maintaining performance

[52] Calculated on the basis of IPCC climate scenarios RCP 4.5 and RCP 8.5

in workplaces with air conditioning was used as a damage indicator. The estimate of energy expenditure is based on maintaining an optimal room temperature of 21°C. The calculation uses the concept of "cooling degree days". The model calculations show that a significant increase in the costs of offsetting a heat-induced reduction in performance in office workplaces is to be expected.[53] According to the modelling, the number of cooling degree days could on average treble by the middle of the century by comparison with a scenario without climate change (RCP 8.5). By the end of the century the average number of such days could increase by between four and more than eight times.[54]

Climate change abroad also affects the German economy

The impacts of global climate change on the German economy were analysed in 2018 as part of the DAS process.[55] Both import and export flows in various sectors were considered. In the quantitative analysis, selected results chains[56] were depicted in a global economic model, projected into the future and validated in model comparison studies. The aim was to evaluate the complex interactions in trade relationships between various world regions and countries.[57]

The overall assessment shows that, because of its strong role in international trade, the German economy is likely to be affected by climate impacts in other world regions. A significant proportion of the costs to the German economy arise from effects outside the EU. In 2015, six percent (€55 billion) of German imports and four percent (almost €50 billion) of exports involved twelve countries or regions that are classed as particularly climate-vulnerable.[58] In terms of trade volumes, by far the largest players among these countries are Brazil, India, South Africa, Vietnam and Thailand. In other parts of the world, too, climate change will have economic consequences that will ultimately affect world trade.

The three analysed results chains "Changes in labour productivity", "Changes in agricultural yields" and "Rise in sea level", plus analysis of possible adaptation options, indicate that negative economic effects are to be expected in all parts of the world. The modelling shows that, via world trade, the climate change impacts that arise outside Europe will have a greater effect on the German economy that those that arise within Europe. This is because EU regions are less severely affected by the direct impacts of climate change than other parts of the world.[59]

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[53] The following input parameters were used for the modelling of potential damage to human performance that is presented here: climatic exposure (climate parameter – temperature), sensitivity (temperature-dependent performance/productivity in humans) and the damage function (costs/effort of maintaining productivity through air conditioning (energy requirement)). The energy expenditure for cooling and hence the costs of maintaining performance in workplaces that can be air conditioned show a robust rise in all model calculations and the RCP 4.5 and RCP 8.5 climate scenarios. Detailed information on the methodology and the underlying data and models can be found in the final report of the project "Behördenkooperation Klimawandel und -anpassung" [Cooperation between public authorities on climate change and adaptation], pp. 111ff. (see Bubeck et al. 2019).

[54] Calculated on the basis of IPCC climate scenarios RCP 4.5 and RCP 8.5

[55] For further information see Peter, Guyer and Füssler (2018, 2019). Available at https://www.umweltbundesamt.de/publikationen/klimawandel-deutscher-aussenhandel and https://www.umweltbundesamt.de/publikationen/folgen-des-globalen-klimawandels-fuer-deutschland.

[56] The three results chains that were modelled were "Change in labour productivity", "Change in agricultural yields" and "Rise in sea level"

[57] For information on the methodology and the underlying data see Peter, Guyer, Füssler, Schwarze, Bednar-Friedl, Bachner, Knittel (2020): p. 24ff.

[58] See Peter, Guyer und Füssler (2019): p. 26. The countries include Bangladesh, Brazil, Egypt, India, Indonesia, Nigeria, Philippines, South Africa, Thailand, Vietnam, plus Other North Africa and Other West Asia.

[59] Peter, Guyer, Füssler, Schwarze, Bednar-Friedl, Bachner, Knittel (2020): pp. 76ff.

Economic risks on the import side arise mainly from extreme weather events that can lead to production losses for producers in various regions. These could lead to delivery delays for the automotive industry in Germany or to a rise in the cost of intermediate goods and hence in production costs.[60] The main risks to exports are the loss of purchasing power and the decline in economic performance in parts of the world severely affected by climate change, since this could reduce the demand for goods from Germany. In addition to risks there would also be some economic opportunities: these would arise in particular from the growing demand from parts of the world severely affected by climate change for investment to adapt to climate change and tackle damage, and from the changing demand for low-carbon consumer goods and investment in emissions-reduction technology.[61]

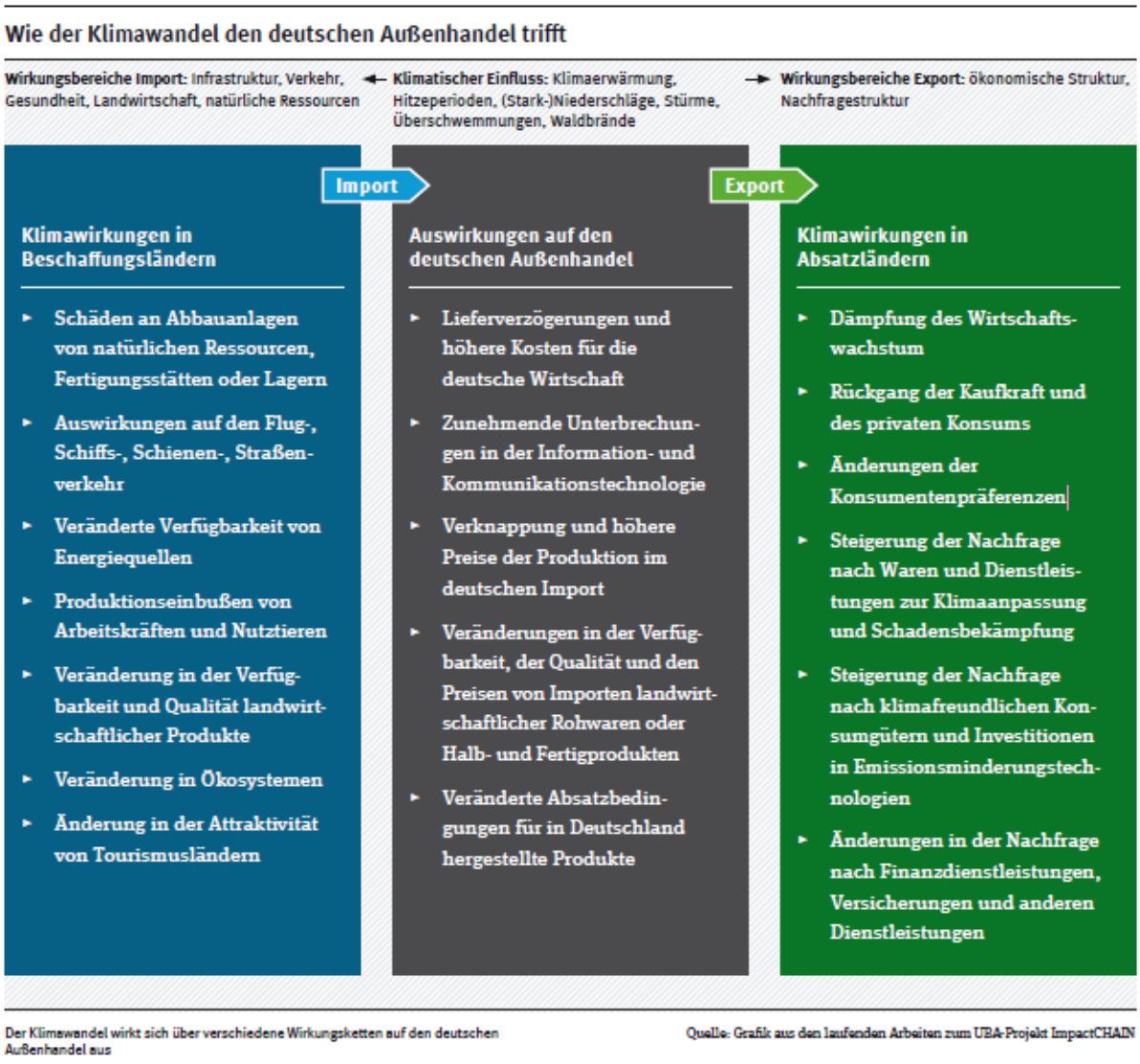

Figure 5: Results chain – the effects of climate change on German foreign trade. Source: Peter, Guyer and Füssler (2018).

[60] See Peter, Guyer, Füssler, Schwarze, Bednar-Friedl, Bachner, Knittel (2020): p. 22
[61] See Peter, Guyer, Füssler, Schwarze, Bednar-Friedl, Bachner, Knittel (2020): p. 23

How climate change affects German foreign trade		
Affected areas – imports: infrastructure, transport, health, agriculture, natural resources	Climatic influences: climate warming, hot spells, (heavy) precipitation, storms, floods, forest fires	Affected areas – exports: economic structure, demand structure
Import		Export
Climate impacts in procurement countries	Impacts on German foreign trade	Climate impacts in export markets
• Damage to resource extraction facilities, production sites or storage facilities	• Delivery delays and higher costs for the German economy	• Slowdown in economic growth
• Impacts on aviation, shipping and road & rail transport	• Increase in interruptions to information & communication technology	• Decline in buying power and private consumption
• Changed availability of energy sources	• Shortages and higher production prices affecting German imports	• Changes in consumption preferences
• Loss of productivity in humans or livestock	• Changes in the availability, quality and price of imports of agricultural commodities or semi-finished and finished products	• Increase in demand for goods and services for climate adaptation and damage limitation
• Change in the availability and quality of agricultural products	• Changed sales conditions for products manufactured in Germany	• Increase in demand for climate-friendly consumer goods and investment in emissions-reduction technology
• Change in ecosystems		• Changes in the demand for financial services, insurance and other services
• Change in the attractiveness of tourism countries		
Climate change affects German foreign trade via various impact chains	Source: Diagram from the ongoing work of the UBA project ImpactCHAIN	

The impacts of climate change on German foreign trade that are described here represent only some of the many impacts on Germany of climate change in other countries. As well as having economic consequences, climate change outside Europe will also have direct impacts on Germany in relation to infrastructure and transport, geopolitics and security risks, human mobility in connection with migration, and the financial sector, to name but a few of the many affected areas.[62]

The above findings on sea-level rise, damage potentials and the impacts of global climate change on the German economy confirm and underpin the climate impacts of major importance identified across all sectors in the 2015 vulnerability analysis by the network of public authorities dealing with vulnerability, and likewise confirm the effects derived therefrom.

[62] See inter alia European Environment Agency (2017)

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B.3. APA II implementation and APA III preparation process

The German Strategy for Adaptation to Climate Change (DAS) provides the policy framework for climate change adaptation in Germany. In order to underpin this strategy with concrete measures, the German government adopted Adaptation Action Plan I (APA I) in 2011 and Adaptation Action Plan II (APA II) in 2015. Adaptation Action Plan III (APA III) was produced and adopted together with this Progress Report. The following section provides a summary of the implementation status of the measures and instruments described in APA II.

APA II implementation status

Three quarters of the 147 measures described in APA II have already been or are currently being implemented[63]. A quarter of the measures are in preparation or their implementation has not yet started. In the survey conducted within the evaluation framework, a third of the measures were described as still under way. Slightly less than a quarter of the measures were described as permanent tasks; this reflects the transition, with APA II and the 2015 DAS Progress Report, from project-based, limited-term measures to longer-term embedded tasks.

Success factors during implementation, [64] according to the survey conducted within the evaluation framework, include the availability of previous outcomes, e.g. from a previous project, practical relevance or needs-based orientation of the measures, stakeholder networking, involvement of stakeholders with relevant skills/responsibilities, public acceptance/consensus, availability of resources, and good communication among participants. Reasons for delays in implementation or non-performance were[65]: lack of personnel capacities, poor communication/coordination, and inadequate data. In addition, some measures were postponed or not implemented due to changes in priorities. The analysis of APA II implementation status also shows that climate change adaptation measures must more systematically address those climate impacts where there is a substantial need for action.[66]

Preparation of APA III: methodology

Adaptation Action Plan III (APA III) was developed in a stepwise and collaborative process by the federal ministries represented in the Interministerial Working Group on Adaptation to Climate Change (IMAA). APA III covers activities to be carried out by the federal government within its own sphere of competence, as well as policy instruments to create appropriate frameworks for climate change adaptation in Germany. The federal government focuses these measures on the climate impacts and needs for action identified as priorities in its vulnerability analysis. The actions identified should be developed and implemented within the time period covered by APA III.

[63] APA II implementation status, as reported here, was surveyed during the DAS evaluation (see Section B.5 and Bundesregierung 2015, p. 8). In terms of procedure, this was performed using the APA status tool (see Evaluation Report, pp. 69-72); additional information on success factors and obstacles in implementing climate change adaptation measures was collected in interviews with persons responsible for APA II measures. The results reported here were correct as at May 2018.

[64] In relation to the implementation status of APA II measures, the survey that was carried out using the APA status tool also enquired about success factors in the implementation of measures. Information about success factors in implementation was provided for a total of 39 measures.

[65] In a total of 29 cases, there were delays in implementing APA II measures or measures were not performed at all. In many instances, the reasons for these delays were stated in the APA status tool.

[66] The evaluation report provides a detailed description of which APA II measures and instruments directly and systematically address climate impacts with a substantial need for action, and which do not.

APA III includes a range of technical proposals which the higher federal authorities participating in the federal authority climate adaptation network (*Behördennetzwerk*)[67] developed within their respective spheres of responsibility and expertise. The proposals are based on an intensive, stepwise process of analysis and evaluation. The evaluation criteria were: effectiveness, flexibility, efficiency, coherence with other federal strategies, and potential to create synergies with other federal objectives and fields of action. A stepwise approach was adopted; this means that the climate change adaptation measures and policy instruments underwent ex ante assessment, involving an expert appraisal by the authorities' representatives. Selected topic areas were discussed within the network.

Other proposals were put forward by the federal ministries and their subordinate authorities. The final decision on which measures and instruments should be included in the APA III was taken jointly by the federal ministries. An overview of the APA III's structure and agreed measures can be found in Chapter D of this report.

[67] The network was set up in 2017 as a permanent network of federal authorities and institutions tasked with supporting the IMAA in implementing the German Adaptation Strategy (DAS). The UBA leads the network's activities and organises its regular meetings. At present, 28 federal authorities and institutions are represented in the network. Further federal institutions are invited to participate as and when additional technical expertise is required. The network provides the IMAA with support for the technical development and coordination of scientific content and proposals to improve the DAS, drawing on the results of completed and ongoing research projects. The specific content of the cooperation is regularly agreed by the network partners on the basis of work and resource planning and is submitted to the IMAA for approval.

B.4. Adaptation measures by other actors

At federal government level, the topic of climate change adaptation is not only dealt with by the Interministerial Working Group on Adaptation to Climate Change (IMAA) and the Vulnerability Network but is also addressed as a cross-cutting task by many other bodies working in areas such as sustainability, rural affairs and urban development.

Interministerial Working Group for the Implementation of the Sendai Framework

For the Interministerial Working Group for the Implementation of the Sendai Framework (IMAG Sendai), climate change and its impacts are becoming more significant in the context of disaster risk management at the national level. The Federal Republic of Germany is committed to implementing the United Nations' Sendai Framework for Disaster Risk Reduction 2015-2030.

Germany's National Focal Point for the Sendai Framework was therefore established in April 2017 by the Federal Office of Civil Protection and Disaster Assistance (BBK) on behalf of the Federal Ministry of the Interior (BMI), the Federal Foreign Office (AA) and the Federal Ministry for Economic Cooperation and Development (BMZ). Its task is to coordinate the implementation of the Sendai Framework in Germany.

The National Focal Point is the main contact for the United Nations on the Sendai process in Germany. It is tasked with ensuring reporting on the United Nations International Strategy for Disaster Reduction (UNISDR). It coordinates and supports national implementation of the Sendai Framework in Germany and the related networking, public relations and administrative activities, taking particular account of the principle of coherence that is intrinsic to the Sendai Framework. This means that in both the national and the international context, there is now more linkage between climate change, sustainable development, humanitarian assistance and disaster preparedness than before.

At the federal level, civil protection is embedded as a cross-cutting issue in the German Strategy for Adaptation to Climate Change (DAS) adopted by the federal government in 2008 and its 2015 update. Cooperation between the Interministerial Working Group for the Implementation of the Sendai Framework and the IMAA is ensured through representation on each other's committees and intensive dialogue.

National Water Dialogue

In October 2018, the BMU launched with the 1st national water forum a two-year process of dialogue on the diverse topics surrounding the future of water resources management in Germany – the National Water Dialogue. The Water Dialogue was conducted with broad-based participation of sector representatives and practitioners, the public authorities, interest groups and research, and aimed to make the German water management sector sustainable and fit for the future (see https://www.bmu.de/wasserdialog/). The discussions focused on the period to 2030 for the adoption of measures, with targets and impacts to be achieved by 2050.

Areas where needs for action were identified and impacts are expected include:

- water management infrastructures: making them climate-resilient, intermeshing with urban development;

- maintaining/restoring, at minimum, a near-natural hydrological balance; improving conditions for water resources in rural areas to be developed in a manner which preserves their natural functions, with more linkage between technical planning in the water industry and regional, spatial and land-use planning;
- responding to the predicted regional increase in competition for access to water resources.

Building on the outcomes of the National Water Dialogue, the BMU intends to present a draft of a national water strategy by summer 2021. Adaptation needs in water resources management and related sectors will form a thematic focus of the strategy.

The federal states (*Länder*)

Since the last DAS Progress Report in 2015, adaptation to climate change has become increasingly embedded as a task at the level of the *Länder*. By the time the present report was adopted, nine German states (*Länder*) had expanded and consolidated their legal frameworks for climate change adaptation, either in the form of climate legislation or an element thereof, or by including additional provisions on climate change adaptation in other specialised legislation. Adaptation strategies and/or action plans have been adopted or updated by almost all the *Länder*. Inter-departmental and inter-agency bodies have been set up to facilitate cooperation within the administration. Furthermore, an increasing number of networks exist or are being established outside the administration, e.g. with business or civil society representatives.

Some *Länder* make use of funding programmes that exist at the federal level (such as the Urban Development Support Programme, which was redesigned in 2020, and the BMU's programme to support measures for adapting to climate change) and EU level (such as the European Social Fund). In some cases, the *Länder* supplement these programmes with their own specific funding schemes. In view of the challenges posed by climate change, the need for financial support for adaptation measures has increased within the regions. In order to provide better support for the regions and municipalities, further coordination of the funding programmes existing at EU, federal and *Land* level is required.

Almost all the *Länder* carry out or are currently developing indicator-based monitoring of climate change, its impacts and adaptation measures. Many *Länder* use the federal government's Monitoring Report (see Section B.1) as a frame of reference here, complementing it with their own region-specific indicators. In 2017, the Standing Committee on Adaptation to Climate Change Impacts (StA AFK; see Section A.1), established as part of the Federation-*Länder* Working Group on Climate, Energy, Mobility and Sustainability (BLAG KliNa), requested the Expert Dialogue on Climate Impacts (*Fachgespräch Klimafolgen*)[68] to align the federal and *Land* indicators as far as possible, mainly to improve comparability of monitoring results. Most indicator systems focus on climate impacts (impact indicators); response indicators, which deal with adaptation measures, are being developed in some German states.

As with monitoring, wherever possible, the *Länder* make use of existing methodological baseline studies conducted at federal level, such as the Guidelines for Climate Impact and Vulnerability Assessments (*Leitfaden für Klimawirkungs- und Vulnerabilitätsanalysen*) (Buth et al. 2017)[69], which were developed

[68] The Expert Dialogue on Climate Impacts (*Fachgespräch Klimafolgen*) is an informal forum for discussion of climate impacts and adaptation. It brings together the Federal Environment Agency (UBA), the German Meteorological Service (DWD) and the *Land* environment agencies/institutes and is led by the UBA.

[69] The Guidelines for Climate Impact and Vulnerability Assessments were published as Recommendations of the Interministerial Working Group on Adaptation to Climate Change in 2017 and are regularly updated.

with input from the *Länder*. The aim of the Guidelines is to provide methodological recommendations on conducting climate impact and vulnerability analyses in order to standardise and improve the comparability of sectoral and cross-sectoral studies, results and assessments at federal and *Land* level. The *Länder* set their own priorities for their analyses and research projects, based on regional needs.

Methodological work already performed at federal level can also be used by the *Länder* to develop methods for evaluation of adaptation strategies. The methodology developed for the first and subsequent regular evaluations of the German Adaptation Strategy (see Sections A.2 and B.5), for example, was published in the form of guidelines[70]. The *Länder* can thus benefit from the evaluation-related activities undertaken at federal level[71].

The German Climate Preparedness Portal (KLiVO[72]) is a further example of good cooperation between the federal government and the *Länder*. This federal government portal collects data and information on climate change and adaptation to its effects. The *Länder* were involved in the portal's conceptual development, provide their own climate adaptation services and participate, for example, in the KlimAdapt[73] network. This cooperation should continue and be expanded in order to build regional actors' capacities to adapt to the impacts of climate change.

Strategic cooperation between the federal government and the *Länder* has also intensified in recent years. It ranges from work initiated by the StA AFK itself to tasks that are mainly carried out by other Federation-*Länder* bodies with the involvement of the StA AFK. In spring 2017, for example, the Federal/*Länder* Ad hoc Working Group on Adaptation to the Impacts of Climate Change in the Health Sector (GAK), led by the Federal Environment Ministry and Federal Ministry of Health, published "Recommendations for Action: Heat Action Plans to Protect Human Health" (*Handlungsempfehlungen zur Erstellung von Hitzeaktionsplänen zum Schutz der menschlichen Gesundheit*), which were developed on behalf of the StA AFK (BMUB 2017). These recommendations are aimed at the local authorities and are intended to serve as a basis for drawing up regional heat action plans. The objective of a heat action plan is to avoid heat- and UV-related illnesses and deaths by preventing exposure. The Ad Hoc Working Group is now established on a permanent basis to facilitate inter-agency dialogue on human health under climate change.

As a further example of more intensive cooperation between the federal and *Land* levels, joint approaches are agreed wherever possible in order to improve the response to the challenges posed by future climate hazards, such as faster sea-level rise. More vertical (Federation-*Länder*-municipalities) and horizontal (cross-sectoral) policy integration are extremely important. For example, adaptation-

[70] Kind, C., Kaiser, T., Gaus, H. (2019) https://www.umweltbundesamt.de/publikationen/methodik-fuer-die-evaluation-der-deutschen

[71] Due to the differing structures of the adaptation process, not only between the federal and *Land* levels but also among the *Länder* themselves, the methodology developed for the DAS evaluation cannot be applied directly to other levels. The guidelines therefore include general advice on strategy evaluation and, on this basis, offer an overview of aspects that should be considered when designing an evaluation; they conclude by identifying key elements of an evaluation.

[72] www.klivoportal.de

[73] The Climate Preparedness Portal (KLiVO), which stems from the first DAS Progress Report (2015), currently comprises the German Climate Service (DKD) and the service for climate adaptation services (KlimAdapt). The DKD is hosted by the German Meteorological Service (DWD), with the BMVI as lead ministry. The KlimAdapt office is located at the KomPass Competence Centre – Climate Impacts and Adaptation in Germany at the Federal Environment Agency (UBA), with the BMU as lead ministry. All the services provided by the DKD and KlimAdapt are presented on the KLiVO Portal.

relevant bodies of the Conferences of Ministers of the Federation and the *Länder* are being integrated more systematically into the work of the StA AFK. Increased coordination of strategic objectives across the federal and *Land* levels offers potential to intensify climate change adaptation in Germany in future.

One opportunity for more "joined-up" cooperation across the federal and *Land* levels is the permanent establishment of climate change adaptation as a topic for the bodies of the Conferences of Ministers of the *Länder*. For example, following a decision by the Conference of Environment Ministers (UMK) at its 90th session, a permanent committee on climate change was established by the German Working Group on Water Issues of the Federal States and the Federal Government (LAWA). The committee (LAWA-AK) examines the impacts of climate change on the water sector and identifies and prioritises needs for action. This includes identifying conflicts of interest between the water sector, agriculture and forestry against the background of climate change, with the aim of developing possible solutions. The LAWA-AK is intended to complement the work of the StA AFK and support the further development of the German Adaptation Strategy.

The Climate Indicators Sub-Group (*Kleingruppe Klimaindikatoren*) set up by LAWA-AK is currently developing a concept for climate impact monitoring in the water sector, which will be coordinated with work being carried out at federal level. In the medium term, this will enable coherent climate impact monitoring to be developed for the water sector, coordinated across the federal and *Land* levels. The Climate Indicators Sub-Group has developed six application-ready DAS indicators; four are based on data from the *Länder*, covering the whole of Germany. All six indicators were integrated into the 2019 DAS Monitoring Report.

In April 2019, the Conference of Agriculture Ministers adopted the Agenda for Climate-change Adaptation in Agriculture, Forestry, Fisheries and Aquaculture.[74] The Agenda identifies areas that are most affected by climate change and where there is a need for practical action. A programme of measures is currently being drafted on behalf of the Conference of Agriculture Ministers.

Municipalities

Municipalities are key players in the development of adaptation measures. The municipalities provide essential public services such as the drinking water supply, wastewater disposal, flood control, energy and local transport infrastructure. Key elements of our infrastructure, including roads, drainage, public buildings and hospitals, are, in many instances, under local authority control. This means that cities and municipalities have numerous opportunities to press ahead with adaptation. They can also capitalise on the commitment of local stakeholders and initiatives and actively support self-provision by local citizens.

The local government associations have an important role to play in climate change adaptation at the municipal level. For example, the Association of German Cities (*Deutscher Städtetag*) promotes dialogue on climate change adaptation among its member cities through its specialist commission on the environment (*Fachkommission Umwelt*), which meets twice a year. In March 2019, the association published a position paper on adaptation to climate change, setting out key demands, guidance and proposals (Dt. Städtetag 2019). The paper is based on the association's 2012 position paper, which is

[74] The Agenda is available on the Federal Ministry of Food and Agriculture (BMEL) website: https://www.bmel.de/SharedDocs/Downloads/DE/_Landwirtschaft/AMK-12-04-19-Agenda-Anpassung-Klimawandel.html

mentioned in the last DAS Progress Report. Among other things, the association is involved as a partner in the annual Municipal Climate Protection Competition (*Klimaaktive Kommune*), which is organised by the BMU and the German Institute of Urban Affairs (Difu) and recognises outstanding local climate action projects, including those focusing on adaptation.

Adaptation to climate change impacts has become increasingly mainstreamed at local level since 2015. A nationwide survey of local authorities[75] conducted online in 2018 sheds light on the DAS's implications for local authorities; it also showed how various instruments, (funding) opportunities and publications available at federal and *Land* level were being utilised, and where the municipalities identified a need for federal and, if appropriate, *Land*-level support in order to implement local adaptation measures[76].

The evaluation of the survey revealed that municipalities were most likely to take action if they themselves were affected by extreme weather events. They were also likely to act if political leaders and senior figures within the administration were convinced of the need for action and identified overlaps with topics already being addressed. In order for municipalities to initiate adaptation measures, a basic policy framework was required. More than a third of the municipalities surveyed stated that a political decision had been adopted, or was in preparation, mandating the drafting of adaptation strategies or policies. Approximately 50% had conducted or were currently working on an internal stocktaking exercise on climate change adaptation within their administration. More than a quarter of respondents had adopted or were preparing a decision on the implementation of existing adaptation strategies or policies. Overall, the majority of municipalities surveyed are already planning or implementing climate change adaptation measures. The measures mentioned most frequently are shown in Figure 6.

[75] See UBA (2019). This survey, which was not statistically representative in the wider sense, was conducted by the German Institute of Urban Affairs (Difu) on behalf of the Federal Environment Agency (UBA).
[76] 249 responses were evaluated for the study. A focus group discussion and interviews with experts were additionally conducted. The participating municipalities vary in size and are located across a wide geographical area, covering almost all the *Länder*.

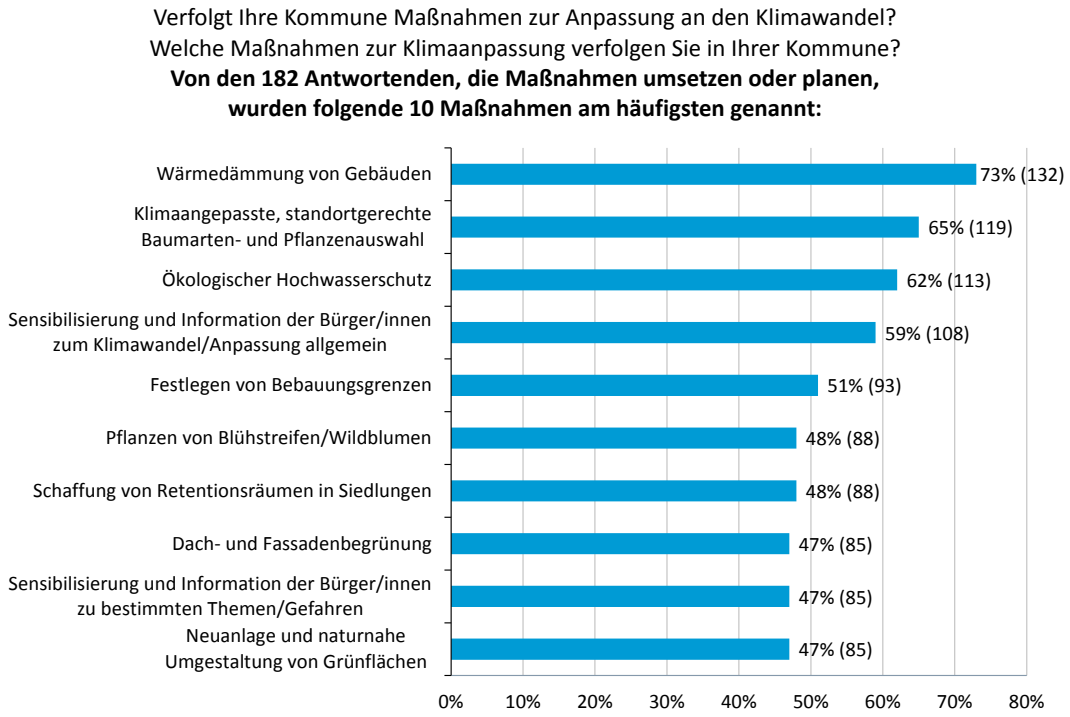

Figure 6: Implemented or planned climate change adaptation measures mentioned most frequently. Source: UBA (2019).

German	**English**
Verfolgt Ihre Kommune Maßnahmen zur Anpassung an den Klimawandel?	Does your municipality implement climate change adaptation measures?
Welche Maßnahmen zur Klimaanpassung verfolgen Sie in Ihrer Kommune?	Which climate change adaptation measures do you implement in your municipality?
Von den 182 Antwortenden, die Maßnahmen umsetzen oder planen, wurden folgende 10 Maßnahmen am häufigsten genannt:	The following 10 measures were mentioned most frequently by the 182 respondents who are implementing or planning measures:
Wärmedämmung von Gebäuden	Thermal insulation of buildings
Klimaangepasste, standortgerechte Baumarten- und Pflanzenauswahl	Selection of climate-adapted, site-appropriate tree species and plants
Ökologischer Hochwasserschutz	Ecological flood protection
Sensibilisierung und Information der Bürger/innen zum Klimawandel/Anpassung allgemein	Awareness-raising and information for the public about climate change/adaptation in general
Festlegen von Bebauungsgrenzen	Building restrictions
Pflanzen von Blühstreifen/Wildblumen	Planting of strips of flowering plants/wild flowers
Schaffung von Retentionsräumen in Siedlungen	Creation of retention areas in settlements
Dach- und Fassadenbegrünung	Greening of roofs and exteriors
Sensibilisierung und Information der Bürger/innen zu bestimmten Themen/Gefahren	Awareness-raising and information for the public about specific topics/risks
Neuanlage und naturnahe Umgestaltung von Grünflächen	Creation and near-natural redesigning of green spaces

Although many municipalities are already moving forward pro-actively with climate change adaptation, the results also show that in at least one third of the municipalities surveyed, adaptation is not being addressed at all. In these municipalities, no decisions on adaptation have been taken at political level, no action programmes are in place and no other adaptation policies or mechanisms exist (and in some cases, none are planned). Furthermore, a third of the municipalities surveyed have no personnel capacities available to deal with climate change adaptation at the local level. Very few have designated more than one full-time position to deal with this issue. This reveals the gap between smaller municipalities and larger cities: the latter are generally able to appoint more staff to deal with climate change adaptation, whereas this is often impossible for smaller municipalities; in such cases, climate change adaptation has to be addressed within the scope of the available capacities. A more comprehensive strategic approach is not achievable in these cases and adaptation measures can only be implemented sporadically.

Accordingly, the municipalities identify lack of resources for the preparation (55%) and implementation (49%) of adaptation measures as the most significant obstacle. Other obstacles also exist, such as lack of experience in climate change adaptation or poor availability of baseline data. A low level of acceptance on the part of the public, local politicians or the municipal administration can also obstruct adaptation activities.

According to the survey, public funding is most likely to come from federal programmes, the funding programme for the German Strategy for Adaptation to Climate Change (DAS), the various funding schemes for urban development, or specific funding programmes established by individual *Länder*. As well as accessing public funding programmes, three quarters of municipalities that responded stated that they used their own funds to support adaptation. Funds from research projects or third parties account for a relatively minor proportion of financial resources. With regard to staffing, 30% of the municipalities that responded have no full- or part-time positions dedicated to climate change adaptation; 19% have a part-time position amounting to at most half of a full-time post; and 26% have one equivalent to between half and a full post. Less than one in two of these posts is longer-term or permanent. “Lack of experience and inadequate baseline data” and “lack of acceptance on the part of the public, politicians and local administration” also have an dampening effect on the implementation of adaptation measures.

Many municipalities – albeit less than 50% – are aware of the principles and objectives set forth in the DAS and the Adaptation Action Plan. Among the wide range of federal instruments and services, the municipalities are most familiar with the *Kommunalrichtlinie* (Local Authorities Guideline), the BMU’s funding programme for the German Strategy for Adaptation to Climate Change (DAS) and the “Climate Navigator”[77]. Among the other products enquired about, the UBA’s website on climate impacts and adaptation was best-known. The municipalities identify shortcomings in the use of these mechanisms, services and publications.

[77] Climate Navigator (*Klimalotse*) is an online guide that assists municipal decision-makers to assess the risks of climate change and develop appropriate adaptation policies: https://www.umweltbundesamt.de/klimalotse

Non-governmental climate change adaptation initiatives

In addition to the federal and municipal activities described above, public- and private-sector companies, research and education institutions and societies, associations and foundations across Germany make a significant contribution to building capacity for adaptation to climate change. For example, regional chambers of industry and commerce, chambers of crafts and chambers of agriculture offer their members **training and awareness-raising on dealing with the impacts of climate change**. Support in responding to specific extreme weather events is also a focus of some associations' work. For example, the German Association of Local Utilities (VKU) provides advice for its members on how to cope with heavy rainfall, offering a range of training, qualification and process management services.

Adaptation to climate change impacts is increasingly being considered in the context of standardisation as well. The **German Institute for Standardization (DIN e. V.)** develops standards for managing the impacts of climate change and shares German expertise in international standard-setting bodies[78]. The Institute also supports the integration of aspects of climate change into existing national and European standards, e.g. by developing practical guidance and support for standardisation bodies[79]. The Institute's environmental protection coordination unit (*Koordinierungsstelle Umweltschutz*) offers support with the systematic assessment of relevant standards and projects. A current example of an adapted standard is VDI 3787 issued by the **Association of German Engineers (VDI)** on urban and regional planning and building. APA III lists the contributions made at the federal level to this field of work.

The Federal Environment Agency (UBA) regularly recognises highly innovative adaptation projects implemented by businesses, research institutes and associations through its **Blue Compass** (*Blauer Kompass)* awards[80]. The purpose of this competition is to identify outstanding initiatives and publicise them nationwide in order to demonstrate what climate change adaptation might look like in practice. Within the DAS framework, it is an important communication tool for promoting self-provision in relation to climate risks.

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[78] For example, ISO 14090:2019-06 is an international standard which sets out principles, requirements and guidelines to help organisations adapt to climate change. This standard was developed with substantial support from Germany and was published as a European and national standard in early 2020 (DIN EN ISO 14090:2020-02). Another international standard, ISO 14091, is currently being developed; it provides guidelines for assessing the risks related to the potential impacts of climate change. This standard draws substantially on experience with the German government's Vulnerability Analysis. Its publication as an international, European and national standard (DIN EN ISO 14091) is expected in late 2020.

[79] See, for example, CEN-CENELEC Guide 32 ("Addressing climate change adaptation in standards") and DIN SPEC 35220 ("Adaptation to climate change – Projections on climate change and ways for handling uncertainties").

[80] For more information and details of the 2018 award winners, see: www.umweltbundesamt.de/blauerkompass

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B.5. Evaluation of the DAS strategy process

In the context of further development and continuous optimisation of the adaptation process, the German government stated in its 2015 Progress Report that the DAS process should be evaluated regularly. The evaluation aims to highlight successes, identify critical points and develop recommendations to improve the process. In addition to generating in-depth findings about the DAS process (knowledge function) and reviewing the implementation of measures (monitoring function), the evaluation seeks to document the achievement of objectives (legitimation function) and, not least, establish a basis for learning from the process (learning function) with regard to the implementation of the DAS as a whole or of individual adaptation measures.

Accordingly, the specific mandate arising from the 2015 Progress Report (p. 98) reads as follows: "The IMAA will evaluate the activities of the federal government regarding the DAS process and the state of implementation of APA II on a regular basis in order to assess the progress made in adaptation to climate change in Germany and in order to make adjustments, if necessary. For this purpose, the IMAA will develop an approved methodology, based on which the working group will perform the first evaluation at the latest by 2019."

During the previous reporting period, a methodology was developed[81] for the evaluation of the DAS. This methodology was discussed with the relevant actors and approved by the IMAA. The IMAA subsequently approved the commissioning of an independent evaluation of the German Adaptation Strategy on the basis of the methodology; the evaluation was organised by the Federal Environment Agency (UBA) within the framework of a research project[82].

The methodology is based on a logic model designed specifically for the evaluation (see Figure 7 and report by Kind et al. (2019)). The following figure shows how activities at political level can ultimately produce outcomes that reduce vulnerability and improve adaptive capacity:

[81] "Evaluation and further development of the DAS" (FKZ UFOPLAN 3715 41 106 0); for results and documentation, see Kind, C. et al. (2019) https://www.umweltbundesamt.de/publikationen/methodik-fuer-die-evaluation-der-deutschen

[82] "Performance of a policy analysis for the evaluation of the German Strategy for Adaptation to Climate Change (DAS) – Policy analysis DAS" (FKZ UFOPLAN 3717 48 199 0).
The evaluation was conducted by the Center for Evaluation (CEval, Saarbrücken) and adelphi (Berlin). The results are documented in the Evaluation Report; see Gaus et al. (2019) https://www.umweltbundesamt.de/publikationen/politikanalyse-zur-evaluation-der-deutschen

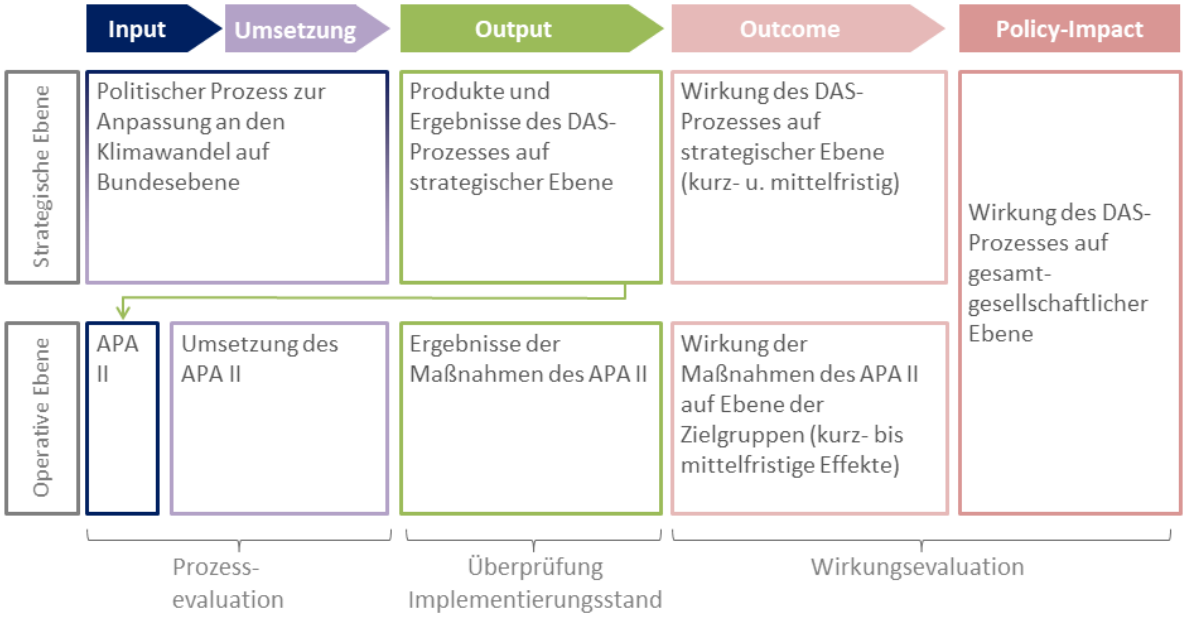

Figure 7: Logic model for DAS process evaluation. Source: Kind et al. (2019, p. 12)

English version of this Figure is on page 12 of: Methodology for the Evaluation of the German Adaptation Strategy – Report

The logic model comprises a strategic level and an operative level. The strategic level represents the policy process for developing and improving the DAS. The operative level shows the implementation of the DAS, focusing on the Adaptation Action Plan II. Against this background, five key evaluative questions were defined[83] and were addressed using a multi-method approach (interview series, document analysis, survey on APA II implementation status, Delphi survey).

The key findings and recommendations at strategic and operative level, as formulated by the independent evaluators, are summarised below:

[83] The following five key evaluative questions were defined: 1. Are the framework conditions suitable for working on the DAS process (for example exchange and coordination, structures for horizontal and vertical cooperation, resources etc.)? 2. What is the APA II implementation status? 3. To what extent has climate change adaptation been suitably embedded (long-term task and mainstreaming)? 4. To what extent has the DAS process led citizens and companies to increasingly assume their responsibility to adapt to climate change (self-provision)? 5. To what extent has the DAS process contributed to reducing vulnerability to climate change impacts?

Strategic level

The priority attached to adaptation varies across the federal ministries: in some cases, it is strongly embedded, for example in the form of specialised thematic units; in others, climate change adaptation is not a key focus of attention, for example if the impacts of climate change appear to be minor or if current resourcing does not allow the topic to be prioritised.

The results of the evaluation warrant the conclusion that there should be stronger institutionalisation of climate change adaptation within the ministries and, associated with that, deeper inter-departmental cooperation (horizontal integration). In addition to this requirement for deeper inter-departmental cooperation, the evaluation identified a need for improved cooperation between the federal government and the *Länder*, with a stronger strategic focus (vertical integration). The existing cooperation between the federal government and the *Länder*, according to the interview findings, is regarded as good, albeit with scope for expansion; in particular, from a *Länder* perspective, the legal bases for climate change adaptation should be strengthened and financial support from the federal level should be expanded, with due regard for Germany's federal structure, in order to improve implementation. The federal government can achieve this, for example, by integrating climate change adaptation into federal funding mechanisms, thus creating scope for investment.

Climate change adaptation requires clear and specific goals if measures are to be effective. The results of the evaluation show that the federal government should define the objectives of climate change adaptation more precisely in its strategy documents (e.g. Progress Reports). The objectives defined in the DAS and the 2015 Progress Report (reduce vulnerability and improve adaptive capacity) provide general orientation but make it difficult to assess to what extent the objectives have been or can be achieved; objectives have been insufficiently specific up to now. Combined with this, the evaluation shows that the DAS documents should be more future-focused; in other words, they should set specific visions and targets for climate change adaptation.

For climate change adaptation to be embedded within society, governmental and non-governmental actors have a key role to play. It was noted in the evaluation that participatory processes were conducted in the ministries, but are not embedded on a comprehensive and systematic basis in the implementation and further development of the DAS. It is therefore recommended, in the DAS evaluation, that participation and consultation be expanded in order to mainstream adaptation more broadly within society and give due consideration to social and justice issues in climate change adaptation.

Operative level

Adaptation measures have the greatest impact if they are focused on areas of greatest need. The evaluation shows that this is not always the case; it therefore recommends establishing direct linkage between 1. substantial need for action; 2. systematic selection of appropriate adaptation measures; and 3. prioritisation of these measures. The planning of measures must focus on those climate impacts where there is a substantial need for action and be more strongly oriented towards implementation. This means that persons responsible for the measures must actually be in a position to implement them (see above: facilitating access to investment funds). The DAS evaluation recommends strengthening the federal government's role as a model of best practice in the implementation of measures. This can be achieved, for example, by building the climate resilience of federally owned buildings, properties and infrastructures, thereby enhancing the federal government's role as an initiator.

The effectiveness of adaptation measures is in some cases directly visible – one example is the impact of blue and green infrastructures in reducing the heat island effect in densely populated regions/cities. In others, however, it takes time for measures to have an effect. In many cases, it is (methodologically) difficult at present to make robust statements about the effectiveness of measures identified in APA II. The evaluation therefore recommends improving the impact assessments of measures and the DAS as a whole.

A key element of the DAS is improving self-provision by citizens and companies. The evaluation shows that while some initial attempts are under way, much more must be done to strengthen self-provision, e.g. through more comprehensive awareness-raising measures and other services – provided, for example, by the federal government – which would enable the public and businesses to identify and implement measures of their own. To that end, more should be done to ensure that the DAS funding programme, which has existed since 2011 and is utilised by some municipalities, reaches business and the public to a greater extent.

In Chapter C of the Progress Report, the conclusions drawn by the IMAA from the evaluation are discussed in more detail.

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C. Conclusions of the Interministerial Working Group on Adaptation to Climate Change

The DAS is evidence of the German government's commitment to active management of adaptation to the impacts of climate change. It provides the strategic framework for the federal government's policy instruments and measures and helps to mainstream adaptation in all realms of society and among the relevant stakeholders. The DAS thereby makes a key contribution to fulfilment of Germany's commitments under the UN Paris Agreement (COP 21, 2015) and to implementation of the 2030 Agenda for Sustainable Development.

The DAS has also succeeded in combining and focusing the activities and capabilities of the German government's ministries and other stakeholders in the public and private sectors. This has enabled integrated consideration of climate change adaptation, the DAS becoming a key element in various policy fields and action areas. This is also due to the constructive collaboration between the government departments and their subordinate agencies within the Interministerial Working Group on Adaptation to Climate Change (IMAA) and the federal authority climate adaptation network, as well as the relevant joint federal/*Länder* bodies.

The DAS has become established on a permanent footing. Adaptation processes at all levels are being implemented continuously, while a need for strategic work remains. These activities need to be consolidated and expanded at a high level, and the capacities of stakeholders responsible for implementing adaptation measures need to be strengthened further. This Chapter takes the form of a programme of work: it outlines how the German government plans in the coming reporting period (2020 – 2025) to develop the DAS policy and strategy process on the basis of the evaluation results in order to create the right conditions for boosting adaptive capacities at all levels.

C.1. Vision and goals of the DAS process

Specify vision and goals

Clear visions and verifiable goals facilitate efficient implementation of policy processes in society, politics and business. The aim of the DAS is to reduce the vulnerability of society, the economy and the environment to climate change impacts and to maintain and enhance their adaptive capacity. Within the setting established by these goals, the IMAA will work with the *Länder* to produce a vision for a climate-resilient Germany in 2060 with a time horizon extending to 2100; in so doing it will take account of the timetable of the EU Adaptation Strategy. As part of the vision for a climate-resilient Germany, specific, transparent and verifiable climate adaptation targets for Germany will be stated for the individual action areas. The IMAA will illustrate the conditions under which these targets are achievable.

Review and supplement action areas

The IMAA will review the existing 15 action areas with regard to current vulnerabilities and add other relevant areas as appropriate, such as telecommunications infrastructure / digitalisation or cultural heritage.

C.2.The enabling environment

Adaptation to climate change impacts requires an enabling environment so that the goals pursued by the DAS can be achieved. The key requirements include continuity of horizontal and vertical cooperation and coordination, identification of appropriate measures and appropriate provision of human and financial resources while utilising synergies and avoiding duplication of structures and remaining within the bounds of the resources available within the individual ministry budget items. Efficient organisational structures must ensure the optimal use of resources and involve the relevant stakeholders. The German Strategy for Adaptation to Climate Change has shown that coordinated action by the federal government, the *Länder* and the municipalities, each in their own spheres of responsibility, is the right approach to implement adaptation policies. This approach should be continued and intensified.

Continue to strengthen the legal basis for adaptation to climate change

Reviewing the legislation relevant to their areas of responsibility is one of the permanent core tasks of all government ministries. Much technical legislation – including that on land use, construction planning and urban development – already covers aspects of adaptation to climate change. In the next reporting cycle the IMAA will highlight how adaptation aspects can be specified in more detail in other areas of legislation, which will have the effect of giving such aspects greater weight. Within the bounds of their individual responsibility, the departments involved in the IMAA will also determine the scope for secondary legislation. Moreover, they will strengthen enforcement, in part by incorporating further precautionary aspects into the setting of standards. In addition, the federal government and the *Länder* will continue to discuss how the framework for municipal adaptation can be strengthened so that precautions against climate risks are taken on the necessary scale in all parts of Germany.

Ensure that collaboration and networking is strategically oriented

At the following levels the federal government will further expand the existing structures for cooperation with the *Länder*, municipalities and other societal actors on the implementation of adaptation strategies and action plans:

Further develop cooperation between the federal government and the Länder: The federal government and the *Länder* are stepping up their already good cooperation in the field of adaptation and paying more attention to conflicts of use that arise from climate change impacts, for example in connection with water use and land use. To put Germany in a climate-resilient position with regard to sea-level rise over the long term, the federal government and the *Länder* will draw up, in close consultation, a strategy for dealing with sea-level rise; in this strategy they will also consider the consequences for the inland parts of the country. In the light of this they will evaluate the special framework plan of the federal/*Länder* Joint Task for the Improvement of Agricultural Structures and Coastal Protection (2009 – 2025); the subject of floods in inland areas also continues to need detailed collaboration with the *Länder* in the context of the National Flood Protection Programme (NHWSP).

Activate key adaptation actors and expand networks: As part of their usual administrative activities, the central DAS bodies – the IMAA and the federal authority climate adaptation network – assist key actors in devising and implementing networking activities in order to mainstream future adaptation to climate change in the regions and increase consideration of it across society. The federal/*Länder* body,

the Standing Committee on Adaptation to Climate Change Impacts (StA AFK), makes an important contribution in this area. The IMAA is examining the extent to which – in the light of the availability of financial resources within the ceiling of individual budget items and in consultation with the *Länder* – collaboration with other actors can be stepped up, for example by setting up an annual municipal conference for the purpose of dialogue with the municipalities or a national climate preparedness congress for cross-disciplinary communication between policy-makers, administrations and the specialist community.

Advisory council on climate preparedness: The establishment of a council as an advisory body has already proved invaluable in other areas and has contributed to the better involvement of civil society. The IMAA will therefore consider setting up an advisory council on climate preparedness whose members could, for example, comprise representatives of municipal umbrella organisations, the academic community, associations and civil society (including voluntary positions). The advisory council's tasks will include regularly drawing up suggestions for the further development of adaptation policy on the basis of societal needs and scientific findings, and identifying relevant areas in which further research is needed.

Research and operational data services: Efficient, consistent and appropriate development and implementation of adaptation actions depends on robust knowledge of climate impacts, vulnerabilities, action options and the impact of adaptation measures. Closing knowledge gaps and ensuring up-to-date information on advancing climate change calls for further research, for example through research and development projects. Also required are operational data services such as the DAS "Climate and water" open service and the Climate Preparedness Portal KliVO. Research and operational data services need to be implemented, expanded and continued. The "Climate and water" open service is still in the establishment phase and has not yet reached its full potential. Building on research results and other available knowledge, the service will at operational level provide a permanent source of predictive and projection data and user-friendly services for the adaptation actions needed in Germany.

Institutionalisation and operationalisation of international reporting commitments and processes in the context of the EU Governance Regulation: The EU Governance Regulation places a large-scale new reporting commitment on Germany. For example, previously unavailable data on the costs of damage and adaptation measures, and information from the *Länder* and municipal levels will have to be collected and reported. To achieve this, Germany must create the institutional and methodological basis that will enable it to deliver climate change adaptation reports to the European Commission in a two-year cycle. To utilise synergies, this work will be closely connected to the coordination office for DAS monitoring at the Federal Environment Agency and consulted on with the IMAA.

DAS reporting system and products: The IMAA will monitor the timing and interlinking of the German Adaptation Strategy's reporting system (monitoring report, vulnerability analysis, progress report). As part of this, the following will be considered: the steps in the climate adaptation policy cycle (see Section A.2), and the opportunities to make greater use of the findings of the monitoring and evaluation processes, both in future action plans and in future DAS progress reports. The IMAA and the DAS monitoring coordination office at the Federal Environment Agency will draw up and implement a proposal for the future DAS reporting system.

Secure financing

Adequate human and financial resources are vital to preparedness for climate change impacts. Because of the nature of adaptation as a cross-cutting task, there are a large number of funding instruments and financing mechanisms in the various DAS action areas at federal and *Länder* level. To date, though, there has been no synopsis of the funds used directly and indirectly for adaptation. This information is increasingly being requested – e.g. at EU level – as a key element of status reports on adaptation financing.

In light of this the IMAA will play a coordinating role in developing a methodology that can be used to depict direct and indirect expenditure on adaptation, including in cross-sectoral areas. The IMAA can be supported by the Federal Environment Agency or the federal authority climate adaptation network. The IMAA will be continuously involved and will decide whether the methodology is appropriate and how it should be designed in order to make it as useful as possible. The account of the financial resources expended on adaptation can be supplemented by textual descriptions. The aim is to use standard criteria and a common procedure to identify the financial resources from the federal budget that are already being invested in adaptation and to take an inventory. This inventory of government expenditure will make the extent of the federal government's numerous climate preparedness activities in the individual action areas more visible than has been the case in the past.

At the same time, the IMAA will explore in more depth the question of what financial needs for adaptation investment actually exist. This will also involve considering and expanding the existing findings on damage potential and the costs of inaction (see Section B.2). The consideration of financial needs will be based on the objectives of the DAS (see C.1 above). Drawing on scientific studies, the IMAA will explore damage potentials and the economic impacts of climate change and adaptation measures in Germany ("What is the cost of inaction?"), including the cultural and environmental impacts.

An overview and balance sheet of the stated aspects will make it possible to benchmark the appropriateness of the German government's activities addressing climate change impacts.

On the basis of this benchmarking, it will then be possible to work with the *Länder* to identify needs for action and draw conclusions about the financing instruments. With this in mind the government departments will in the coming reporting period start to review the existing federal programmes relevant to adaptation in terms of whether they meet requirements and serve goals. They will consider whether in their view there may be a need to optimise financial and human resources for implementation of the third Adaptation Action Plan (APA III). Where still necessary, they will also draw up proposals on how the measures for adapting to climate change impacts can be better addressed in existing funding programmes (e.g. by specifying the funding conditions) and on whether it is necessary to set up new funding programmes.

Within the limits of its constitutional competencies and available budgetary resources, the federal government will ensure that the financial and human resources are aligned with federal objectives in each ministry. Any additional requirements within the constitutional competencies of the federal government are to be met in terms of financing and staff posts via the individual departmental budget plans, without prejudice to future budget negotiations. The federal government will review whether, in addition to the embedding of adaptation in the departmental programmes, it is possible to create a budget item for the federal government's cross-cutting adaptation actions. This would enable account

to be taken of the fact that, in addition to the particular programme-specific funding purposes, overarching adaptation management at federal level within a systematic approach is essential.

In order to also expand its function as a catalyst in the funding of adaptation and create incentives for integrated and sustainable adaptation, the federal government will target the funding of innovative adaptation projects more precisely. As part of this, it will strive to include those actors (e.g. municipalities) that as yet have little experience of climate preparedness.

The various funding programmes operated by the *Länder* provide broad-based municipal funding that promotes the climate resilience of the municipalities nationwide. Within the scope of its constitutional competencies and available budgetary funds, the federal government makes studies of damage potentials and methods available to the *Länder* where required.

When taking out large loans or insurance policies or making investment decisions, private enterprises are increasingly being required to consider the risks of climate change and state what precautions they are taking. The federal government therefore supports national and international initiatives on disclosing climate-change-related risks and other changes. It supports international activities in connection with the systematic evaluation of the climate resilience of private investment and evaluation of organisations' standards for managing adaptation to climate change impacts, as well as activities seeking to establish a taxonomy of sustainable adaptation financing.

C.3.Selecting measures

As the state of knowledge with regard to risks and vulnerabilities improves, the impacts of climate change become increasingly recognisable and the allocation of resources becomes increasingly targeted, implementation of the DAS through concrete measures moves ever further into the spotlight. In this connection, the federal government will in future set a special priority:

Taking account of disparate social situations

The IMAA will in future give greater consideration to the disparate adaptive capacities of different sections of society (differentiated according to low-income and affluent households, gender, age, etc.) and align the DAS instruments and measures in a more strategically targeted manner with the concrete adaptation needs of specific groups. This will contribute to social equity and environmental sustainability.

The federal government's assessment of climate impacts and effectiveness

Within the scope of its constitutional competencies and available budgetary funds, the federal government will fulfil its leading role by doing more to implement necessary adaptation actions within its own sphere of responsibility. The ministries of the IMAA will strive to ensure that new strategies, measures and programmes and ones that are due for revision are examined to determine whether there are synergies in relation to adaptation, whether there are possibly conflicting objectives and how they can if necessary incorporate corresponding requirements.

The measures in the Adaptation Action Plan will in future be compiled in a more transparent and easily understood way by providing an estimate of the impact of measures wherever possible. As part of this approach, the measures to be drawn up via the federal authority climate adaptation network will be appraised on the basis of the urgent climate impacts and requirements for action that arise from the

climate impact and vulnerability analysis and of a criteria-based individual assessment that is to be drawn up. Wherever possible, these measures will be assessed in terms of their effectiveness and harmonised with other sustainability goals. The IMAA will coordinate a procedure for this.

To improve assessment of the overall impact of the DAS, the evaluation methodology will also be refined. This aspect will become increasingly important as implementation of the DAS proceeds. The IMAA will create the necessary prerequisites in early 2021 – in good time before the start of the next evaluation.

Measures by other actors

In order to enhance the effectiveness of the federal government's action planning, the instruments and measures of the *Länder* and other actors in Germany will in future be included in the federal government's action plans for information purposes; this will occur as necessary and in close consultation with the actors concerned. In order to make it easier for actors who have not yet addressed adaptation to climate change in any detail to make a start in this area, the possibility of including recommendations for municipalities will be considered in the DAS in close consultation with the municipal umbrella organisations.

C.4.Communication and participation

Responsibility for implementing measures in the field of adaptation to climate change does not lie solely with the federal government; the *Länder* and municipalities, the general public and businesses must also play their part in this task, which is for the whole of society. Active participation of all actors is necessary in order to address the appropriate (responsible) level in a particular case and enable it to identify the risks arising from climate change, assess their impact and take action where necessary.

Expanding participation and boosting private provision

In the context of the DAS process, the IMAA persistently seeks the participation of stakeholders on a broad basis. Via discursive participation procedures and dialogue formats it will involve other stakeholder groups, such as organised civil society and business and industry, even more closely in order to align the federal government's activities with their needs and to trial and demonstrate examples of good practice at regional and local level.

An important aspect of adaptation is effective strengthening of private provision by citizens and businesses in areas outside the responsibility of the state. Private actors must therefore be informed about possible risks and enabled to take steps towards adaptation themselves. Many strategies and measures for adapting to climate change that lie within the decision-making scope of private households and businesses and are also in their own interest can usefully supplement – but not replace – state action to reduce the risks that arise from the impacts of climate change. This requires the development of schemes tailored to specific target groups that address the particular factors determining private provision in these target groups and also take account of their economic situation.

The ministries represented in the IMAA will to this end expand their activities in the field of press and awareness-raising work. In addition, the Federal Environment Agency provides instruments that can be employed to systematically assess and review the effectiveness of the participation procedures and formats used.

Specifically addressing decision-makers

Another factor determining the success of adaptation to climate change is the involvement of decision-makers and multipliers in areas such as public administration, agriculture and forestry, the fire service, associations and the private sector who frequently have to deal with climate change impacts. As a key basis for the implementation of adaptation measures, the ministries represented in the IMAA will accord high priority, within the scope of their competencies, to the communication of knowledge and appropriate training schemes for decision-makers. Regional events, competitions and sponsorship schemes that enable municipalities to offer mutual advice and support can create a targeted means of address and additional incentives for the municipalities.

The ministries represented in the IMAA will review the permanent funding of the German Climate Preparedness Portal (KliVO) to the end of 2022 and work closely with the subordinate agencies on adding to the content of KliVO.

Another communication instrument in the context of the DAS is the Blue Compass competition (www.umweltbundesamt.de/blauerkompass), which grants awards to outstanding climate adaptation projects, thus highlighting and upscaling concrete solutions. The IMAA aims to continue the competition on a two-yearly cycle and is exploring opportunities for permanent funding, primarily through the Federal Environment Ministry's departmental budget.

Permanent continuation of consultation

The consultation with the *Länder*, municipal umbrella organisations, economic, environmental and social associations and other civil society organisations on the progress reports will be established as a fixed component of the DAS process and in particular of the progress report.

D. Political priorities

Effective climate change preparedness in Germany can only be achieved through concerted action by the federal government, *Länder* administrations, municipal authorities and civil society groups. The current findings and outcomes relating to climate impacts and adaptation actions set out above (Chapter B) underscore this. The IMAA's conclusions derived from those findings (Chapter C) point to three fields that will become particular priorities for the further strategic development of the DAS in the coming reporting period:

- Developing a vision for a climate-resilient Germany in 2060 and defining specific, transparent and verifiable goals for that purpose. The IMAA will work with the *Länder* to produce this vision with a time horizon extending to 2100. In so doing it will take account of all relevant points in the timetable of the EU Adaptation Strategy. The IMAA will illustrate and characterise the conditions under which the goals set for the various action areas in the vision are achievable.
- Improving appraisals of effectiveness when developing actions to be included in the Adaptation Action Plan. The actions proposed by the federal authority climate adaptation network underpin discussions. The effectiveness of these actions is to be appraised in future, wherever possible. The network's proposals are based on the urgent climate impacts and requirements for action that arise from the climate impact and vulnerability analysis, and on criteria-based individual assessments. The IMAA will seek agreement on a procedure.
- Taking stock of the federal government's adaptation expenditure, including the anticipated benefits of such expenditure in the various fields, and surveying the damage potential and economic impacts of climate change and adaptation actions in Germany. The Federal Environment Agency will assist the IMAA in developing the methodology for such stock-taking exercises and the federal authority climate adaptation network will be involved.

Adaptation Action Plan III: Federal policy instruments to reduce Germany's vulnerability to climate change

The three policy priorities set out above will be pursued within the framework of the concrete policy instruments available to the federal government to reduce Germany's vulnerability to climate change. These are reflected for the coming five years in the third Adaptation Action Plan (*Aktionsplan Anpassung* – APA III), which is presented in the following.

APA III activities are grouped in clusters: "Water", "Infrastructure", "Land", "Health", "Economy" and "Spatial Planning and Civil Protection". Activities that cut across action areas, such as the provision of data and information services, or adaptation financing, are grouped in the "Cross-cutting" cluster. The following sections briefly profile key actions in each cluster.

Mechanisms and actions in the water cluster

The **National Flood Protection Programme (NHWSP)** will be carried forward to tackle the growing risks of flood events in a coordinated manner across all *Länder*. The "Preventive flood protection" special framework plan of the federal/*Länder* Joint Task for the Improvement of Agricultural Structures and Coastal Protection provides federal funding for this purpose, co-financed from *Land* resources. The federal government will urge harmonisation of **flood hazard maps** in the course of their updating. **Restoring to a more natural state** the watercourses regulated as waterways and in federal ownership, together with their floodplains, through the **federal government's Blue Belt Germany programme** contributes to flood protection. It also fosters attainment of "good ecological status" or "good ecological potential"[84] of watercourses. Particularly where inland shipping on waterways undergoes change, opportunities arise to improve the hydromorphology of water bodies and their ecological continuity, and to improve the status of floodplain areas.

Climate change may lead to lengthy dry periods (as experienced in 2018 and 2019). Problems then arises in terms of water resource shortages, which lead to competition over use of the available resources (for potable water, agricultural irrigation, water storage for fire extinguishing, inland shipping, etc.). To **resolve such conflicting uses in future periods of drought**, proposals shall be made that concretise human potable water requirements, which may have priority, in order to determine a potential hierarchy of water uses where conflicts arise. There is also a need to analyse across the *Länder* the risks posed by more low-flow events, and thereby to **develop a foundation for systematic and structured handling by the federal government and *Länder* administrations of low-flow and drought issues**.

At the level of the *Länder* bearing a constitutional responsibility for these matters, numerous measures are already in place to handle flood events, low-flow situations and the impacts of sea-level rise. The federal government will continue to broaden its cooperation with the *Länder* in these fields within the scope of its competencies (see above, Chapters B and C).

A mounting risk of heavy rainfall events causes flood hazards to increase. Municipal authorities have an obligation to take precautions against this. APA III provides for elaboration of a **guideline on the preparation of hazard and risk maps for local heavy rainfall events**. The guideline should define minimum standards for the production of hazard and risk maps; it builds upon the LAWA strategy for effective heavy rain risk management (see Section B.4). Moreover, the **potential of decentral rainwater harvesting in residential areas and industrial zones** should be examined. This can help to maintain a natural water regime and avoid having to install larger sewage piping diameters that may become necessary in the course of climate change.

Furthermore, **extreme events and damage are to be recorded systematically**. In order to be in a position to better quantify the extent and frequency of meteorological and hydrological extreme events and the damage and environmental impacts caused by them, Germany shall set up a database documenting (past) events, modelled on those already established in other countries.

Mechanisms and actions in the infrastructure cluster

In thematic area 1, "**Adapting transport and infrastructure to climate change and extreme weather events**", the BMVI network of experts will produce a climate impact analysis for the types of transport

[84] In accordance with the stipulations and definition of Directive 2000/60/EC (Water Framework Directive).

infrastructure: roads, railways and waterways. The purpose of this analysis will be to gain an understanding of the potential impacts of climatic effects and natural hazards upon federal transport infrastructure.

Beside damage caused by extreme weather events, climate change leads to increasingly frequent heatwaves, which can cause indoor temperatures in buildings to rise. APA III therefore makes provision for the **integration of climate resilience aspects in construction (new-build and the building stock) in the context of funding programmes**. The aim here is to design buildings such that steps are taken to counter the rise of indoor temperatures in the wake of climate change, and to do so in a manner with minimum climate impact. This can be achieved by, for instance, summertime thermal insulation approaches (shading) or evaporative cooling.

Furthermore, the **climate-smart building construction** mechanism ensures that available findings and knowledge about extreme weather events is taken up in technical rules and standards governing the maintenance, repair and new construction of buildings. In the context of funding programmes this can help to recognise major hazard potential early on and minimise damage events substantially. The tools envisaged include assessment guidance and regional safe load tables.

Within the sphere of competence of the Federal Waterways and Shipping Administration (WSV), concrete steps are under way to integrate the aspect of climate change systematically in planning processes. Such WSV climate proofing integrates data services, guidelines and training programmes.

Mechanisms and actions in the land cluster

It continues to be a core task of agriculture to provide appropriate nutrition for a growing global population in a sustainable manner. However, farming and forestry are affected particularly by climate change impacts, as are fisheries and aquaculture (as experienced in 2018 and 2019). In response, the Federal Ministry of Food and Agriculture (BMEL) already began in the autumn of 2018 to formulate an adaptation agenda for agriculture, forestry, fisheries and aquaculture; the process involves the *Länder* administrations, the BMU and departmental research programmes. The agenda is based on DAS guidelines, and shall become an integral part of them hereby.

The adaptation agenda for agriculture, forestry, fisheries and aquaculture was adopted in April 2019 by the conference of agriculture ministers. A programme of action is currently being finalised. This will comprise both actions serving as immediate responses to acute extreme weather events, and actions for long-term adaptation of farming and forestry to changing weather patterns. Five fields of action have been defined: plant production (specialty crops and arable crops), forests, livestock, fisheries and aquaculture, and overarching issues. For each of these fields of action, expert groups have produced catalogues of actions. The overarching issues include research on adapting crops and varieties through breeding activities, actions to preserve and utilise genetic resources, and ways to bring about climate-smart and site-appropriate crop rotations and variety selection.

Climate change can put at risk the very survival of native species. APA III therefore promotes the **development of viable, nationwide habitat networking**. The aim here is to create opportunities for species and habitat types to persist, and to facilitate geographic adaptation of organisms in the wake of climatic changes. One approach here is to **optimise the habitats of climate-sensitive and/or endangered species to improve their resilience and adaptive capacity**, e.g. by setting aside sufficiently large

areas providing habitat protection functions. The **Federal Programme for Biological Diversity** implements the National Biodiversity Strategy, the "ecosystem services" funding priority of which explicitly makes provision for actions to safeguard capacity to adapt to climate change.

To gain a better understanding of the changes in and rapid decline of species diversity, the BMBF launched in 2019 its **research initiative for species diversity conservation**, which is a FONA lighthouse initiative. This will substantially advance biodiversity research, pool relevant research activities, and make a sustained contribution to countering the ongoing loss of biological diversity.

Through a **programme securing the extent of and rewetting bogs and fens**, it is envisaged that, initially, individual pilot projects for mire soil conservation are to be carried out with federal funding. In addition, under the Climate Action Plan and with EKF funding, actions are planned to substitute peat uses and to establish a mire conservation programme in agriculturally utilised areas.

Furthermore, a **climate impact soil monitoring network is to be set up and established as a long-term scheme**. The purpose of this mechanism is to record, monitor and document, throughout the territory of Germany, the current status of soils and the changes resulting from climate change. To this end, the network will ensure simplified access to soil-related measurement data for users in academia and administrations, will coordinate and network the activities of measurement system operators and users, and will integrate diverse levels of measurement intensity.

Creating climate-resilient forests in federally owned stands involves the stable, structurally rich and site-appropriate development of mixed forests. Activities here are guided by state-of-the-art research. the **Forest Climate Fund (WKF) funding scheme** shall be used to implement actions of particular federal interest that serve forest adaptation to climate change and preserve the indispensable contributions that near-natural, structurally rich and species-rich forests make to safeguarding the natural bases of life in the long term. The positive effects in terms of harnessing the energy potential and CO2 reduction potential of forests and timber are to be amplified. In addition, promoting forest adaptation to climate change is to be advanced in the context of the federal/*Länder* Joint Task for the Improvement of Agricultural Structures and Coastal Protection.

Mechanisms and actions in the health cluster

Climate change will lead to extreme weather events in Germany, such as increasingly frequent heatwaves. The heat exposure associated with such events is currently one of the largest impacts on human health. Particular attention is therefore devoted to this aspect and actions adopted accordingly. These include **information for the wider public or for health professionals**, and developing **outreach to particularly vulnerable groups of the population** (e.g. the elderly, people with pre-existing conditions, children).

To handle heatwaves better, it is essential to study the effects of mechanisms adopted and to use the findings to develop further actions. To this end **a survey, analysis and evaluation of existing heat action plans** will be carried out.

The existing provisions and applicable **state rules on occupational safety and health** with regard to heat and UV radiation will be reviewed, and any need for amendment determined. This concerns, for instance, the Technical Rules for Workplaces (ASR). Furthermore, the **Ordinance on Preventive Occupational Healthcare** (*Verordnung zur arbeitsmedizinischen Vorsorge* – ArbMedVV) will be evaluated

with regard to its thresholds for preventive checkups for occupations involving outdoor activities subject to intensive exposure to natural UV radiation.

A further action in this cluster is the study of pathogenic **modes of action of new pollen allergens**, as exemplified by Ambrosia artemisiifolia. In addition, **trend analyses of imported vector-borne infectious diseases in Germany** will be carried out. To this end, the RKI continuously evaluates the surveillance data on imported vector-borne infectious diseases at national level and publishes the key findings.

Furthermore, steps are under way to **improve the integration of health and environmental monitoring**, so that existing structures can be used in the framework of an integrated surveillance system at federal level to monitor health-related environmental factors and assign them to health impairments.

Information and early warning systems will be adjusted and expanded, whereby the channels of information and the forms in which it is transmitted will be adjusted to match all target groups. This action area includes establishing and refining warning systems for medical and nursing facilities and the population groups concerned, and integrating heat, UV and air pollutant exposures into suitable early warning systems.

Mechanisms and actions in the economy cluster

To ensure the safety of technical and industrial facilities during extreme events, APA III provides for **review by the Commission on Process Safety (KAS) of the Technical Rules on Plant Safety 310 (Precipitation and floods) and 320 (Wind, snow and ice loads), including requirements for updates to reflect recent findings on climate change**.

Climate change also impacts on Germany's tourism sector. APA III therefore includes the **provision of guidelines on how to implement adaptation actions, e.g. for the elaboration of emergency preparedness plans for responding to various kinds of extreme weather events**. Sudden weather events in particular can cause hazardous situations affecting the tourism sector and tourists. For instance, in the winter of 2018/19 heavy snowfall trapped holidaymakers in their destinations and accommodations. Local crisis plans should therefore take account of these target groups.

Mechanisms and actions in the spatial planning and civil protection cluster

In view of the local and regional manifestations of climate change, urban and spatial planning has a key role to play in climate adaptation. Adaptation is therefore being given **greater attention in urban development promotion programmes**. The 2020 administrative agreement for urban development promotion programmes (*Verwaltungsvereinbarung Städtebauförderung 2020*) refined and coordinated by the German federal government and *Länder* now makes "climate change mitigation or adaptation actions, notably through improving green infrastructure (e.g. urban green spaces)" a mandatory precondition to receiving public funding.

Numerous activities carried out to implement the measures of the "Green Spaces in the City" white paper (*Weißbuch Stadtgrün*, 2017) contribute to climate change mitigation and adaptation. One key element is the promotion of urban green space projects, notably within the framework of the above-mentioned urban development promotion programmes, national-level urban planning projects (federal programme), the National Climate Initiative, the "Measures for adaptation to climate change impacts" funding programme, and pilot projects on climate adaptation and modernisation in urban areas.

Further actions are concerned with disseminating information about tools for and good practice in climate-resilient urban development, and research on low-carbon and climate-resilient construction and climate-smart urban development. Actions are guided by the vision of developing an urban green infrastructure that maintains quality of life in cities and utilises green spaces to mitigate climate change and the impacts of heavy rainfall, heat and drought. To this end the federal government promotes a range of research projects, notably on climate-smart construction, climate-resilient urban redevelopment, water-sensitive urban development techniques, and ways to enhance urban nature. These activities build on small-scale recording and monitoring of the quantity and quality of urban green space elements, which increasingly employs remote sensing techniques (laserscan data, unmanned aerial vehicles, aircraft and satellite imagery).

The "sponge city" vision shall continue to be pursued in order to improve sustainable rainwater management in cities. In this thematic vein, **approaches for decentral irrigation of urban green as precaution against drought** will be developed further and a **model recommendation** formulated. Research projects will explore the requisite types, quantities and qualities of water in order to preclude adverse environmental or health impacts.

Beside spatial planning, civil protection also faces challenges that need to be addressed in the APA III context. The action for **further development of risk communication on storm-related hazards to the public** will improve existing information services, e.g. on heat (here there are links to the health cluster) and heavy rain. Such services will be embedded within comprehensive risk communication strategies. Furthermore, **recommendations on cooperation between spontaneous helpers and volunteer responders in extreme weather event situations** will be expanded and supplemented with a compilation of examples of good practice. This will involve an evaluation of experience gathered with civil engagement during storm events and a review of ISO Standard 22319:2017 in Germany. The United Nations Sendai Framework for Disaster Risk Reduction (SFDRR) will create valuable impetus over the coming years. A strategic foundation for implementation of the framework is currently being elaborated. Major synergies are anticipated between disaster resilience enhancement and climate change adaptation. These shall be harnessed as added value for the implementation of both strategy processes.

Cross-cutting mechanisms and actions

The draft APA III envisages with regard to data and information services that the **KLiVO German Climate Preparedness Portal** and the **KlimAdapt system of adaptation services** be continued and expanded. KlimAdapt is a module of KLiVO, which assembles, processes and provides products, services and assessments for the identification and implementation of adaptation actions and for the further development of the German Adaptation Strategy (DAS).

The **DAS "Climate and water"** open service will provide climatological, oceanographic and hydrological data and advisory inputs for the individual action areas of the German Adaptation Strategy. The service will give decision-makers and planners comprehensive, up-to-date, uniform and quality-assured data foundations for adaptation actions in Germany. A projection service for waterways and shipping (**ProWaS**) is in preparation as a pilot project that will form the first module of the open service. The German Adaptation Strategy also lists numerous research activities that will build the knowledge base on climate change and will advance climate modelling at various scales. These include **publicly funded programmes on the economics of climate change** and on **climate resilience through urban and regional actions**, which aim to build action-oriented knowledge about climate adaptation and mitigation.

In many instances, the climatic determinants in the specific fields stated above are still insufficiently researched. A particular need for further research remains in the analysis of the robustness of modelled extremes in terms of their modelability, characteristics and probabilities of occurrence. Among other activities, new research programmes funded by the German Research Ministry (BMBF), such as ClimXtreme and RegIKlim, will deliver initial results over the next years of relevance to the analysis of rare events and refined regional and global climate modelling.

A further action is **"Local climate and environmental models for cities and regions of the future"**, a pilot initiative comprised of several components. The first involves development of an urban climate model capable of capturing all relevant urban climate processes. Two further components will lay the groundwork for the next generation of climate information services and will compile and link data on a broad range of local environmental aspects.

Existing technical rules and standards need to take systematic account of climate change impacts. An action on **climate-proofing existing rules and technical standards** comprises specific departmental research, active involvement in relevant bodies, integration in statutory provisions, and consideration in federal government tendering procedures. Furthermore, the **need for and practicability of steps to integrate climate change adaptation in technical laws** is to be examined. This is important because the implementation of the DAS, particularly at municipal level, can be boosted if it is embedded within a statutory system with mandatory substantive focuses and procedural requirements. The first step is therefore to examine which technical laws are relevant and which regulatory contents should be taken up.

The permanent establishment of the **federal authority climate adaptation network** mandated by the Interministerial Working Group on Adaptation to Climate Change (IMAA) promotes DAS implementation. The **BMVI expert network** of the Federal Ministry of Transport and Digital Infrastructure is a departmental research network of particular relevance to DAS implementation. Its purpose is to provide scientific findings of practical relevance to challenges cutting across all modes of transport, such as climate change, environmental protection and ageing infrastructure.

Various funding programmes aim to create a financial framework for adaptation actions. Under the European Union's new multiannual financial framework for 2021–2027 an increased percentage of all financial resources is to be deployed for climate-relevant actions.

The **Blue Compass award** scheme, by which the Federal Environment Agency regularly showcases local and regional lighthouse projects for coping with climate change impacts, is to be continued on a permanent basis insofar as budgetary resources allow.

Furthermore, a **system for analysis of the effectiveness of actions and mechanisms** is to be established. This will improve the targeted selection of DAS actions and policy mechanisms, and will facilitate coordination among departmental strategies.

Nature-based solutions for biodiversity and climate

The synopsis of APA III actions shows that many climate change adaptation activities are nature-based and utilise ecosystem processes. Positive examples of adaptation options through nature-based solutions (NbS) that contribute effectively and sustainably to attaining biodiversity and climate goals, generate synergies between these two and other development goals and rely on natural ecosystems include:

- Restoring wetlands and river courses (preventing damage by improving high-water runoff regulation)
- Implementing blue and green infrastructures such as parks, roof planting, lakes and small water bodies in urban areas (reducing the heat island effect of cities and thus reducing human health impacts during heatwaves, improving air quality and making a generally positive contribution to human health and wellbeing, enhancing environmental quality and human quality of life, improving flood management according to the "sponge city" principle)
- In forestry, converting forests to climate-appropriate mixed stands with site-appropriate and mostly native tree species helps to ensure that forests can perform their ecosystem functions over the long term.
- In agriculture, low-impact and conservation tillage helps to preserve natural soil functions (such as water storage capacity) and reduces erosion and compaction.
- Conserving and restoring natural ecosystems (e.g. increasing resilience to climate change impacts)

Climate change adaptation should rely more strongly on nature-based solutions, as these are associated with ecological, economic, social and cultural benefits (see on this e.g. the studies on Germany's natural capital). Numerous studies confirm the positive cost-benefit ratio[85]. Nature-based solutions moreover help to build the resilience of societies and ecosystems[86].

The predominantly long-term benefits of nature-based solutions, their positive cost-benefit ratio and their contribution to attaining sustainability goals are recognised at many levels. This also applies at EU level, where the EU biodiversity strategy[87] and adaptation strategy[88] give priority to such solutions. In Germany the benefits of nature-based solutions are gradually being recognised[89], as reflected by the urban nature master plan (*Masterplan Stadtnatur*)[90].

International responsibility

The Paris Agreement adopted in December 2015 is the first agreement that is universal and binding in international law and thus marks a turning point in international climate and development policy. It sets out commitments for all 197 states and has been ratified in the meantime by 187 parties (as of January 2020). Its goal is to limit global warming to well below 2°C, preferably to 1.5°C, compared to pre-industrial levels. Upon the agreement's entry into force climate change adaptation gained, for the first time, the same political weight as greenhouse gas emissions reduction. The state parties have committed to building adaptive capacities, boosting resilience and reducing vulnerability to climate change. Furthermore, financial flows are to be redirected in support of transitions towards low-carbon

[85] https://www.ufz.de/teebde/

[86] See e.g.: Seddon N, Chausson A, Berry P, Girardin CAJ, Smith A, Turner B (2020) Understanding the value and limits of nature-based solutions to climate change and other global challenges. In: Philos. Trans. R. Soc. B Biol. Sci. 375. doi:10.1098/rstb.2019.0120; Faivre N, Fritz M, Freitas T, de Boissezon B, Vandewoestijne S (2017) Nature-Based Solutions in the EU: Innovating with nature to address social, economic and environmental challenges. In: Environ. Res. 159, 509–518. doi:10.1016/J.ENVRES.2017.08.032.

[87] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/eu-biodiversity-strategy-2030_de

[88] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12381-EU-Strategy-on-Adaptation-to-Climate-Change/public-consultation

[89] https://www.bmi.bund.de/DE/themen/bauen-wohnen/stadt-wohnen/stadtentwicklung/gruene-stadt/gruene-stadt-node.html

[90] https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/masterplan_stadtnatur_bf.pdf

and climate-resilient development. The Nationally Determined Contributions (NDCs) updated and submitted every five years are pivotal to attainment of these long-term goals.

However, the poorest and most vulnerable states in particular often lack resources and capacities to avert and buffer the damage caused by climate change impacts such as more frequent or intensive extreme weather events (e.g. heavy rain, tropical storms, flooding, drought, periods of extreme heat) and gradual climate-related changes (such as sea-level rise, salination, altered precipitation and temperature patterns, rising water temperatures, ocean acidification) and their consequences. To meet its international responsibility, Germany therefore assists developing and newly industrialising countries within the scope of its development cooperation activities. It also provides assistance through the International Climate Initiative (ICI) and through financial contributions to the Adaptation Fund, the Special Climate Change Fund (SCCF), the Least Developed Countries Fund (LDCF), the Strategic Climate Fund (SCF) and the Global Environment Facility (GEF), all of which support adaptation actions in developing countries.

Germany's commitments contribute to fulfilment of international climate finance pledges: At the Copenhagen Climate Conference in 2009 the industrialised countries made a collective commitment to jointly mobilise, from public and private sources, USD 100 billion a year by 2020 for climate action in developing countries. At the Paris Climate Conference they further agreed to continue to provide USD 100 billion a year from 2021 to 2025. As announced by Federal Chancellor Dr Merkel, Germany will double its international climate financing from public resources to EUR 4 billion by 2020 from a 2014 baseline. In 2018 the federal government pledged some EUR 1.54 billion for adaptation actions, this being 46% of the total EUR 3.36 billion budgetary resources (including grant elements of KfW development loans); of this, more than 80% comes from the budget of the Federal Ministry for Economic Cooperation and Development (BMZ). Until a new post-2025 international climate financing goal is agreed, ongoing activities must build upon the pledges already made. This is why the BMZ plays a pivotal role in the implementation of adaptation actions. Other ministries also contribute to climate adaptation in and for partner countries, notably the Federal Environment Ministry (BMU) via the International Climate Initiative (ICI), and to a lesser extent the Federal Ministry of Education and Research (BMBF), the Foreign Office (AA), The Federal Ministry of Food and Agriculture (BMEL), the Federal Ministry for Economic Affairs and Energy (BMWi) and the Federal Ministry of Transport and Digital Infrastructure (BMVI). A recent analysis by the German Institute for Development Evaluation (DEval) shows that climate vulnerability substantially increases the probability that a country receives German adaptation finance. The more vulnerable a country is, the greater the likelihood that funding for adaptation measures is approved[91].

The table in Annex 2 gives an overview of the broad assistance in and for partner countries, profiling exemplary projects for the various clusters and action areas. Up to now Germany has directed the bulk of its assistance to adaptation in the water, agriculture and natural resource management (incl. forests and coasts/oceans) sectors. However, the priorities of cooperation with partner countries also include disaster preparedness, climate risk insurance and finance, and ecosystem-based adaptation. Germany advances the adaptation agenda through multilateral partnerships and initiatives, linking implementation closely to the 2030 Agenda. This includes the founding of and support for the NAP Global Network, which assists partner countries in developing and implementing their National Adaptation Plans (NAPs); the founding of and support for the NDC Partnership, which helps its member countries raise

[91] https://www.deval.org/de/pressemeldung-detail/anpassung-an-den-klimawandel-finanzierung.html

the level of ambition of their NDCs and integrate climate and development goals; support for the InsuResilience Global Partnership for climate and disaster risk finance and insurance solutions launched in 2017 by the BMZ together with G20 and V20 partners; and the Global Initiative on Disaster Risk Management (GIDRM) set up to boost resilience to climate-induced disaster risks. Furthermore, Federal Chancellor Dr Merkel is acting as patron and Development Minister Dr Müller as commissioner of the Global Commission on Adaptation (GCA) launched in 2018 to embed adaptation issues more firmly in the international agenda. Based on the GCA report "Adapt Now – A Global Call for Leadership on Climate Resilience" (https://gca.org/globale-commission-on-adaptation/report), concrete measures are being carried out globally since late September 2019 in the Year of Action in eight action areas.

Annex 1

Adaptation Action Plan III

National Actions

Last updated: 21 October 2020

Notes on the tables for APA III

General notes
The structure of APA III corresponds to the logic of APA II. The actions prioritised in APA II on the basis of the 2015 vulnerability analysis continue to be the substantive basis for the sectoral priorities of APA III. APA III is structured in clusters which thematically organise the DAS fields of action (see 2020 Progress Report, pp. 16ff). In the following, five table sheets initially list an overview of climate impacts in each cluster (Water; Infrastructure; etc.). No climate impacts are assigned specifically to the "Spatial Planning and Civil Protection" and "Cross-sectional" clusters, hence there are no overview tables for those two clusters. This is followed by tables presenting actions and mechanisms for all of the seven clusters.

Notes on the overview tables of climate impacts
These tables have been **adopted for informational purposes** from the 2015 Progress Report (Annex 3, pp. 210 – 217) in order to provide a rapid overview of the assessment of climate impacts and the need for action.

Assessment of climate impact: This corresponds to the state of knowledge when the 2015 vulnerability analysis was produced (2015 Progress Report Annex 1, section 2). It underpins the determination of the need for action.

Duration of adaptation: This refers to the period needed for a system or field of action to adapt. It depends on a range of factors and is appraised here as either "short" or "long". If it is long, the planning and implementation of adaptation actions should commence soon. This information therefore also feeds into the determination of the need for action.

Need for action: Actions are needed in all fields and with regard to all climate impacts. To assist prioritisation of necessary actions and mechanisms, only climate impacts presenting an intermediate or major need for action were identified and colour-coded.

Notes on the tables presenting actions and mechanisms
These tables list proposed actions/mechanisms for Germany's Adaptation Action Plan, grouped in each cluster according to type of action/mechanism (Adaptation of infrastructures; Adaptation of legal instruments; etc.). In addition to information about the action, column F assigns the action to climate impacts, using the abbreviations for these impacts. Where the need for action with regard to a climate impact is intermediate or major, this is indicated by colour-coding, which establishes a link to the overview tables of climate impacts (Water; Infrastructure; etc.).

Notes on the "Period" column
This column states the planned duration of actions and mechanisms. Where proposed actions or mechanisms are permanent tasks, they are shaded grey in the tables. Permanent tasks are those which must be pursued over a lengthy period in order to attain the goals of the German Strategy for Adaptation to Climate Change (DAS) and safeguard goal attainment over the long term. The period of implementation therefore regularly extends beyond the term of a given Adaptation Action Plan. Efforts are envisaged to safeguard the funding of these tasks over the long term.

Notes on the "Funding" column
Where there is already a federal-government funding source and budget items for actions and instruments, these are stated. For the other actions and instruments, the government reserves the option to scrutinise and fund them; this status is labelled as "to be determined". The "no information" or "no extra costs" labels are used in cases concerning a) envisaged regulatory and statutory actions or pure planning mechanisms or their review, or b) actions to be implemented by way of agreements with other actors that are not expected to entail funding contributions from federal government.

"Water" cluster

Climate impact		Assessment of climate impact:			Duration of adaptation	Need for action major intermediate
		Present	Near future			
			minor change	major change		
Water regime, water management						
WW						
WW-01	Discharge	low	low	medium	short	
WW-02	River flooding and flash floods	medium	medium	high	long	
WW-03	Impacts on sewer networks and sewage treatment plants	medium	medium	high	long	
WW-05	Water availability from groundwater sources	low	low	medium	short	
WW-06	Water availability from surface waters	low	low	medium	short	
WW-07	Drinking water availability	low	low	medium	short	
WW-08	Dam management	low	low	medium	short	
WW-09	State of water bodies	low	low	medium	long	
Coastal protection and marine conservation						
KUE						
KUE-01	Impacts on built structures and infrastructure	low	low	high	long	
KUE-02	Damage to coasts (physiographic changes)	low	medium	high	long	
KUE-03	Storm surges	medium	medium	high	long	
Fisheries						
FI						
FI-01	Alien species, species assemblage	medium	medium	high	long	
FI-02	Growth, reproduction and mortality of fish stocks	low	medium	high	long	
FI-03	Aquaculture (damage included)	low	low	medium	short	
FI-04	Conditions for capture fisheries	low	low	medium	short	

"Infrastructure" cluster

Climate impact		Assessment of climate impact:			Duration of adaptation	Need for action major intermediate
		Present	Near future			
			minor change	major change		
Building industry						
BAU						
BAU-01	Damage to buildings and infrastructure caused by storm surges	low	low	high	long	
BAU-02	Damage to buildings and infrastructure caused by river flooding and flash floods	medium	medium	high	long	
BAU-03	Damage to buildings and infrastructure caused by high winds	medium	low	medium	long	
BAU-04	Urban climate and air quality	medium	medium	high	long	
BAU-05	Indoor climate and cooling	medium	medium	high	short	
Energy						
EW						
EW-01	Energy demand for heating	low	low	medium	short	
EW-02	Energy demand for cooling	low	low	medium	short	
EW-03	Hydropower	low	low	low	long	
EW-04	Cooling water for thermal power plants	medium	low	medium	long	
EW-05	Wind energy use, land-based and at sea	low	low	low	long	
EW-06	Damage to power plants and generation facilities	low	low	medium	long	
EW-07	Damage to transmission networks	low	low	low	long	
EW-08	Reliability of energy supply	low	low	low	long	
Transport, transport infrastructure						
VE						
VE-01	Icing of inland waterways	low	low	medium	long	
VE-02	Icing of aircraft	low	low	medium	short	
VE-03	Heat and frost damage to roads, rail infrastructure, runways	low	medium	medium	long	
VE-04	Navigability of inland waterways	low	medium	medium	long	
VE-05	Flooding and undermining of roads and rail infrastructure	medium	medium	high	long	

"Land" cluster

Climate impact		Assessment of climate impact:			Duration of adaptation	Need for action major intermediate
		Present	Near future			
			minor change	major change		
Soil						
BO						
BO-01	Soil erosion by water and wind and by earth slide	low	low	medium	long	
BO-02	Soil moisture level, percolating water	medium	medium	high	long	
BO-03	Productive functions (site stability, soil fertility)	low	low	medium	long	
BO-04	Soil biodiversity, microbial activity	medium	medium	medium	long	
BO-05	Organic matter in soil, N(P) balance, substance output	medium	medium	medium	long	
Biodiversity						
BD						
BD-01	Dispersal of invasive species	low	low	high	long	
BD-02	Distribution areas of species	low	low	medium	long	
BD-03	Ecosystem services	low	low	medium	long	
BD-04	Biotopes and habitats	low	low	medium	long	
Agriculture						
LW						
LW-01	Agrophenological phases and growth periods	medium	medium	high	short	
LW-02	Yield	low	low	low	short	
LW-03	Drought damage and frost damage	low	low	medium	short	
LW-04	Pests and plant health	low	low	medium	short	
LW-05	Damage caused by extreme states	low	low	medium	short	
Woodland and forestry						
FW						
FW-01	Tree species composition	low	low	medium	long	
FW-02	Productive functions	low	medium	high	long	
FW-03	Protective functions	low	low	medium	long	
FW-04	Damage by harmful organisms	medium	medium	high	long	
FW-05	Heat and drought stress	low	low	medium	long	
FW-06	Forest fire risk	low	low	medium	long	
FW-07	Windthrow damage	medium	medium	medium	long	

“Health” cluster

Climate impact		Assessment of climate impact:			Duration of adaptation	Need for action major intermediate
		Present	Near future			
			minor change	major change		
Human health						
GE						
GE-01	Heat exposure	high	medium	high	short	
GE-02	Respiratory complaints caused by ground-level ozone	medium	medium	high	short	
GE-03	Pathogen carriers/vectors	medium	medium	medium	long	
GE-04	Pressures upon emergency services, hospitals and doctors	low	low	low	long	

"Economy" cluster

Climate impact		Assessment of climate impact:			Duration of adaptation	Need for action major intermediate
		Present	Near future			
			minor change	major change		
Trade and industry						
IG						
IG-01	Danger of potential release of hazardous substances	medium	medium	medium	long	
IG-02	Damage to commercial and industrial infrastructure due to extreme events	low	medium	medium	long	
IG-03	Impairment of land-based goods transport	medium	medium	high	long	
IG-04	Impairment of production processes and logistics	low	low	medium	short	
IG-05	Impairment of production due to water shortage	low	low	low	short	
IG-06	Energy consumption for cooling	low	low	medium	short	
IG-07	Energy availability	low	low	low	short	
IG-08	Climate impacts upon sales markets	low	low	low	short	
IG-09	Planning processes for operating procedures	low	low	medium	short	
Tourism						
TOU						
TOU-01	Service interruptions	low	low	low	short	
TOU-02	Climate-related requirements upon tourism infrastructure	low	low	medium	long	
TOU-03	Seasonal and regional shifts in demand	low	low	medium	short	
Financial services sector						
FiW						
FiW-01	Impacts of climate change upon the insurance industry	low	low	medium	short	
FiW-02	Impacts of climate change upon the banking sector	low	low	low	short	

Ref. no.		Title and brief description of the mechanism/action	Fields of action	Lead organisation(s) / partner(s)	Period	Funding / funding provider	Climate impacts addressed (for abbreviations see overview table of climate impacts)
"Water" cluster							
1 Adaptation of infrastructures							
1.	1	**Renaturation of watercourses and floodplains** To achieve the "good ecological status" or "good ecological potential" of watercourses specified in the Water Framework Directive, measures that improve the status of the watercourses and floodplains are envisaged (including land-use change, reinstatement of embankments, riverbank restoration, connection of backwaters, ecological continuity). The Blue Belt federal programme adopted by the German government aims at the renaturation of federal waterways and floodplains in the medium and long term. On waterways with altered traffic use, in particular, this provides opportunities to improve the hydromorphology and biodiversity of the watercourses and the status of the floodplains. This safeguards and benefits the populations of numerous plant and animal species in a sustainable manner, thus making them more resilient in the face of climatic changes. In addition, the envisaged biotope network has the effect of providing better opportunities for shifting the primary distribution areas of the species present as part of adaptation to climatic changes. The stated effects are also to be expected in connection with improvements to ecological continuity at barrages as part of the legal responsibility of the Federal Waterways and Shipping Administration (WSV) for fish populations.	Cutting across all fields	**BMU / UBA / BfN, BMVI / WSV / BAW /BfG / BImA**	Permanent task to 2050, ongoing	Funding secured to 2023 in departmental budget (Epl., *Einzelplan*) 16 (2020: 6.8 million, VEs 2021-2023: 12.4 million in total)	BD WW BD-01 BD-02 BD-03 BD-04 WW-09
1.	2	**Enhanced implementation of NWRM (Natural Water Retention Measures)** These measures promote synergies between implementation of the Floods Directive, the Water Framework Directive, Natura 2000 Directives and adaptation to climate change. At national level, opportunities for considering NWRM should be examined during planning of the measures to implement the Water Framework Directive and the Floods Directive and – where appropriate – implemented as a priority.	Cutting across all fields	**BMU / UBA/BfN, BfG, *Länder***	Permanent task, ongoing	cf. 1.1	WW-02
1.	3	**Development of quality standards for the protection of health and the environment in connection with regional water reuse (e.g. in agriculture or for irrigation)** Including examination of water reuse options for irrigation in urban areas. The action has substantive links to 1.8 and 1.9.	Water regime, Water management	**BMU/UBA/BMG/ BMEL**		Departmental funding (ReFoPlan)	
1.	4	**Creating ecological continuity on federal waterways** Almost all native fish species in German rivers move between different habitats in the course of the seasons and at different stages in their life cycle – e.g. to find suitable places for reproduction or overwintering. Some species also migrate in order to temporarily avoid unfavourable environmental conditions such as high temperatures and low oxygen content. In addition, fish species in river systems having linear continuity shift their distribution areas in the medium to long term in response to climatic changes that affect factors such as water temperature and flow conditions. Free-flowing rivers and rivers that are designed to be ecologically continuous at barrages – for example, by means of fish ladders – enable fish to migrate or spread and thus help to improve the resilience of aquatic species communities to climatic changes. Since 2010, Section 34 of the Federal Water Act (WHG) has made the WSV responsible for creating ecological continuity at the barrages that it operates on federal waterways. To achieve the objectives described in the European Water Framework Directive (WFD), measures are being put in place at some 240 barrages to support upstream and downstream migration of fish and invertebrates. The German Federal Institute of Hydrology (BfG) and the Federal Waterways and Engineering Research Institute (BAW) advise and support the Federal Waterways and Shipping Administration (WSV) in connection with the planning, implementation and quality assurance of these measures.	Fisheries, Biodiversity	**BMVI / WSV / BfG / BAW**	WFD cycles to 2021 and 2027, furthermore a permanent task	BMVI departmental funding	FI-01 FI-02 BD-01 BD-02 BD-03 BD-04

2 Adaptation of legal instruments and technical rules and standards							
1.	5	**Examination of methodological approaches to the systematic identification and assessment of the impacts of climate change in the context of river basin management** Assessment of the ecological state of water bodies in accordance with the WFD is based inter alia on evaluation of the biological components of the specific type of water body by comparison with defined reference conditions. Systematic assessment of the influence of climate change on the quality components relevant to the evaluation of ecological status is therefore an important factor in management planning. Furthermore, an assessment of the influence of climate change on the effectiveness of measures to improve the ecological status of water bodies is important (climate proofing).	Cutting across all fields	**BMU/ UBA, BfG**	2019-2021, in preparation	€140,000 departmental research	WW
1.	6	**Examination of the potential of decentral rainwater management in residential and commercial areas** Establishing a systematic planning procedure and a comparative ecological and economic assessment of different approaches involving decentral rainwater management measures. In particular when conditions are unfavourable (e.g. functional limits of existing infrastructure facilities are reached, major renovation needs, new developments in the face of capacity shortages), the planning and implementation of decentral rainwater management measures should be considered. In residential and commercial areas that are being newly developed, the precedence of decentral rainwater management over mains drainage should be prescribed if these measures score better, both ecologically and economically, in the comparison of variants. Measures that should be considered include rainwater retention, decentral infiltration, evaporation, avoidance of sealed surfaces and also the use of rainwater for energy (building cooling). This can maintain the natural water regime (discharge, infiltration, evaporation) and enable enlargement of the sewerage system as a potential response to climate change to be avoided. In areas that are under pressure (e.g. areas with high traffic volumes, or industrial and commercial zones), careful consideration must be given to whether direct infiltration of the discharge water is compatible with environmental protection requirements, whether any prior treatment measures are necessary, or whether it must be discharged to the sewerage system. Expansion of the rainwater retention infrastructure should also provide capacity for heavy rain events. Above-ground infiltration systems should therefore be designed as flood pools or safety channels.	Water regime, Water management	**BMU**	Permanent task	No extra funding requirement	WW-02 WW-03
1.	7	**Flood hazard maps** The Floods Directive requires the *Länder* to produce flood hazard maps for all water bodies and to provide information on the possible extent of flooding. The hazard maps provide a basis for the production of risk maps for environmental assets, human health, economic activity, and cultural assets; the risk maps are used to draw up flood risk management plans. The flood hazard maps must be updated every six years and must be published. The federal government encourages harmonisation of these maps by assisting the responsible LAWA bodies with the formulation of minimum requirements for the preparation and updating of flood hazard maps. Suitable financing instruments should be found to cover the additional costs specifically attributable to harmonisation in connection with the production and updating of hazard and risk maps.	Water regime, Water management	**BMU / UBA / BfG, BMEL** ***Länder***		To be determined	WW-02 WW-03 BAU-02 VE-05 IG-01 IG-02
1.	8	**Examination of the potential for partial substitution of drinking water consumption by the use of water of lower quality, such as grey water or rainwater** In areas where it may not be possible to fully meet demand in hot periods, the use of water of lower quality (e.g. for green areas, sport and recreation facilities, etc.) may be an option. The action has substantive links to 1. 3 and 1.9.	Water management, Human health	BMU/UBA/BMG		Departmental funding (ReFoPlan)	WW-03 WW-05 WW-07 WW-09
1.	9	**Clarification of conflicts of use in periods of drought** Drawing up proposals for ways to specify the **human** demand for drinking water as a potential priority, proposals for drawing up a possible hierarchy of water uses, and proposals for criteria and procedures for assessment and decision-making in the event of conflicts of use, taking into account and evaluating appropriate examples from other states. The action has substantive links to 1. 3 and 1.8.	Water management	BMU/UBA, BMEL		Departmental funding (ReFoPlan)	WW-03 WW-05 WW-07 WW-09
4 Funding and incentives							

1.	10	**Updating the National Flood Protection Programme** The National Flood Protection Programme (NHWSP) serves to tackle the growing risks of flood events in a coordinated manner across all federal states (*Länder*). It can be seen as supplementing the comprehensive flood risk management plans under the EU Floods Directive. The NHWSP focuses on improving preventive flood protection. Continuous updating of the NHWSP is essential for actions with a supra-regional impact involving controlled flood retention, reinstatement of embankments and the removal of weak points in existing installations that affect people upstream and downstream. In the light of climate change, supra-regional protection against extreme flood events acquires new priority and calls for updating of the NHWSP.	Cutting across all fields	**BMU** / UBA, BfN, BfG, BMEL	Ongoing	*Länder* budgets, federal budget (Epl.10, BMEL) under GAK, and third-party sources as appropriate	WW-02 KUE-01 KUE-02 KUE-03 BAU-02 IG-02
5 Research and monitoring							
1.	11	**Chart of North Sea surface temperature (North Sea SST chart)** Since 1969, charts of surface temperatures in the North Sea have been generated from data from various sources (observations made by ships, buoy readings, remote satellite sensing). They are an important instrument for assessment of oceanographic and climatic trends in the North Sea – e.g. for the EU Marine Strategy Framework Directive (MSFD), for validation of ocean and climate models, for defining specifications for temperature-sensitive building materials (shipping, the offshore industry), and for explaining temperature-related changes in the North Sea's ecosystem.	Water regime, Water management, Marine conservation, Biodiversity, Fisheries, Transport, Transport infrastructure	**BSH,** various institutions and authorities	Permanent task since 1969	BSH budget	KUE
1.	12	**Time series of the North Sea's salt and heat content** Information about the North Sea's salt and heat budget provides an important foundation for estimating the development of the North Sea's physical status. This budget is an important instrument for assessment of oceanographic and climatic trends in the North Sea – e.g. for the EU Marine Strategy Framework Directive (MSFD), for validation of ocean and climate models, and for explaining temperature-related changes in the North Sea's ecosystem.	Water regime, Water management, Marine conservation, Biodiversity, Fisheries, Transport, Transport infrastructure	**BSH,** various institutions and authorities	Permanent task since 1999	BSH budget	KUE
1.	13	**Argo data and information service** Information on temperature, salt content and sea level from the UN's ARGO measurement programme provides basic data for describing the sea's current status (e.g. for the MSFD), identifying the transport of heat in the thermohaline circulation from the tropics to the mid-latitudes and beyond and from the atmosphere to the deep ocean, monitoring oceanic sea-level rise and generating climatological time series and benchmarks against which past and future climatic states can be compared.	Water regime, Water management, Marine conservation, Biodiversity, Fisheries, Transport, Transport infrastructure	**BSH,** research institutes, EuroArgo, ARGO International, ARGO secretariat	Permanent task since 1990 (since 2008 for BSH)	BSH budget	KUE

1.	14	**Operational low and mean water level prediction** On behalf of the BMVI and the WSV, the BfG has for several decades developed, maintained and operated traffic-related prediction models and systems for the inland waterways. These models and systems are used operationally in collaboration with the WSV; the data are provided via the ELWIS system.	Water regime, Water management, Transport, Transport infrastructure, Trade and industry	BMVI, WSV, BfG	Permanent task	BfG budget	WW-02 WW-03 WW-06 WW-07 WW-08 VE-04
1.	15	**Water level forecasting services for the North Sea and Baltic** A forecasting, warning and advice service is needed to ensure the safety of shipping in areas influenced by wind and sometimes tides, and for protection against storm surges. The necessary information comes from astronomical calculations, water and gauge measurements, and meteorological and oceanographic forecasting models. Other forecasting procedures such as empirical methods, regional numerical models and the MOS (Model Output Statistics) process are also used to predict water levels and storm surges. The forecasting procedures must be constantly refined and adapted to users' needs. Significant aspects for further development are the production of longer-term forecasts and the evaluation of uncertainties (e.g. via ensemble forecasting). The data and results from the water level forecasting services are important for analysis of hydrodynamic events on the coasts, determination of sea-level rise and validation of effect models in connection with adaptation to climate change.	Water regime, Water management, Marine conservation, Coastal protection, Transport, Transport infrastructure, Civil protection / emergency response	**BSH**, DWD, BfG, WSV, *Länder* authorities	Permanent task	BSH budget	KUE VE-04 IG-04
1.	16	**Further development of water level forecasting** Swift identification of the runoff situation is important for effective management of medium and low water, enabling preventive action such as controlled water retention or regulation of the water level to be taken promptly. Water (quantity) information is a key parameter in many cause-and-effect chains. The focus here should be on a) creating probabilistic prediction products and b) extending the forecasting period. This action is related to the BMVI action plan "Low water on the Rhine".	Water regime, Water management, Transport, Transport infrastructure, Trade and industry	**BMVI / BfG**, WSV, DWD	2020-2023	BfG budget	WW-02 WW-03 WW-06 WW-07 WW-08 VE-04
1.	17	**ExMon – Monitoring extreme meteorological events** Daily monitoring of various meteorological parameters nationally and internationally to identify whether relevant events have occurred; if necessary, the BMVI, other authorities and the general public are informed of these events and their climatological classification via reports from the German weather service (DWD). If data are available, the damage caused by the extreme events may also be documented.	Cutting across all fields	DWD	Permanent task	DWD budget	
1.	18	**ClimXtreme extreme events climatology** – producing an extreme events climatology for the period from the start of the 20th century until now. This can then be used to explore whether the intensity and frequency of extreme events have changed as a result of observed climate change, and to evaluate the ability of re-analysis data sets and climate project data to reproduce such events. Because of the limited density of data prior to 1950, quantitative and qualitative damage descriptions are also needed here for the climatological classification. The specific features of the ClimXtreme event catalogue are currently being agreed with external consortium partners. The catalogue provides a basis for coordinated research in the ClimXtreme consortium.	Cutting across all fields	DWD	2020-2022	BMBF supporting action	
1.	19	**Investigating the impact of changed groundwater levels in hot periods, combined with higher temperatures and rising biotic and abiotic turnover rates** Falling groundwater levels may cause aquifer horizons to switch from a saturated to an unsaturated state and be affected by changes in the redox conditions. This could lead to the dissolution of certain minerals and the release of hazardous heavy metals (such as chromate). It is not currently possible to assess impacts that result from changes in temperature-dependent turnover rates (chemical and biological).	Water management, Water regime	BMU/UBA		Departmental funding (ReFoPlan)	

1.	20	**Investigating the effect of changed boundary conditions in transport pipes on the stability of drinking water quality, especially with regard to recontamination and colonisation by invertebrates**	Water management	BMG		To be determined	
1.	21	**Maximally precise real-time modelling of groundwater recharge in catchment areas depending on various water extraction quantities in order to identify the (medium-term) maximum for resource use** Better user-friendly tools, including for smaller water suppliers that have limited personnel resources.	Water management	**BMG** **BMU/UBA**		To be determined	
7 Public awareness, communication, information (education, guidance)							
1.	22	**Comprehensive provision of hydrographic measurement data; advising on and producing data products for monitoring** The BfG is the German government's scientific institute for research, reporting and advice in the fields of hydrology, water body use, water body status, and ecology and water body protection. As part of this role, the BFG – together with the WSV – makes hydrographic measurement data available, including data on ecological and chemical parameters and radiological investigations.	Cutting across all fields	**BMVI / BfG**, DWD, WSV	Permanent task	BfG budget	WW VE-04 IG-04
1.	23	**Preparation of guidelines on heat load plans taking account of the influence of climate change** The guidelines to be drawn up shall cover the issue of the future influence of climate change. They should also make clear that heat load plans do not consider individual impacts but rather the overall impact / summation of influences along a river against the backdrop of climate change. The guidelines should set out an overall framework; they should also highlight the importance of involving all affected stakeholders and provide advice on this. A key requirement here is that heat load plans must be reviewed in the light of changed hydrological and temperature conditions (modelling) so that climate-related production bottlenecks as a result of restricted water withdrawal and conflicts over water use can be avoided. If balanced and appropriate measures are to be identified, the modelling needs to include differentiated consideration of the various influences on the water temperature. The interactions between high nutrient inputs from agriculture and the water body temperatures must also be taken into account, as must transboundary effects in catchment areas as a result of the elevated temperature.	Water regime, Water management, Trade and industry, Biodiversity	**BMU/UBA,** BMVI/BfG		Departmental funding (ReFoPlan)	WW-01 EW-04
1.	24	**Instructions from the German government on the further development of existing guidelines on decentral rainwater management in residential and commercial areas for climate-friendly and space-saving settlement development** In relation to the specific issue of climate change, instructions on the further development of existing guidelines on decentral rainwater management cover various key issues, especially: (1) Consideration of specific causal relationships between climate change and locality-specific physical processes (such as evaporation processes); (2) Specification of a systematic procedure for considering the range of possible climate change adaptation measures and formulating advice on the analysis and evaluation of such measures, taking into account the locality-specific framework conditions of decentral water management in residential and commercial areas (both existing and to be planned). The further development of guidelines on decentral rainwater management is linked to the vision of "water-sensitive urban development" in the context of new construction and conversion of the existing housing stock, and it should also consider extreme events, such as heavy precipitation.	Water regime, Water management	**BMU/ DWA**		To be determined	WW-05 WW-06
1.	25	**Further development of the early warning system (in terms of severe weather forecasting)** Development of an integrated forecasting system (IFS) for the DWD (see LAWA 2018, p. 22f.); this needs in particular to take account of further developments in relation to the system's different target groups and users (e.g. the flood forecasting centres of the *Länder*). The general conditions that apply to management of the risk of heavy rain need to be considered in the design of the system (see LAWA 2018, 9). They include the following: heavy rain events cannot be prevented. It is virtually impossible to predict exactly when or where they will occur. Their occurrence in Germany is likely to increase. Absolute protection against the adverse impacts of flooding caused by heavy rain is not possible.	Water regime, Water management, cutting across all fields	BMVI/DWD		BMVI departmental funding	WW-02 WW-03 KUE BAU-02 VE-05 LW-05 IG-02 FiW-01

1.	26	**Federal government guidelines on producing hazard and risk maps for local heavy rain events** The guidelines should be viewed as minimum standards for the production of hazard and risk maps. The production of heavy rain maps cannot usefully be linked to implementation of the Floods Directive; preparation of such maps is therefore not compulsory. Instead, it is necessary to draw up minimum standards that ensure wide understanding of heavy rain maps. The guidelines should be compatible with the LAWA strategy for effective heavy rain risk management. When formulating and reaching agreement on minimum standards, the various target groups of heavy rain risk management should be considered (federal and *Länder* level, municipal level and private stakeholders, see LAWA 2018).	Water regime, Water management	BMI BMU / UBA BMVI / DWD *Länder*		To be determined	WW-02 WW-03 BAU-02 VE-05 IG-02
1.	27	**Providing consumers with better information on regional water scarcity during hot spells** Methods and ideas should be developed (e.g. as a toolbox) to promote long-term awareness-raising of careful water use among the population. Particular attention should be paid to uses that need to be restricted in some regions during hot periods (e.g. garden watering).		BMU/UBA, BMEL		To be determined	
8 Miscellaneous							
1.	28	**Developing threshold values for geothermal heat reservoirs** As part of the transformation of the energy system in order to achieve the German government's climate protection targets, it will in future be necessary to make greater use of underground resources. In particular, heat storage in suitable geological strata can make an important contribution to seasonal buffer systems, to utilisation of excess electricity (power to heat) and above all to the cooling of buildings during hot periods – which will increase as a result of climate change. However, thermal use of underground resources may compete with use by the water sector. Heat inputs into aquifers cause physical, chemical and biological changes there. Steps must therefore be taken to ensure that geothermal use of the subsoil does not lead to unfavourable changes in relation to groundwater and drinking water production. Although the Federal Water Act sets out clear rules on the protection of groundwater and the precedence of use by the water sector over other uses, thermal groundwater use is not covered by any concrete statutory provisions – such as thermal threshold values – at federal level. Local or regional thermal management of the subsoil is therefore required with the aim of avoiding overuse of groundwater and conflicts of use.	Water regime, Water management	**BMU/UBA**	Ongoing	€400,000 departmental research	WW
1.	29	**Identifying basic principles for systematic and structured handling of low water and aridity by the German government and the *Länder*** Insufficient precipitation can lead to low water levels in running waters and to falling groundwater levels that affect many fields of action and sectors (e.g. waterway transport, power plant cooling, water supply, water body ecology) and can cause significant economic and environmental damage. It is clear from climate projections that the frequency of droughts may increase. It is therefore necessary to analyse, across all federal states (*Länder*), the risks that accompany an increase in low-water events, thereby developing the basis for systematic, inter-sectoral and synergetic handling of these risks.	Cutting across all fields	**BMU** BMVI BfG WSV	2019-2021 and to 2025 if appropriate	BMVI budget, BMU budget (ReFoPlan)	WW-05 WW-06 WW-07 WW-08 EW-03 EW-04 VE-04 LW-03 IG-05
1.	30	**Federal government / *Länder* strategy for dealing with accelerated sea-level rise** Because of the major and inter-sectoral significance of the consequences of accelerated sea-level rise for both coastal and non-coastal *Länder* – see e.g. the IPCC Special Report on the Ocean and Cryosphere – the German government will, in close collaboration with the *Länder*: 1. summarise the risks of sea-level rise and 2. specify the steps needed to deal with sea-level rise in a federal/*Länder* strategy. As part of this work, the German government and the *Länder* will also analyse and evaluate further research needs and options for action.	Coastal protection and marine conservation, Water regime, Water management, cutting across all fields	**BMU**, BMEL, BMVI/BSH, BfG, BAW, WSV, further federal ministries and authorities technically responsible, *Länder*/LAWA, AFK	2020-2022	Ongoing departmental funding	KUE
1.	31	**Federal spatial development plan for flood protection**	Cutting across all fields	**BMI/BBSR**	2020-2021	BMI budget	WW-02, KUE-01 KUE-02, KUE-03 BAU, EW, VE

Ref. no.		Title and brief description of the mechanism/action	Fields of action	Lead organisation(s) / partner(s)	Period	Funding / funding provider	Climate impacts addressed (for abbreviations see overview table of climate impacts)
"Infrastructure" cluster							
1 Adaptation of infrastructures							
2.	1	**Organisational establishment of the task of "Adaptation to climate change" in the Federal Waterways and Shipping Administration (WSV)** 1. Creation of the organisational conditions and development of corresponding administration-specific rules. 2. Provision of a WSV manual on "Climate proofing – Safeguarding the transport infrastructure against the impacts of climate change". 3. Creation of a training programme for practising hydraulic engineers on performing climate impact analyses in planning practice (training and professional development of technical staff, combined university/practical training, training of candidates and trainees).	Water regime Water management, Transport, Transport infrastructure	**BMVI / WSV** BfG BAW DWD BSH	Permanent task commenced in 2018	BMVI departmental funding	VE WW KUE IG BAU
2.	2	**Determination of strategic alternative routes** As a result of climate change (e.g. storms, landslides, floods), the length of time during which important rail routes are not fully functionable will be non-tolerable. Drawing on a hazard analysis and in collaboration with the infrastructure operator (DB Netz AG), steps should be taken to determine which alternative routes must be retained long-term to buffer these events; these alternative routes thus acquire strategic importance.	Transport, Transport infrastructure	**BMVI, DZSF / EBA**	In preparation	BMVI departmental funding	VE-05 IG-03
2.	3	**Identifying the vulnerability of rail infrastructure** It must be assumed that not only increased heavy rain events but also heat and aridity will affect some regions in future. In view of possible impacts on the infrastructure – e.g. in the form of floods, landslides, embankment fires or storm damage (due in part to drought stress in trackside vegetation) – vulnerability assessments are required that cover all modes of transport; these are currently being produced.	Transport, Transport infrastructure, Water regime, Water management, Marine conservation	**BMVI, DZSF / EBA**	Ongoing, outcomes expected for 2025 (should be established as permanent task)	BMVI departmental funding	VE-03 VE-05 IG-03
2.	4	**Evaluation of statements on climate compatibility in EIAs for both new construction and expansion projects** Reviewing building applications for statements on climate compatibility in the context of Environmental Impact Assessments (EIAs).	Transport, Transport infrastructure	**BMVI / EBA, WSV**	Since 2015, ongoing (to be concluded in 2019; should be established as permanent task)	BMVI departmental funding	VE-03 VE-05 IG-03
2.	5	**Climate proofing transport infrastructure: federal waterway – the Kiel Canal** 1. Short-term simulation model system for operational forecasting for water management of the Kiel Canal (2020-2025) 2. Identification and analysis of options for refurbishment of the large Kiel-Holtenau locks (2018-2035) 3. Consideration of the impacts of sea-level rise on the canal and the federal waterway installations.	Cutting across all fields	**BMVI, WSV, BfG,** BAW, BSH, DWD	2018-2035	€500,000 departmental funding	KUE-03 VE-04 IG-04 WW-02

2.	6	**Climate proofing transport infrastructure: federal waterway – the Eider** 1. Regionalised long-term simulations to identify boundary states and framework data for regulatory operations in connection with water management for the Eider and for operation of the Eider barrage, including identification of design and operating values for the other structures on this federal waterway 2. Short-term simulation model system for operational forecasting for water management of the Eider and operation of the Eider barrage, including identification of control parameters for the other structures on this federal waterway 3. The rise in sea level requires monitoring and possible adaptation of the installations on the federal waterway	Water regime Water management, Transport, Transport infrastructure	**BMVI / WSV,** BfG, BAW, BSH, DWD, processed at present by BfG, WSA Tönning	In preparation, to 2021	€200,000 departmental funding	KUE-01 KUE-03 VE-04 BAU-01 IG-04 WW-02
2.	7	**Climate proofing transport infrastructure: federal waterway – the Lower Trave, Trave, Peene and Peenestrom** 1.Regionalised long-term simulations to optimise the future maintenance strategy in the area where the Lower Trave flows into the Baltic. 2. Model studies to draw up adaptation strategies for the reduction as a result of sea-level rise in the discharge gradient of the water bodies flowing into the Baltic. 3. The rise in sea level means that monitoring and possible adaptation of the installations on the federal waterway are required.	Building industry, Water regime, Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfGBAW, BSH, DWD	2020-2025	Departmental funding	KUE-01 KUE-03 VE-04 BAU-01 IG-04 WW-09
2.	8	**Climate proofing transport infrastructure: federal waterway – the Outer Elbe** 1. Regionalised long-term simulations to monitor the functionality and integrity (especially development of the potholes) of the Kugelbake breakwater where the Elbe flows into the North Sea, including identification of design and operating values for the other installations on this federal waterway. 2. The rise in sea level means that monitoring and possible adaptation of the installations on the federal waterway are required.	Water regime, Water management, Marine conservation, Coastal protection, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW, BSH, DWD	In preparation	Departmental funding	KUE-01 VE KUE-03 VE-04
2.	9	**Climate proofing transport infrastructure: federal waterway – the Lower Weser** 1. Identification and analysis of adaptation options for operation of the storm surge barrages and water management in the tributaries of the Lower Weser federal waterway. 2. The rise in sea level means that monitoring and possible adaptation of the installations on the federal waterway are required.	Building industry, Water regime, Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW, BSH, DWD	In preparation	Departmental funding	KUE-01 KUE-03 VE-04 BAU-01 IG-04 WW-09
2.	10	**Climate proofing transport infrastructure: federal waterway – the Elbe Lateral Canal** 1. Management of water resources in relation to water management of the Elbe Lateral Canal (ELC) federal waterway, taking into consideration the field irrigation of agricultural land (2013-2017). 2. Development of an instrument for water management of the ELC to identify decisions concerning water abstraction for the field irrigation of agricultural land, taking into consideration the groundwater inflow and operation of the pumping station (2018-2021).	Building industry, Water regime, Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW	2013-2021	€300,000 departmental funding	WW-05 WW-06 EW-04 VE-04 IG-04 LW-01
2.	11	**Climate proofing transport infrastructure: federal waterway – the Weser** 1. Provision of discharge and water budget projections for the catchment area of the Weser (inner) federal waterway. 2. Establishment of a Weser Conference to promote dialogue between riparian stakeholders. 3. Optimisation of maintenance measures on the Upper Weser federal waterway.	Building industry, Water regime, Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW	2016-2025	€250,000 departmental funding	WW-01 WW-02 WW-05 WW-06 WW-08 VE-04 IG-04

2.	12	**Climate proofing transport infrastructure: dams for which the federal government is responsible** 1. Impacts of the changing climate on management of the Eder and Diemel dams 2. Changing the management of dams in the light of climate change. In a changing climate, the multifunctional use of dams can be facilitated by means of adaptive dam management.	Cutting across all fields	**BMVI, WSV,** BfG, BAW	Not yet commenced	Departmental funding	WW-01, WW-02 WW-06, WW-07 WW-08 TOU-01, TOU-02 VE-04 IG-04, IG-05 EW-04 LW-03
2.	13	**Climate proofing transport infrastructure: federal waterway – the Rhine**	Building industry, Water regime Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW	Permanent task	Departmental funding	VE-04 IG-04 WW-02, WW-03 WW-06, WW-07 WW-08
2.	14	**Climate proofing transport infrastructure: federal waterway – the Danube** Regionalised long-term simulation; influence of climate change on the low-water discharge quantities of the Danube, taking into consideration the water transfer to the Regnitz-Main area by the state of Bavaria.	Building industry, Water regime Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG BAW	Not yet commenced	Departmental funding	WW-05 WW-06 VE-04 EW-03 IG-04
2.	15	**Climate proofing transport infrastructure: federal waterway – the Rhine-Main-Danube Canal** Regionalised long-term simulation to identify boundary states and framework data for regular operation for water management; influence of climate change on the operating water supply of the Main-Danube Canal, taking into consideration the quantities discharged into the Danube; specification of whether and how adaptation of the infrastructure for operational water supply can and should take place.	Water regime, Water management, Tourism industry, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW, DWD	Not yet commenced	Departmental funding	WW-06 VE-04 IG-04
2.	16	**Climate proofing transport infrastructure: federal waterway – the Oder** Production of climate and discharge projections for the Oder catchment area	Building industry, Water regime Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG, BAW, DWD	Not yet commenced	Departmental funding	WW-02 WW-06 VE-04 IG-04
2.	17	**Climate proofing transport infrastructure: federal waterway installations on the North Sea** Basic analysis of tidal water states on German coasts and estuaries by extending the monitoring network in the area of the German North Sea, in order to be able to depict a tide that is uninfluenced and not adversely affected by freshwater discharge.	Building industry, Water regime Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG BAW, DWD, BSH	Planned	Departmental funding	KUE-01 KUE-03 VE-04 BAU-01 IG-04 WW-09
2.	18	**Climate proofing transport infrastructure: federal waterway – the Upper Havel waterway** Identification and analysis of adaptation options for water management	Building industry, Water regime Water management, Transport, Transport infrastructure	**BMVI, WSV,** BfG BAW, DWD	2016-2025	Departmental funding	WW01 WW02 WW06 WW09

2.	19	**Topic area 1 "Adapting transport and infrastructure to climate change and extreme weather events" in the expert network of the Federal Ministry of Transport and Digital Infrastructure** Activities in topic area 1 include drawing up illustrative climate impact analyses for the transport modes of road, rail and waterways. The climate impact analyses investigate climatic influences and the hazard potentials of climate-induced natural hazards on the basis of climate projections, hazard maps and other data for the future until 2100. In addition, methods and model tools are developed which in some cases are then transferred into permanent climate advice services (e.g. the DAS "Climate and water" open service, PROWaS).	Transport, Transport infrastructure, Cutting across all fields	**BMVI, DWD, DSZF/EBA BSH, BfG (2020-2025 coordination phase), BASt (2016-2019 coordination phase), BAW**	2016-2025	BMVI departmental funding	WW KUE VE
2.	20	**Federal programme for adapting urban spaces to climate change** Project funding for climate-adapted urban development involving targeted development and modernisation of green spaces in urban areas.	Human health, Biodiversity, Water regime, Water management, Cutting across all fields	**BMI / BBSR**	2021-2023	EKF €200 million (guaranteed level of funding)	BAU BAU-04
2 Adaptation of legal instruments and technical rules and standards							
2.	21	**Evaluation of adaptation of the technical rules and standards as applicable to Deutsche Bahn AG Infrastructure** At DB Netz AG, implementation of the process of transferring climate-sensitive parameters into technical rules and standards needs to be reviewed at regular intervals.	Transport, Transport infrastructure	**BMVI / EBA,** Deutsches Institut für Normung (DIN), stakeholders interested in standardisation	Since 2015, ongoing	BMVI departmental funding	VE-03 VE-05
4 Funding and incentives							
2.	22	**Promoting increased investment via the Federal Transport Infrastructure Plan (Road)** Storm damage affecting road infrastructure can be reduced by checking vegetation and slopes. Floods and undermining by water are also relevant to the road infrastructure. Aspects of adaptation to climate change should be taken into account in investment under the Federal Transport Infrastructure Plan. The instrument aims to convert the existing road infrastructure to make it more robust in the face of potential damage from extreme weather events, thereby avoiding potential failures in the transport system as a result of the damage. This involves not only roads but also bridges, tunnels and transshipment points.	Transport, Transport infrastructure	**BMVI**	Regular rollout of investment programmes (five-year plans) and of BVWP	To be determined	VE VE-05
2.	23	**Adaptation of the rail infrastructure to the state of the art** The instrument aims mainly to convert the existing rail infrastructure to make it more robust in the face of potential damage from extreme weather events, thereby avoiding potential failures in the transport system as a result of damage. An important aspect of this is the design of embankments, as they are potentially vulnerable to storm damage. Transport failures can also be prevented by maintaining alternative routes.	Transport, Transport infrastructure	**BMVI**		To be determined	VE VE-05
2.	24	**Integrating aspects of climate-resilient construction (for both new and existing buildings) into funding programmes** Climate change results in an increased incidence of heat waves. This block of measures aims to design buildings so that they counteract the rise in indoor temperatures as a result of climate change in a climate-friendly manner. Examples of ways in which this can be achieved include summer heat protection (shading) and evaporative cooling. The buildings should, where possible and appropriate, have facilities for ventilation during the cooler night hours (preferably ventilation systems). The KfW funding programmes "Energy-efficient construction and renovation" (EBS) for residential and non-residential buildings are aimed both at private housing owners and at municipal and commercial owners/applicants.	Building industry	**BMWi (for the KfW EBS funding programmes)**		No information	

2.	25	**Feasibility study on green roofs and façades** The first step towards making use of the potential of green roofs and façades in future involves compiling a feasibility study as the basis for funding guidelines at federal level. The project's main aim is to evaluate ongoing funding of green roofs and façades. In addition, as a basis for the establishment of a possible funding programme, the current state of knowledge will be summarised – e.g. by describing practical building solutions and their contribution to climate change mitigation, summer temperature reduction, rainwater management, ecological diversity, etc.	Building industry, Water regime, Water management, Biodiversity, Human health	**BMI / BBSR**	2020-2021	BMI departmental funding	BAU-04 BAU-05 BD-02 BD-03 BD-04 GE-01 WW-02 WW-03
5 Research and monitoring							
2.	26	**Assembling key data required to take account of climate impacts when defining projects as part of federal transport infrastructure planning** A need for action as part of federal transport infrastructure planning can arise if impacts of climate change make changes or additions to infrastructure necessary at network level. This applies in particular if the climate-induced circumstances do not impact or do not impact only on the technical design of the measures but also affect the routes used by road and rail. This would be the case if, for example, relevant links used by transport or freight flows are at high risk of disruption. It is entirely possible that the adaptation-related framework conditions will be integrated into the existing review process that accompanies the Federal Transport Infrastructure Plan and thus included in the planning process at a very early stage. However, there is a need for research, because necessary data that need to be taken into account in the Federal Transport Infrastructure Plan are not yet available. For example, rules on spaces with pronounced climate-related risks must be spatially specified in more detail and available in a resolution that corresponds to the scale of other spatial investigations of the Federal Transport Infrastructure Plan (e.g. transport route plausibility checks from an environmental and nature conservation perspective). At the same time, in view of the fact that the Federal Transport Infrastructure Plan does not define any specifications in connection with the routing of proposed federal transport infrastructure projects (these specifications arise only in the planning phases that follow the Plan), clarification is also needed of whether the costs and benefits of taking climate impacts into account when defining projects at the level of the Plan are proportionate.	Transport, Transport infrastructure	**BMVI**	Permanent task, in preparation	BMVI departmental funding	VE-04 IG-04
2.	27	**Reports and charts of ice cover in the Baltic, the North Sea and other marine areas worldwide** For the safety of shipping in areas with seasonal or year-round ice cover, reports and charts on the state, extent and future distribution of sea ice are needed. The information from the ice information service of the Federal Maritime and Hydrographic Agency of Germany (BSH) is an important basis for climatological time series and investigations. The BSH ice service covers mainly the western Baltic and the North Sea, but advice is also provided to German shipping worldwide. Against the backdrop of climate change, advice services relating to polar waters (northern sea routes, the Antarctic) are becoming increasingly important.	Transport, Transport infrastructure, Building industry, Coastal protection, Fisheries	**BSH,** DWD, DLR, ice services of neighbouring states	Since 1926, permanent task	BSH budget	VE IG-04
2.	28	**Initiating systematic recording of damage to the railway infrastructure** The systematic recording of damage to the railway infrastructure by river floods provides an important basis for understanding causal links relevant to this natural hazard. Damage to the infrastructure is recorded by the infrastructure operators. The Federal Railway Authority (EBA), in dialogue with the infrastructure operators, creates heightened awareness of the issue of a standardised, systematic and detailed (including damage, timing, locality, etc.) system for recording damage that can be categorised and evaluated as the work continues.	Transport, Transport infrastructure	**BMVI/DSZF/EBA**		Departmental funding	BAU-02 VE-05
2.	29	**Producing a hazard map for river flooding – rail infrastructure** Flood hazard maps provide the basis for designating areas of the rail system that are potentially at risk from flooding. As part of the first phase of the expert network, an initial flood hazard map has already been generated. More detailed consideration of climate change (updates provided by the *Länder*), the additional inclusion of return periods or the incorporation of track heights and flood heights would enable future impacts of flooding to be recorded in more detail: the information could be made available to the infrastructure operators and appropriate recommendations for action could be drawn up.	Transport, Transport infrastructure, Building industry, Water regime, Water management	**BMVI/DSZF/ EBA,** BfG		Departmental funding	BAU-02 VE-05

2.	30	**Sensitivity analysis of vegetation along federal transport routes with regard to extreme weather and climate change** Hazards as a result of storm damage and embankment fires are a significant risk and one that is amplified by climate change. It is necessary to identify the (vegetation) factors that lead to storm damage and vegetation fires (focus: topographical data, tree type, geology, soil, moisture levels, …). Recommendations for action on adapted vegetation management (species adapted to more extreme weather conditions) should be drawn up; they should take account of ecological aspects (invasive species, relevance to health, …) (link with TF-2). The incidence of easily flammable vegetation should be identified.	Transport infrastructure	**BMVI/DSZF/EBA**	2021-2022	€200,000 in BMVI departmental funding	
7 Public awareness, communication, information (education, guidance)							
2.	31	**Optimising road drainage with particular attention to conflicts of objectives in preparedness for local heavy rain events** The mechanism is based on further development of existing instruments for dimensioning road drainage in connection with preparedness for local heavy rain (e.g. B. KOSTRA-DWD), taking account of climate projections (see DWD 2015, 2017b, BMUB 2016, p. 34, see also Die Bundesregierung 2015, p. 241). Three priorities are pivotal to the mechanism: (1) Optimising the dimensioning of road drainage on the basis of up-to-date climate projections with associated calculation runs for forward-looking consideration of climate change; (2) Drawing up general instructions for dealing with conflicts of objectives when optimising road drainage in preparedness for local heavy rain events (e.g. optimising road spaces with regard both to above-ground discharge of local heavy rain events and to the accessibility of road spaces); (3) Documentation and dissemination of good examples and best practices in connection with the optimisation of road drainage in preparedness for heavy rain.	Transport, Transport infrastructure, Building industry, Water regime, Water management	**BMVI/BaSt,** BfG, BMU/UBA, DWD		To be determined	WW-03 BAU-02 VE-05 IG-03
8 Miscellaneous							
2.	32	**Climate-adapted building construction** As a general point, it should be noted that compliance with current technical codes provides the federal government's buildings and structures with sufficient resistance against normal weather events. However, to strengthen buildings and structures against future challenges arising from climate change and extreme weather events that already need to be coped with now, existing knowledge and information about these events must be incorporated into the technical regulations on upkeep, maintenance and new construction. This would enable significant hazard potentials to be identified promptly and damage events to be reduced significantly (see "Safeguarding buildings and structures against heavy rain"). Assessment guides, local/regional safe load tables and so on are desirable so that the increasing design loads for buildings and installations as a result of (a) floods, heavy rain, sewer backpressure, (b) hail, (c) storm and (d) heat and aridity can be addressed via confident action from the building trade. The German government's Assessment System for Sustainable Building (BNB) enables "resistance to natural hazards" to be assessed by means of an issue-related questionnaire that comes with explanatory notes. The risks of wind, heavy rain, hail and snow, and floods are considered. (Source: BBSR brochure: Klimaangepasstes Bauen bei Gebäuden BBSR-Analysen KOMPAKT 2/2015 [Climate-adapted building construction] silvia.haupt@bbr.bund.de; https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/analysen-kompakt/2015/DL_02_2015.pdf?__blob=publicationFile&v=3)	Building industry	**BMI/BBSR**, BMU BMF/ BImA	Ongoing, delayed	Departmental funding	BAU-02 BAU-03
2.	33	**Examining the potential of reviewing heat load plans under changed hydrological and temperature conditions** Risks to energy generation by thermal power plants and to production in industrial processes can arise from hydrological changes to water bodies from which cooling water is taken. Higher water body temperatures can also lead to more frequent restrictions on the discharge of cooling water, or to limited permissible water withdrawal during periods of low water. Consideration therefore needs to be given to the extent to which power plant management should be optimised. In this connection the most up-to-date technology and the availability of cooling technologies that prevent the discharge of heated water should also be examined.	Water regime, Water management, Energy industry	BMU BMVI BfG	In preparation, to be implemented by 2050	€200,000	EW-04

Ref. no.		Title and brief description of the mechanism/action	Fields of action	Lead organisation(s) / partner(s)	Period	Funding / funding provider	Climate impacts addressed (for abbreviations see overview table of climate impacts)
"Land" cluster							
3.	1	**Programme of measures to support the agenda for adapting agriculture, forestry, fisheries and aquaculture to climate change** In 2019, a programme of measures for climate adaptation was developed on the basis of the agenda for adapting agriculture, forestry, fisheries and aquaculture to climate change. Representatives of the federal government and the *Länder* worked in expert groups to develop climate adaptation measures for the following specialist areas: crops (arable and specialty crops), forests, livestock, fisheries and aquaculture, as well as the area of "superordinate themes". In the subsequent coordination process, the following priority areas were identified: "Research", "Risk assessment", "Practical transfer", "Breeding" and "Water management".	Agriculture, Soil, Woodland and forestry, Fisheries	**BMEL, BMU, *Länder*, DWD, TI, JKI, FLI**	Ongoing	Federal government and *Länder*	LW-01 LW-02 LW-03 LW-04 LW-05 FW-01 FW-02 FW-03 FW-04 FW-05
1 Adaptation of infrastructures							
3.	2	**Development of a nationwide functional habitat network** to create survival opportunities for native species and habitats and to allow for geographical adaptation of organisms on foot of climatic changes.	Biodiversity	**BMU/ *Länder***	Ongoing	Utilisation of existing grant programmes	BD-02 BD-04
3.	3	**Optimising the habitats of climate-sensitive and/or endangered species in order to make them more resilient and adaptable.** For example, maintaining sufficiently large areas with habitat protection function, intensifying development measures to promote greater naturalness of ecosystems, allowing natural ecosystem dynamics to function.	Biodiversity	**BMU/ *Länder***	Permanent task	Utilisation of existing grant programmes	BD-02 BD-04
3.	4	**Creation of climate-resilient forests in federal ownership** "Taking into consideration the intended purposes of the different federal forests, BImA is developing stable, structurally diverse, site-adapted mixed forests, exploiting natural succession processes for this purpose. In this respect, it is being guided by the latest research." (Adaptation Action Plan, APA 2011, Activity B.3.13; BMF/BImA, from 2011)	Woodland and forestry	**BMF / BImA, BMU,** BMEL	Permanent task since 2011	No extra financing requirement	FW FW-04 FW-05 FW-06
3.	5	**Systematic consideration of the climate protection functions of soils in federal projects** Soil can counteract climate change by means of its function as a carbon store and its cooling function in the lower atmosphere. Many interventions in the soil result in a reduction in this climate protection function. As a construction and planning authority, the federal government is a land user. It can be a role model for the protection of the soils' climate protection functions. Planning, implementation and operational phases of federal projects should be systematically reviewed as to their potential for optimisation and adapted accordingly.	Cutting across all fields	**BMU / UBA,** BMEL, BGR	Permanent task, ongoing	No extra financing requirement	BO
3.	6	**Creation and permanent safeguarding of site-appropriate, near-natural, structurally rich, climate-stable and ecologically high-quality forest ecosystems consisting predominantly of native tree species** This also includes the promotion of natural forest regeneration as opposed to planting wherever sites are suitable, as well as the alignment of hunting activities (size of game populations) to the forests' needs.	Woodland and forestry, Biodiversity	**BMEL, BMU, *Länder***	Permanent task	GAK resources	BD 02 BD 03 BD 04 FW 01 FW 02 FW 03

4 Funding and incentives							
3.	7	**Forest Climate Fund (Waldklimafonds, WKF) funding instrument** The measures under the Forest Climate Fund are intended to exploit and optimise the CO2 reduction, energy and substitution potential of forests and timber and to support the adaptation of German forests to climate change.	Cutting across all fields	**BMEL, BMU**, FNR	Ongoing since 2013	€24.5 million from EKF for 2020 financial year	FW
3.	8	**Federal Biodiversity Programme (Bundesprogramm Biologische Vielfalt)** Implementation of the German National Strategy on Biological Diversity. The "ecosystem services" funding priority explicitly mentions "ensuring adaptability to climate change".	Biodiversity	**BMU**	Ongoing since 2011	€44.95 million departmental financing (2020) (BMU, Federal Biodiversity Programme)	BD
3.	9	**Measures to safeguard the remaining stock of raised bogs and fens, and rewetting** The programme aims to maintain or restore natural water levels. Among other things, financial resources are to be made available for compensation payments to farmers and the purchase of agricultural land.	Soil, Agriculture, Forestry, Biodiversity	**BMU, BMEL *Länder***	Ongoing	Departmental financing	BO BD
3.	10	**Further development of support for measures to adapt forests to climate change as part of the joint task "improvement of agricultural structures and coastal protection" (GAK)**	Forestry, Biodiversity	**BMEL, *Länder*,** BMU	Ongoing	GAK purpose code 5a resources	BD 02 BD 03 BD 04 FW 01 FW 02 FW 03
3.	11	**Support for forest areas with natural forest development in order to create a system of reference areas that can provide indications for climate change adaptation in forest management through systematic monitoring**	Biodiversity	**BMEL, *Länder*,** BMU	Ongoing	GAK purpose code 5a resources	BD 02 BD 03 BD 04
5 Research and monitoring							
3.	12	**Research on sustainable use of peatlands** Alternative uses should be developed that allow for the sustainable and economically viable use of wet and rewetted peatlands without permanent drainage. Efforts to survey and evaluate the properties and functions of peatland soils must be intensified. The effects of climate change, utilisation of and restoration measures in peatlands must be recorded as part of soil monitoring schemes.	Soil, Biodiversity	**BMU** / BfN, BMEL, TI, JKI, FNR	Permanent task	Departmental financing (ReFoPlan)	BO BD
3.	13	**Research on Payments for Ecosystem Services, PES** Payments for ecosystem services involve voluntary transactions between a service provider and a beneficiary. A financial incentive for the provider (e.g. the farmer) to manage his/her land sustainably results in the protection of ecosystem services. Ecosystem services may be financed by the government as well as by private companies or organisations. An example is Vittel in France, where Vittel pays for the service of a low-impact (low-nitrate) farming sector in the surroundings of the Vittel spring. Measures undertaken as part of a contractual conservation management agreement may also be understood as PES. Since only a few pilot examples are available to date and conceptual questions are still to be resolved, this approach should be defined in greater detail and further developed by means of research assignments. In addition, requisite framework conditions should be identified, analysed and taken into account in the further implementation of pilot projects. Furthermore, the pilot projects should generate data, especially for surveying and evaluating the benefits of ecosystem services. Pilot projects could be undertaken in public-private partnerships as well as within the private sector. Moreover, investigations should be undertaken to examine the extent to which the practical application of payments for ecosystem services can be supported.	Biodiversity	**BMU** / BfN, BMEL	Permanent task, ongoing	Departmental financing (ReFoPlan)	

3.	14	**Safeguarding ecosystem integrity in a changing climate** Based on scenarios for climate change and other stressors, projections of the development of ecosystem functions and services as well as biodiversity are to be made and a nationwide uniformly applicable assessment system for the status and sustainable development of near-natural terrestrial ecosystems is to be developed.	Biodiversity, Woodland and forestry	BMU / UBA / BfN, BMEL, implementation also by *Länder*	Permanent task	Further financing is uncertain. Application could be supported via other grant programmes.	BD-03 BD-04 BO-03 BO-05 FW-01 FW-02 FW-03 FW-05
3.	15	**Update and validation of nationwide data on climate change impacts on soil erosion by water** Initial nationwide data on potential soil erosion risks due to water are available from the Federal Institute for Geosciences and Natural Resources (BGR) and on possible climate change-related trends from the Federal Environment Agency (UBA), at a scale of 1:1,000,000. Objective: To update the nationwide data and maps on the impacts of climate change on soil erosion by water which have been available since the beginning of 2010. The basis to date has been the WETTREG climate model. In order to be able to assess the range of future developments in soil erosion and to have valid data at hand, an ensemble of climate scenarios will be considered in a further step.	Soil	**BMU / UBA,** BMWi / BGR	Ongoing	BMU/BMWi departmental financing	BO-01
3.	16	**Determining changes in humus content and their causes** A soil's humus content largely determines its yield capacity and forms a major carbon sink in the global carbon budget. Changing land-use patterns and a change in climatic variables determine the humus dynamics and thus the soils' humus content in the future. The ongoing research activities on the collection and modelling of carbon contents must be networked and, where necessary, supplemented with missing parameters and other aspects. The results are to be integrated into the Federal Soil Protection Ordinance (BBodSchV) and serve as technical underpinnings of Section 17 of the Federal Soil Protection Act (BBodSchG).	Soil	**BMU / UBA** BMEL / TI	Ongoing	BMU departmental financing	BO-05
3.	17	**Intensifying research on the interactions of climate change, pests and diseases, and damaging abiotic and biotic factors and their impacts on our forests in order to develop recommended actions for creating and securing site-appropriate, near-natural, structurally rich, climate-stable and ecologically high-quality forest ecosystems consisting predominantly of native tree species.** Monitor and quantify risks to forests, adapt tree species recommendations with a focus on creating stable, structurally rich and site-appropriate mixed forests, revise site mapping, forest fire and pest prevention.	Woodland and forestry	**BMEL / TI, BMU, BfN, DWD, JKI**	Permanent task	BMU departmental financing	FW
3.	18	**Support for research and innovation to adapt environmental assessment and risk management of plant protection products and their active substances to changing climatic conditions** Support is needed particularly in the following areas: Estimation of the degradation and exposure of active substances of plant protection products in the environment (groundwater, surface waters). Advancement of models and scenarios with regard to changing climatic conditions, taking into account the objective of a harmonised assessment of exposure at the EU level. Further development of methods for risk reduction under changing climatic conditions.	Cutting across all fields	BMU / **UBA,** BMEL	Permanent task since 2015	BMU departmental financing	WW-09
3.	19	**Continuation and strengthening of research on biodiversity and climate change** Research on biodiversity with relevance to climate change mitigation and climate adaptation is being continued in the course of projects. Additionally, adaptation strategies are being developed in the fields of species and site conservation with a view to reducing losses of climate-sensitive species of animals and plants. Field research is being intensified to this end. Action-oriented recommendations for climate change-appropriate management of protected areas are being developed.	Biodiversity, Spatial planning, regional and urban development	**BMU / BFN, BMEL, TI**	Permanent task	Departmental financing (ReFoPlan)	BD

3.	20	**Research initiative for the conservation of biodiversity** In order to better understand the varied changes in biodiversity, some of which are climate-related, and the rapid decline in biological species diversity, the Federal Ministry of Education and Research (BMBF) launched the Research Initiative for the Conservation of Biodiversity as a FONA flagship initiative in 2019. This will significantly advance biodiversity research, more strongly bundle relevant research activities and make a sustained contribution to combating the ongoing loss of biological diversity. As an immediate measure, it is planned to commence a national assessment in 2021, which will comprehensively process the current state of knowledge on key issues of the research initiative in an easily understandable manner and as quickly as possible, develop concepts to guide research and to provide an information system that freely gives access to the literature and data basis underlying the assessment. Moreover, on the basis of the BiodiWert support measure ("valuing biodiversity"), a total of 19 conceptual phases for research projects on the protection of biodiversity and the conservation of important ecosystem services will commence from late 2020.	Biodiversity, Soil, Water regime, Water management	**BMBF**	2020-2024 (ff)	Departmental financing	BD BO LW LF FI-01 KUE-02
3.	21	**Strengthening research on soil biology** Soil organisms make a key contribution to the nutrient supply, substance flows and turnover of substances in soils. Site-specific climate-relevant factors such as soil moisture and soil temperature impact on the occurrence, distribution and performance of soil organisms. Action required: Evaluation of studies. We need: Reference values for soil organisms for soils in Germany, methods and indicators, linkage of monitoring programme to existing programmes (UBA/Thünen). Impacts resulting from UV exposure should also be included here.	Soil, Biodiversity	**BMU/ UBA + BfN, BMEL, TI**	Permanent task	Departmental financing (ReFoPlan)	BO-04
3.	22	**Cooperation projects with partner institutes. Development of an operational monitoring and forecasting portal which indicates erosion risks and critical soil moisture (in relation to soil trafficability)** Soil erosion caused by wind and precipitation is an increasing threat to arable soils and environmental waters. A possible increase in weather conditions favouring soil erosion as a result of climate change must be taken into account. Soil compaction poses a risk to soil fertility. Soil moisture is one of the most important influencing variables and it is subject to possible fluctuations as a result of climate change. Federal-level soil information systems, as envisaged by the sectoral technical network on soils (Fachnetzwerk Boden.Bund), must be further developed. Farmers need information on how conditions may change as a result of climate change. The interdisciplinary contact point for agricultural meteorology (inKA) is to operationalise soil information for the ISABEL online portal (information system for agricultural meteorological advice for the *Länder*).	Soil	**DWD,** BMEL/JKI, TI, BGR	Permanent task, ongoing	DWD budget	BO-01 BO-02
3.	23	**Water conservation cooperation projects with partner institutes. Climate change adaptation of irrigation practices and crop protection measures. Development of a monitoring and forecasting portal** Efficient water use, the reduction of groundwater nitrate pollution and improvements in the sustainable use of plant protection products are tasks that must be addressed, especially in a changing climate. Fundamental agrometeorological and climatological work is required with regard to new crop cultivars and energy crops as a result of climate change. Farmers must be given tools allowing them to implement sustainable farming operations in the sense of good agricultural practice. The interdisciplinary contact point for agricultural meteorology (inKA) is to operationalise soil information for the ISABEL online portal (information system for agricultural meteorological advice for the *Länder*).	Agriculture	**DWD,** BMEL/JKI, TI	Permanent task, ongoing	DWD budget	LW-01 LW- 02 LW- 03 LW- 05
3.	24	**Cooperative projects to investigate future threats to forests from stormy weather conditions, fires and pests as consequences of climate change** Investigation of the adaptation of certain pest species (e.g. European spruce bark beetle) to the impacts of climate change. Conduct site climate studies with a view to climate-related tree species recommendations, aided by agrometeorological models. Investigate the extent to which the frequency of potentially forest-damaging storms as well as slope and forest fires will change as a result of climate change.	Woodland and forestry	**DWD,** BMEL, BMU	5 years from launch onwards, currently in preparation	To be determined	FW-01 FW- 02 FW- 03 FW - 04 FW- 05 FW - 06 FW - 07

3.	25	**Examining the potential of coordinated action by the federal government and the *Länder* to establish a programme monitoring direct and indirect climate change impacts on biodiversity in Germany** Targeted and permanent monitoring is required to detect direct and indirect climate change impacts on biodiversity in Germany at an early stage and to document changes. On the basis of Section 6 of the Federal Nature Conservation Act, (BNatSchG), the main subjects of such monitoring should be changes in the abundance and range of species, changes in biotic communities and habitats, as well as possible indirect climate change impacts due to changes in land use. Established nationwide monitoring programmes such as avifaunal monitoring, monitoring of Natura 2000 sites, monitoring of high nature value farmland or butterfly monitoring are only of limited utility in this context and would need to be expanded. In addition, a nationwide monitoring of biodiversity in agricultural landscapes (MonViA) is being developed on behalf of the Federal Ministry of Food and Agriculture (BMEL), which integrates meteorological data and site factors in cause-effect relationships. Furthermore, there is a need to establish new programmes, especially for the monitoring of habitats, vascular plants and invertebrates, with a focus on climate change impacts. These programmes should also cover the implementation of climate change adaptation measures and the success of such measures in the area of biodiversity.	Biodiversity	**BMU, BfN, BMEL, TI, JKI, BLE** ***Länder***	Depends upon financing	To be determined	BD
3.	26	**Studies on soil water content and on altered biochemical turnover of substances in the soil in the wake of increasing droughts and heavy rainfall events** Investigation of the influence of changing precipitation patterns on the overall soil water balance and its various components (surface runoff, storage, deep infiltration, changes in turnover of substances, plant nutrient supply, changes in soil moisture). Based on this, development of recommendations for site-adapted soil management. Recommendations for additions to or more detailed specification of best practice provisions or other legal acts in order to reduce flood risks due to increasing heavy rainfall events by improving soil infiltration capacity and reducing surface runoff of agricultural soils.	Soil	**BMU/ UBA, DWD**	Permanent task 2017-2022	ReFoPlan BMU/ UBA	WW-06 BO-02 BO-03 BO-04 BO-05
3.	27	**Assessment of the genetic suitability of the different spatial populations of native tree species in Germany for climate change adaptation by means of expanding the programmes of the federal government and the *Länder* in the area of forest tree breeding and provenance research as well as cooperation in working groups with countries at the European level. Continuation and strengthening of networking activities in the area of forest genetic conservation at the national and European levels.**	Forestry, Biodiversity	**BMEL, *Länder* (forest research centres) /** TI, BMU	Ongoing	BMEL departmental financing (departmental research plan)	FW 01
3.	28	**Maintenance and expansion of the network of long-term trial sites for tree species and provenance trials, as well as progeny testing, including for non-native provenances of native tree species.**	Forestry, Biodiversity	**BMEL, *Länder* (forest research centres) /** TI, BMU	Ongoing	BMEL departmental financing (departmental research plan)	BD 03 FW 04 FW 05
3.	29	**Improved utilisation of unsealing potential for the restoration of soil functions and for climate adaptation** The proportion of sealed soil surfaces in Germany continues to increase. Currently, every day approximately 60 hectares are newly designated for settlements and transport infrastructure in Germany. Around half of this area will be sealed. Unsealed soils in urban areas preserve biodiversity, help rainwater to infiltrate, recharge groundwater reserves and support evaporation. They thus contribute to improving the inner-city climate and to climate adaptation. By unsealing the soil, it can at least partially they returned to fulfilling its diverse functions. As part of the research project, the Federal Environment Agency identifies existing unsealing potential, examines the existing legal situation and reviews further instruments for promoting unsealing measures. Proposals for improvement will be developed on this basis.	Soil	BMU, UBA, BMEL	2019-2021	€90,000 ReFo-Plan BMU/UBA	BO-02 BO-03 BO-04 BO-05

3.	30	**Implementation and long-term establishment of the climate impact soil monitoring network (Klimafolgen-Bodenmonitoring-Verbund)** The aim of the network is the nationwide recording, monitoring and documentation of the current status of soils in Germany and the changes resulting from climate change. To this end, the network creates easy access to soil-related measurement data for users in science and administration, coordinates and networks activities of operators of monitoring stations and of users, makes long-term soil monitoring activities known to the climate impact and adaptation community, provides the basis for improvements in data quality, and networks different levels of measurement intensity. The focus is on selected priority topics: Soil water balance, soil organic matter, soil biology and soil erosion. Participation in the network is voluntary and free of charge. Measurement data remain in the hands of the data-collecting agencies. A framework participation agreement regulates the participants' tasks and responsibilities. A central office, probably the Federal Environment Agency (UBA), will assume responsibility for future coordination and serve as a contact point. It will operate the website of the climate impact soil monitoring network including map applications and links to participating measurement activities. A steering group including stakeholder representatives will continuously monitor the network's implementation and operation.	Soil	**BMU / UBA, BMEL** TI, *Länder*, DWD, BGR, research institutes	From 2020	Approx. €250,000 annually in first 5 years, approx. €75,000 annually thereafter	BO
6 Networks and cooperation arrangements							
3.	31	**Consolidation of the sectoral technical network on soils (Fachnetzwerk Boden.Bund)** Meetings take place 1-2 times a year at working level. Work priorities of the sectoral network: German Climate Change Adaptation Strategy, Adaptation Action Plan, harmonisation of data evaluation and quality assurance, joint processing of focal issues and research topics in soil protection such as microplastics in soils, application of satellite remote sensing for obtaining soil data.	Soil	**BMU / UBA, BGR, DWD, BMEL /JKI, TI, BAM**	Permanent task	Budgets of authorities involved	BO
3.	32	**Science-policy dialogues on climate change and biodiversity** Organisation and implementation of conferences/meetings/workshops/seminars on climate change and biodiversity for persons involved in science, administration/authorities, nature conservation practice and policy in order to promote the mutual exchange of information and to develop projects/strategies/programmes that serve the implementation of scientific results in practice and policy and highlight current scientific issues of relevance to society.	Cutting across all fields	**BMU / BfN**	Permanent task, ongoing	Departmental financing (ReFoPlan)	BD
7 Public awareness, communication, information (education, guidance)							
3.	33	**Target group-oriented qualification measures to take into account the cooling function and the carbon storage function of soils in the course of their utilisation** Soil can counteract climate change through its function as a carbon store and its cooling function in the lower atmosphere. Many interventions in the soil result in a reduction in this climate protection function. The climate function of soils has already been severely reduced in large areas of Germany. This is highly evident from the high levels of greenhouse gas emissions from agriculturally used peat soils and the formation of urban heat islands. Soil users (e.g. farming sector, forestry, construction industry) must be aware of both these functions and the options for protecting them so that they can take them into account in their land use.	Cutting across all fields	BMU/ UBA, BGR, BMEL	Permanent task	€240,000	BO
3.	34	**Information campaigns on climate change and impacts on biodiversity** Information campaigns on climate change and impacts on biodiversity are to be carried out as part of the public relations work on the German National Strategy on Biological Diversity, in connection with the activities of the UN Decade on Biological Diversity (2011-2020) proclaimed at the end of 2010, and in the implementation of the UN Decade of Education for Sustainable Development (2005-2014) (APA 2011, Activity B.1.2.260; BMU/BfN, period 2011 ff.). In this context, the general population should also be involved as knowledge carriers in order to utilise available knowledge.	Biodiversity	**BMU / BfN**	Permanent task	Departmental financing EP 16 (1604, 1611)	BD

8 Miscellaneous							
3.	35	**Sustainable design of compensation and replacement measures taking into account the consequences of climate change** The rules on intervention mitigation (*Eingriffsregelung*) under German nature conservation law are designed to maintain the status quo ante of the natural resources and scenic qualities of the landscape despite considerable adverse impacts caused by projects. To this end, avoidable impacts are, first and foremost, to be avoided. Unavoidable adverse impacts must be compensated by means of compensatory and replacement measures. Given the effects of climate change and its impacts on biodiversity, the question arises as to how the compensation and replacement measures are to be designed in such a way that they sustainably compensate for the impacts of developments. This requirement relates to both the functional effectiveness as informed by conservation principles and the efficiency of implementation and permanent maintenance of compensation measures. A starting point is the project mentioned in the 2011 Adaptation Action Plan on the "Development and implementation of compensation measures to address the impacts of interventions by using synergies with conservation-oriented adaptation measures", in which methodological approaches were to be developed to take account of climate aspects in the assessment of interventions and in the design of compensation measures.	Biodiversity, Spatial planning, regional and urban development	**BMU / BfN**	Permanent task	Departmental financing (ReFoPlan)	BD
3.	36	**Development and pilot implementation of landscape management measures to maintain the continuity of landscapes** In the context of a planned measure, all types of landscape management measures designed to preserve and develop nature and the landscape, to avoid or compensate for the impacts of interventions, to mitigate the impacts of climate change and to sustainably design land uses are to be assessed for their relevance to climate change adaptation. The focus here is on the model of a permeable landscape that is thus robust in the face of climate change and at the same time allows for sustainable infrastructure development. The package of measures is initially to be implemented and tested as a pilot scheme. The package of measures is closely linked to the Federal Defragmentation Programme.	Biodiversity	BMU / BfN	Permanent task	Departmental financing	BD-04
3.	37	**Inclusion of specific soil protection requirements in the CAP funding envelope** The CAP is an important instrument for the farming sector and thus also for the preservation of soil functions of agricultural soils. The sustainable management soils – a finite resource – is also a prerequisite for increasing the resilience of soils to climate change, especially in extreme weather events. It is therefore appropriate to firmly embed in the CAP requirements for the preservation and improvement of soil functions, including as a basis of direct payments. Going beyond the requirements of direct payments, measures are also partly promoted by means of agri-environment-climate measures (AECMs) under Pillar 2, which serve to protect soils, such as the retention of catch crops and undersown crops over the winter or cultivation methods in sites susceptible to erosion. These measures can also be attributed to the regenerative/restorative farming sector. Outside of the CAP funding envelope, the Federal Ministry of Food and Agriculture (BMEL) is planning a programme to promote humus formation as part of the Climate Action Programme.	Agriculture Soil	BMEL, BMU	Permanent task	CAP funding (especially Pillar 1 / direct payments)	BO-01 BO-02 BO-03 BO-04 BO-05

Ref. no.		Title and brief description of the mechanism/action	Fields of action	Lead organisation(s) / partner(s)	Period	Funding / funding provider	Climate impacts addressed (for abbreviations see overview table of climate impacts)
"Human health" cluster							
4.	1	**Government rules and regulations on occupational health and safety** Occupational health and safety measures provide protection against work-related hazards resulting from climate change, such as heat or UV radiation. Existing regulations as well as relevant government rules on occupational safety and health are being examined and potentially required adjustments determined. This concerns, for example, the Technical Rules for workplaces (Technische Regeln für Arbeitsstätten, ASR).	Human health	**BMAS/BAuA, BMU/BfS,DWD**	Ongoing	No information	GE GE-01
4.	2	**Ordinance on Preventive Occupational Health Care (ArbMedVV)** In 2019, the Ordinance on Preventive Occupational Health Care (ArbMedVV) was amended to include an "Optional health care" provision, i.e. preventive occupational health care which must be offered as an option, for outdoor activities involving intensive exposure to natural UV radiation. In connection with "Optional health care", the ordinance additionally clarified that priority must be given to technical and organisational protective measures (e.g. sun awnings, changed working hours). The amendment to the ArbMedVV is being evaluated. The purpose of the evaluation is to gain new insights into occupational health protection from work-related exposure to natural UV radiation.	Human health	**BMAS/BAuA**	2020 - 2024	Departmental financing	GE
3 Education and training							
4.	3	**Target group-specific information for health sector professionals** Development of information and training offers (e.g. multiplier training) on preventive and health-promoting measures to close knowledge gaps in the area of health-related climate change impacts.	Human health	BMG/BZgA, RKI, DGUV	Ongoing	To be determined	GE
4.	4	**Information materials and tools for training and education for employers and employees in enterprises** Target group-specific information materials and recommendations with regard to the health burden caused by UV radiation, heat and necessary protective measures as well as measures to be taken in the event of infestations by pests detrimental to human health. Review of existing information for employers and employees regarding protective measures to be taken in the event of increased occupational burdens, for example as a result of the prevailing outdoor climate, e.g. due to overheated rooms without air conditioning or in outdoor areas due to increased heat and UV exposure.	Human health	**BMAS/BAuA**, BMVI/DWD, BMU/BfS/UBA DGUV		To be determined	GE-01
4.	5	**Conceptual design of professional training programmes for the social, health and nursing care sectors regarding specific aspects of climate change** In this respect, the federal government supports activities undertaken by the Public Health Service (ÖGD) and the Academy for Public Health (Akademie für Öffentliches Gesundheitswesen). In addition, the federal government supports projects that address climate impacts such as heat for the benefit of practitioners in nursing professions as well as paediatricians.	Human health	BMU, *Länder*	Ongoing	No information	GE-01

4.	6	**Support services for the adaptation of curricula and education and development programmes for schools and early childhood education institutions, with the following objectives:** • Include heat and UV exposure as well as measures and recommendations in the event of infestations by pests detrimental to human health in school and early childhood education. • Topics that should be included in school and early childhood education (RKI/UBA 2013, 17): a. Impacts of heat exposure b. Impacts of high UV exposure c. Impacts of air quality effects d. Information on possible protective measures e. Addressing motivation and knowledge deficits with regard to appropriate outdoor behaviour f. Wide dissemination of the regional UV index (information on UV intensity and corresponding protective measures) g. Raise awareness of skin cancer screening as preventive healthcare. • Use of existing up-to-date educational materials (e.g. from BMU) in school and early childhood education. • Promotion of the educational materials at suitable trade fairs (regional and national), travelling exhibitions of the German Federal Environmental Foundation (Deutsche Bundesstiftung Umwelt, DBU)	Human health	BMU	Ongoing	No information	GE-01
4.	7	**Support for the adaptation of curricula for vocational schools and degree programmes** Integration of the topics of heat and UV exposure, infestations by pests detrimental to human health, and air quality effects into third-level curricula as well as staff development and advanced training for, among others, the following occupational profiles: Cosmetics, optometry, teaching, occupational safety, architecture and urban planning, pest controllers, landscape architecture, landscape design, construction professions and business administration (environmental management, corporate policy). To this end, a basic catalogue is being drawn up for the preparation of third-level curricula designed to impart technical knowledge on the health effects of heat and UV exposure and the corresponding preventive measures (Das UV-Schutz-Bündnis, 2017, 10). With regard to health professions, the federal government supports activities undertaken by the German Climate and Health Alliance (Deutsche Allianz Klimawandel und Gesundheit e.V., KLUG), among others, as part of the Federal Environment Ministry's (BMU) funding of associations with a view to mainstreaming climate change and adaptation, including in national curricula and syllabi.	Human health	BMU/UBA BMBF/KMK, *Länder*	Ongoing	No information	GE-01
		5 Research and monitoring					
4.	8	**Examination of the framework conditions for the consolidation and expansion of health and environmental monitoring systems** It is a problem for continuous data collection/analysis that some monitoring activities have so far only been carried out on a project-related basis and for limited periods. There is currently no consolidation of, for example, the monitoring of important disease vectors, such as mosquitoes (especially Aedes and Culex species), Phlebotominae sand flies, scale ticks, pathogen circulations of important pathogens in natural foci of infection, e.g. in TBE microfoci, or red-backed voles as vectors of the human pathogenic hantavirus. Proposal: In order to achieve consolidation of existing project-funded monitoring systems, the first step should be to examine how this consolidation could be undertaken and, in particular, which systems are already in existence and which responsibilities individual authorities should assume. The survey should also cover options for the integration of these responsibilities and substantive foci into legislation, for the systems' funding and for required changes in legislation regulating access to data.	Human health	**BMU / UBA,** BMVI/DWD, BMEL / BVLBMG/RKI	Ongoing, partly implemented, permanent task envisaged, as yet only time-limited activities, e.g. R&D projects from 2013 to 2014 and again from 2020 to 2022 (IG II 7) (BMU)	No information	GE

4.	9	**Sensitisation monitoring in Germany as part of the nationwide continuous health monitoring programme** In the course of climate change, it is reasonable to expect temporal and spatial changes in allergen levels and new allergen sources (examples: Ambrosia species during the growing period or indoor moulds during mild, rainy and humid winters). As surveys of the spread of allergen sources are fraught with significant methodological issues, it is hardly possible to realistically estimate exposure on this basis. It is more appropriate to start from sensitisations that have occurred in humans, i.e. to rely on the identification of allergen-specific IgE antibodies in the blood serum. This requires repeated testing of a representative sample of the population (DEGS2-RKI, a survey to be conducted by the Robert-Koch Institute). Sensitisation monitoring will allow for up-to-date assessments and analyses of trends over time. This could also provide nationally representative data on sensitisation prevalences with regard to climate-associated allergens.	Human health	**BMG / RKI**	Currently under review	Departmental financing, no extra costs	GE
4.	10	**Effect mechanisms of emerging pollen allergens** The pathogenic effect mechanisms of emerging pollen allergens will be investigated, using the example of Ambrosia artemisiifolia.	Human health	**BMU/UBA**	2020 - 2022	€550,000	GE
4.	11	**Trend analyses of imported vector-borne infectious diseases in Germany** Germany's public health institute RKI continuously evaluates surveillance data on imported vector-borne infectious diseases (e.g. chikungunya virus, dengue virus, malaria) at the national level and publishes important results. The focus is on the analysis of trends over time, changes in the main countries of infection and on detailed processing of cases that may have been imported from southern European countries or that are autochthonous. Moreover, risk assessments are carried out regarding the possible occurrence of autochthonous cases in particularly warm regions of Germany (assuming the establishment of competent vectors).	Human health	**BMG / RKI**	Permanent task	Departmental financing, no extra costs	GE-03
4.	12	**Ticks and their pathogens in a changing climate (ZePaK)** The aim of the ZePaK project is to investigate tick species new to Germany and the pathogens they carry. Information on locations, tick species and possible pathogens is to be made publicly accessible in the form of an online platform. At the same time, the platform will also provide general information on ticks.	Human health	**BMG/RKI**	2020	€112,040	GE
4.	13	**Analyses of the effectiveness of health adaptation measures in the context of heat action plans** Nationwide survey, analysis of effectiveness and evaluation (i) of recommended actions for the preparation of heat action plans for the protection of human health that are operational/in implementation (cf. 2017 BMU document - www.bmu.de/WS4443), (ii) of heat action plans that are planned or already being applied, (iii) of heat prevention measures that are already operational.	Human health	**BMU / UBA**	07.2019-07.2022	€404,157	GE-01 GE-04 BAU-04 BAU-05 EW-02
4.	14	**Examination of the framework conditions for an integrated health and environmental monitoring system and for the implementation of protective measures for infection prevention (in the sense of ONE HEALTH).** Establishment of an integrated environmental health monitoring system at the federal level on the basis of existing structures, which allows for health-relevant environmental factors to be observed and adverse health impacts to be attributed. In the context of health adaptation to climate change, integrated data collection and synergistic analysis, e.g. pollen and allergy monitoring, increased monitoring during hot spells by food safety agencies and the assessment of environmental and mortality data would be advisable.	Human health	BMG / RKI, BMU / UBA, BfS, BMVI/DWD		No information	GE
4.	15	**Evaluate existing measures and, where appropriate, make them permanent** Evaluation of the implementation and effectiveness of recommended actions and prevention measures (e.g. heat warning system, UV index), including the drafting of recommendations for their updating and further development (RKI/UBA 2013, 16). • Evaluation of existing and newly developed care and treatment strategies in periods of intense heat (RKI/UBA 2013, 21). • Evaluation of measures with regard to behavioural adaptations of the population and also of conditions (RKI/UBA 2013, 16) (Das UV-Schutz-Bündnis, 2017). • Assessment and utilisation of existing monitoring data (e.g. monitoring of developments regarding deployments (BBK 2016, 38)) for the evaluation.	Human health	BMU, UBA, BfS, BMG, RKI, DWD		To be determined	GE-01

4.	16	**Conduct/support studies on health impacts of climate change** Development of robust methods and models aimed at assessing the impacts of climate change on the health system, as is already being endeavoured as part of the Vulnerability Network (Netzwerk Vulnerabilität) initiated by higher federal authorities (RKI /UBA 2013, 9). Effects due to UV exposure should also be included here. Investigation of the impact of climate change on the vulnerability of specific population groups from the point of view of regionally differentiated demographic change. Identification and characterisation of regions that are highly vulnerable to climate change (RKI /UBA 2013, 9).	Human health	BMG/RKI, BMU/ UBA, BfS, DWD		To be determined	GE
4.	17	**Conduct/support studies on climate adaptation measures in urban planning** Develop indicators for monitoring (impact indicators, response indicators, governance indicators) (BBSR 2016, 48). Effects due to UV exposure and air quality effects should also be included here. Evidence of cooling effects of green façades and green roofs is lacking (BBSR 2016b, 76). Analyses of exceedances of certain heat warning thresholds and cartographic processing to identify heat stress hot spots (BBSR). Evidence of true heat and UV exposure at relevant locations such as outdoor areas of kindergartens and schools or for public spaces is lacking; modelling of this exposure in GIS programmes (such as those used by architects) for the purposes of urban planning and construction as well as landscape architecture.	Human health, Spatial planning, regional and urban development	**BMI/BBSR, DWD**		To be determined	GE-01 BAU-04 BAU-05
4.	18	**Development of a method for the identification of specific areas in which to take heat stress reduction measures** Identification of heat stress hot spots by overlaying spatially delimited areas of heat stress (duration, intensity, frequency) and sensitive urban structures (e.g. proportion of older people, single-person households, small living spaces, ethnic concentrations).	Human health, Spatial planning	BMU / UBA, BMI/ BBSR, DWD		To be determined	GE-01 GE-04
4.	19	**Study on outreach to vulnerable persons** Information materials for vulnerable groups of the population (e.g. young children, older persons or persons with underlying health conditions) should be produced and disseminated in a target group-oriented manner. Various outreach options are to be considered in this context.	Human health	BMG		To be determined	GE
4.	20	**Revision of the status report on climate change and health** (Klimawandel und Gesundheit – ein Sachstandsbericht, published by the RKI in 2010). The update contains a comprehensive, scientific presentation of the various issues. The update also adds focal topics that were not previously included. The revised report will provide a systematic review of the complex topic of climate change and health.	Human health	BMG, RKI	2020 - 2022	Departmental financing	GE
4.	21	**Expansion of the Allergy Information Service** (www.allergieinformationsdienst.de) at the German Research Center for Environmental Health (Helmholtz Zentrum München). A module on climate change and allergies is under consideration. The aim is to provide evidence-based information in plain language.	Human health	BMG /Helmholtz Zentrum München	2020 - 2022	Departmental financing	GE
4.	22	**Research: Junior Research Groups on Global Change: Climate, Environment and Health (Nachwuchsgruppen Globaler Wandel: Klima, Umwelt und Gesundheit)** Funding is provided for junior research groups that conduct scientific research into the interrelationships between changes in the climate, environment and health and develop appropriate measures that help protect public health and contribute to sustainability.	Human health	**BMBF**	2021 - 2026	Departmental financing (planned)	GE

6 Networks and cooperation arrangements							
4.	23	**Intensify and establish health sector cooperation between the federal government, the *Länder* and the local authorities** Linkages should be established between the health-related activities under the national DAS-APA (Adaptation Action Plan of the German Strategy for Adaptation to Climate Change) and corresponding activities of the *Länder* as well as between and within the *Länder*. Joint cooperations between the federal government, the *Länder* and local authorities can be encouraged and coordinated in terms of responsibilities. A joint institutional Federal/*Länder* instrument would have to be established to this end (cf. RKI 2013, 25); the establishment of further alliances between authorities is necessary in order to, for example, leverage synergies and draw on benefits from different action programmes, action plans and federal government programmes in addition to coordinated crisis management (win-win situation). In this context, the research project results should be meaningfully integrated and communicated among all participants. With regard to the introduction of an integrated environment and health monitoring system based on existing structures at the federal level, there is a need for cooperation between authorities of the federal government and the *Länder* (RKI 2013, 25).	Human health	BMU, BMG, BMI/BBK, DWD		No information	GE
7 Public awareness, communication, information (education, guidance)							
4.	24	**Warning systems for scale ticks and scale tick-borne infections** Scale ticks are widespread in Germany and are the most significant vectors of pathogens. A number of projects have provided evidence of their dependence on certain macro- and microclimatic factors; a wider overview was given by UFOPLAN project FKZ 3713 40402, which was completed in November 2016. Among the scale tick species, the castor bean tick Ixodes ricinus is of particular importance as a vector of TBE, Lyme disease and many other diseases. In milder winters, it extends its period of activity, favouring the overwintering of ticks. Proposal: Warning systems should be used for public education on protection against tick infestations and tick-borne pathogens. The methodology of short-term predictions needs to be validated against long-term time series. Such a warning system should be given long-term support and funding to ensure long-term public access to information based on reliable data models. Other ways of raising awareness about protective measures also need to be strengthened, e.g. a mobile phone app for tick information, possibly regional activity assessments based on locational and meteorological factors as well as current data on infections. Mobile phones could also be used for GPS-based reporting (and possibly photographic confirmation) of ticks. On this basis, other users in the vicinity could learn about tick records in their area.	Human health	**BMU / UBA** BMG/RKI BMVI/DWD	2013-2018, ongoing (permanent task envisaged)	BMU departmental financing	GE-03
4.	25	**Information materials and tools for civil protection training and education** Adapt information services to the needs of civil protection systems (e.g. fire brigade, THW, other emergency management institutions) (BBK 2016, 37). Generate awareness among helpers themselves of the issues they face (BBK 2016, 45).	Human health, Civil protection	BMI/BBK		To be determined	GE-01
4.	26	**Information materials and tools tailored to vulnerable target groups** Target group-oriented information materials on the health impacts of climate change and possible preventive and health-promoting measures. The focus is on particularly vulnerable groups (e.g. young children, older persons or persons with underlying health conditions) with regard to exposure to heat or UV radiation and air quality issues as well as suitable preventive measures during outdoor activities against pests detrimental to human health.	Human health	BMG, BZgA, BMU, BMI/BBK, BMVI/DWD		To be determined	GE
4.	27	**Adaptation of information and early warning systems and expansion of the target group of early warning systems** Adaptation of information and dissemination pathways with regard to all target groups (RKI/UBA, 16). • Technical and organisational prerequisites are to be created to ensure that warnings from different official sources can generally be harmonised and disseminated to as many people as possible by means of suitable channels. The corresponding warning systems (e.g. MoWaS) are already in existence and are being continuously advanced. • Establishment and further development of warning systems also for hospitals and residential care facilities (BBSR 2016b, 80) as well as for associated groups of people (e.g. doctors) (BSSR 2016, 49). • Participation in international exchanges; adoption of experience gained in other countries, e.g. Italy (UBA/IÖW 2013, 12). • Integration into relevant early warning systems of heat, UV radiation and air quality issues as well as potential infestations by pests detrimental to human health for those engaging in outdoor activities.	Human health	BMVI/DWD, BMU/ BfS, UBA		To be determined	GE

4.	28	**Planning tools and information materials on climate-resilient and allergen-free urban trees for municipalities** Improved provision of information for local authorities on the effects, characteristics and site factors of climate-resilient, non-allergenic and locally adapted urban trees in the context of climate change adaptation. • Planning instruments, web tools, guidelines and/or recommended actions for climate-resilient, non-allergenic and locally adapted tree species, in cooperation with expert bodies where necessary (e.g. German Landscape Research, Development and Construction Society FLL). • Information on the properties of different tree species and on site factors, explaining how urban trees can be used in such a way that through the shade they cast and their transpiration processes they counteract as effectively as possible the stresses caused by heat and UV radiation in highly dense settlement areas, especially at ground level, and contribute to improving climate comfort. • Information on characteristics of different tree species and on site factors which indicates how heat, UV and drought stresses can be reduced or avoided (e.g. minimising exposure to road salt, rows of trees instead of single trees, etc.) (BBSR 2016, 31). For example, give preference to woody plants tolerant of heat and drought stresses; cf. climate/species matrix (Klima-Arten-Matrix) produced by the Institute of Forest Botany and Forest Zoology at the TU Dresden (BBSR 2016, 31; BBSR 2106b, 62). • Air quality and cooling: Information on how to ensure canopy formation that promotes air exchange (through permeable canopies) for optimal pollutant binding capacity per leaf surface area.	Human health, Spatial planning	BMU/ BfN, UBA, BfS, BMVI/DWD		To be deter-mined	GE-01 BAU-04 BAU-05 BD-03 BD-04

Ref. no.		Title and brief description of the mechanism/action	Fields of action	Lead organisation(s) / partner(s)	Period	Funding / funding provider	Climate impacts addressed (for abbreviations see overview table of climate impacts)
"Economy" cluster							
5.	1	**Reviewing the state of implementation of the EMAS Regulation and other corporate management and reporting systems with regard to climate adaptation aspects, and formulating recommendations for improved implementation** The requirements established by international environmental management system standard ISO 14001 are a component of environmental management systems pursuant to EMAS. The EMAS amendment has extended the requirements upon the environmental review (Annex I) and upon the environmental management system (Annex II) to cover new aspects of ISO 14001: 2015. These include the determination of the organisational context and the documentation of risks and opportunities. The organisational context comprises, among other things, environmental events and states such as extreme events and water availability, which will change as a result of climate change. This action involves reviewing the extent to which organisations already consider these demands upon climate risk analyses in the context of the EMAS environmental statement or other corporate management and reporting systems, and how such consideration can be improved.	Trade and industry	**BMU/UBA,** BMWi	2019-2021, permanent task	No extra financing requirement	IG
5.	2	**Review by the Commission on Process Safety (KAS) of the Technical Rules on Plant Safety 310 (Precipitation and floods) and 320 (Wind, snow and ice loads), including requirements for updates to reflect recent findings on climate change** The Federal Immission Control Act (BImSchG) and the Major Accidents Ordinance (the Twelfth Ordinance on the Implementation of the Federal Immission Control Act – 12. BImSchV) seek to ensure, among other things, that human health and environmental quality are protected against hazards arising due to facilities containing hazardous substances. This includes such hazards that arise from natural influences determined by the surroundings of facilities. Climate change calls for a reassessment of such hazards; the relevant technical rules need to be evaluated and improved. This concerns the Technical Rules on Plant Safety (TRAS) 310 "Precautions and measures against hazard sources – Precipitation and flooding" and TRAS 320 "Precautions and measures against hazard sources – Wind, snow and ice loads". Furthermore, the KAS is obliged under Section 51a BImSchG to review the TRAS within 5 years of their promulgation in the federal gazette as to whether they continue to comply with the state-of-the-art in safety engineering. A KAS working group has been established to review the two TRAS. Its work is being supported by a research project.	Trade and industry	**BMU/KAS**	2019-2020, permanent task	€190,000 departmental funding	IG-01
5 Research and monitoring							
5.	3	**Review of the effects of lengthier or more intensive periods of hot days and tropical nights upon storage facilities for thermally instable hazardous substances** Preliminary research within ReFoPlan project 3718483250. Review of TRAS 310 and 320.	Trade and industry	**BMU/UBA**		No information	IG-01
6 Networks and cooperation arrangements							
5.	4	**Rhine low-water action plan** Eight actions in response to the climate-related challenges for industrial facilities on the Rhine and its tributaries have been defined in four fields: provision of information; transport and logistics; infrastructure; long-term solutions. The Rhine low-water action plan was developed together with representatives of major industrial companies in the Rhine catchment and representatives of inland shipping in order to ensure reliably calculable transport conditions on the Rhine. Links to actions 1.16, 5.6, 7.34	Transport und Transport infrastructure, Trade and industry	**BMVI** Federations and representatives of industry and commerce WSV, BAW, BfG	Ongoing	Departmental funding for the actions for which the BMVI is responsible	VE-04 IG-04 IG-05 IG-09

7 Public awareness, communication, information (education, guidance)							
5.	5	**Provision of guidelines for the performance of adaptation measures, e.g. for the elaboration of emergency/evacuation plans** Sudden weather events in particular can cause hazardous situations affecting the tourism sector and tourists. For instance, in the winter of 2018/19 heavy snowfall trapped holidaymakers in their destinations and accommodations. Local crisis plans should therefore take account of these target groups. Furthermore, tourists affected by an extreme weather event require a reliable source of information on whether they can travel to specific areas and on how to leave affected regions if necessary.	Tourism	**BMI** BBK		Departmental funding	TOU
8 Miscellaneous							
5.	6	**Adaptation of transport systems and optimisation of transport and cargo containers** The goal is optimised handling of extreme low-water events under prevailing conditions. In addition to exploiting transfer opportunities and creating and fully utilising storage capacities, the development and suitable availability of ship types suited to low-water conditions, the deployment of modern barge systems and the digitalisation of inland shipping all hold potential for optimisation. The federal government can promote such approaches through supportive measures.	Transport und Transport infrastructure, Trade and industry, Water regime, Water management	BMVI WSV BfG BAW Federations of industry and commerce	In preparation	Departmental funding	VE-04 IG-04 IG-09

Ref. no.		Title and brief description of the mechanism/action	Fields of action	Lead organisation(s) / partner(s)	Period	Funding / funding provider	Climate impacts addressed (for abbreviations see overview table of climate impacts)
"Spatial planning and civil protection" cluster							
6.	1	**Necessity to adapt standards and regulations in the construction industry** The aim of this departmental research project is to establish a knowledge base that can contribute to the more appropriate consideration of climate change in construction industry standards. Specifically, the aim is to identify those standards and technical regulations in the construction industry that may be affected by extreme weather events and climate change. The project is also concerned with standards which may support adaptation to the impacts of climate change. In addition to DIN standards, this also involves standards set by other standardisation bodies in Germany, such as the VDI Standards or the DWA Rules and Standards. The measure contributes to 7.2 "Climate-proofing existing rules and technical standards".	Physical development planning, Civil protection	**BMI / BBSR**	2019-2021	Departmental funding	BAU
3 Education and training							
6.	2	**Integration of "climate change" or "climate change adaptation" as a topic in courses taught at the Academy for Crisis Management, Emergency Planning and Civil Protection (AKNZ) of the Federal Office of Civil Protection and Disaster Assistance (BBK)** Impacts of climate change, e.g. background information on climate research findings and their consequences for civil protection (e.g. changed scenarios, effects on critical infrastructure) will be integrated into the AKNZ trainings in a case-based format.	Civil protection incl. emergency aid	**BMI / BBK**	Permanent task	Funding is ensured from BBK budgetary resources	
4 Funding and incentives							
6.	3	**Strengthening climate adaptation through urban renewal and development** With the further development and coordination of the 2020 administrative agreement between the federal government and the *Länder* on financial assistance for urban development measures (VV Städtebauförderung 2020), "climate change mitigation and adaptation measures, in particular measures to improve green infrastructure (e.g. urban green)" are now a mandatory condition of eligibility. This also means that climate measures as a cross-sectoral theme are eligible for funding under all programmes. The "greening of building surfaces" is also mentioned as an example of measures eligible for funding. Process evaluation and results orientation: Evaluation of the use of funds for climate adaptation in urban renewal and development programmes, evaluation of the application processes and recommendations for improving the application of funds for climate adaptation.	Spatial planning, regional and urban development	**BMI / BBSR**	Ongoing	2020: €790 million	BAU
5 Research and monitoring							
6.	4	**Risk analysis in civil protection (e.g. droughts, extreme meltwater flooding events originating in the low mountain ranges, winter storms)** Leveraging synergies with regard to results; risk analysis at federal level is carried out in accordance with legal mandate (Section 18(1) German Civil Protection and Disaster Assistance Act (ZSKG)); no extra costs at present.	Civil protection incl. emergency aid	**BMI,** executive agencies of the federal ministries (AK), *Länder*, academia, private sector	Permanent task	No extra funding requirement	

6.	5	**Identification of spatial hotspots over a long time horizon with a view to flood prevention by means of urban planning and construction** In a research project, case studies are to be used to develop procedures for the production of heavy rainfall risk maps and the identification of areas at high risk of flooding. A) Simple procedure: Compilation of hazard zones from full-coverage digital terrain models (DTM) and baseline data for trial areas; overlay with documented ex-post heavy rainfall events. Combination, if necessary, with existing morphological heavy rainfall risk maps including flow paths and terrain depressions to generate simple hazard maps. B) Modelling: combination of DTM with (hydraulic) runoff models, combination with ex-post heavy rainfall events and raster data from radar precipitation climatology data. Data mining and use of secondary information from insurers and third parties (e.g. fire brigades). Coordination with the strategic alliance of authorities (KlamEx project). Examination of options for publication of the information obtained. In terms of knowledge gain and research objectives, the focus should be on the need for standardised full-coverage heavy rainfall hazard maps.	Spatial planning, regional and urban development, Water regime, Water management	BMI/BBSR		Departmental research funding	WW-02
6.	6	**Further development of a "sponge city" model** The model of the “sponge city” has already become widespread in the Anglo-American world and in China. It is considered a strategic and feasible approach to addressing climate resilience, urban greening and quality of life in high-density urban neighbourhoods. Globally there are now several detailed concepts for the sponge city model that allow for more sustainable rainwater utilisation. Rainwater can for example be harvested and used for irrigation of green spaces, evapotranspiration can be fostered in order to improve microclimates and combat urban heat. Moreover, it offers the potential to also capture higher levels of precipitation and to either repurpose it on foot of the precipitation event and/or to release it again more slowly. The aim of future research will be to investigate barriers to implementation, feasibility options, and ways to overcome obstacles on the way to implementing the model (e.g. lack of space, road safety obligations, pollutant deposition into groundwater and soils, areas of water as mosquito breeding grounds, divergent legal provisions). Clarification is also needed on the potential contribution of sponge cities to mitigating the impacts of heavy rainfall and drought and to dealing with heatwaves. The concept is thus to be developed and trialled as a key instrument for fine-tuning climate adaptation in densely developed municipalities with a view to implementing a growing number of positive examples in the future, not least with regard to the model of "properties without runoff".	Spatial planning, regional and urban development, Water regime, Water management	BMI /BBSR, BMU/UBA		Departmental research funding	WW-02 WW-03 WW-05 WW-07 BAU-02 BAU-04 VE-05 GE-01
6.	7	**Further development of concepts for decentralised irrigation of urban green with a view to drought prevention, and development of a sample set of recommendations** The research studies should clearly define which type of water source (e.g. groundwater, rainwater stored decentrally) is being considered. They must address the issue of water quantity as well as aspects of water quality so as to avoid environmental and health impacts.	Spatial planning, regional and urban development, Water regime, Water management	BMI/BBSR, BMU/BFN		Departmental research funding	BAU-04 WW-05 FW-05
6.	8	**Tools for climate-resilient urban regeneration** Ongoing retroactive urban densification intensifies the effects of climate change in towns and cities, i.e. heat, drought, heavy rainfall. The research project on “Climate resilient urban regeneration – successful planning, cooperation and communications processes” (Klimaresilienter Stadtumbau – Erfolgreiche Planungs-, Kooperations- und Kommunikationsprozesse (2017-2019)) compiled good examples of promising planning structures and processes for climate adaptation in urban regeneration into a toolbox. These examples were drawn from case studies conducted in eight cities. The aim is to provide municipal administrations with a digital portfolio of practice-oriented working materials, fact files and transferable examples. Prior to this, the project on “Climate-resilient urban regeneration – transfer of results of the research programme StadtKlimaExWoSt (2014-2016)” provided urban areas with analogous tools for climate-resilient urban regeneration, in particular for the assessment of climate impacts, the identification and funding of measures, the commissioning of expert opinions, exchanges of experiences between municipalities, knowledge acquisition and the positioning of climate adaptation in the various departments and at various administrative levels.	Spatial planning, regional and physical development planning	BMI, BBSR	2014-2020	Departmental funding (ExWoSt Programme)	Bau-02 Bau-04 Bau-05 WW-02 GE-01

6.	9	**How green are German cities? – Remote sensing survey and urban-functional differentiation of greenspace provision in German cities** Information on the monitoring of greenspace and open space development for public purposes, the quality and quantity of settlement and urban green structures, residential environments and open spaces is necessary for spatial monitoring and sustainability monitoring by the federal government (urban development and regional planning reports, white paper on urban green (Weißbuch Stadtgrün), National Sustainable Development Strategy progress reports, progress report on the Adaptation Action Plan of the German Strategy for Adaptation to Climate Change, DAS). This project aims to answer the basic question as to how well German cities are provisioned with green spaces. The aim therefore is to conduct a nationwide full-coverage survey of urban greenspaces and to develop a typology of the green-space provision of cities in Germany, differentiated in terms of urban space and function. Moreover, spatial-functional areas experiencing shortcomings in greenspace provision are to be identified on which the federal government is to focus its activities, also with regard to funding for urban renewal and development where necessary.	Spatial planning, regional and physical development planning, Human health, Civil protection, Water regime, Water management, Biodiversity, Cutting across all fields	**BMI / BBSR**	2018-2020	Departmental funding (general departmental research)	BAU-04 GE-01
6.	10	**Green infrastructure in the retroactively densifying city** It is the aim of this research field to define requirements and solutions for urban green infrastructure measures, especially with regard to planning, design, funding, utility and architectural quality. While accelerated construction of new housing is the overall priority, a focus is to be placed on securing, qualifying and redeveloping greenspaces in densely developed and densifying cities. Principles of high-quality open space design are to be developed as part of dual internal development (retroactive densification and greening). The research field focuses on densely developed inner-city areas of large and medium-sized cities. The project's aim is to strengthen the importance of urban green infrastructure in urban planning processes during the planning process and to develop a model for urban green design in cities subject to retroactive densification.	Water regime, Water management, Biodiversity, Human health, Cutting across all fields	**BMI / BBSR**	2020-2023	Departmental funding (ExWoSt Programme)	
6 Networks and cooperation arrangements							
6.	11	**Continuation of the strategic alliance of authorities on climate change adaptation** The main objective of this cooperation is to improve society's approach to the impacts of climate change, especially extreme weather events – from long-term strategic planning to short-term operational measures. The German Strategy for Adaptation to Climate Change (DAS) highlights "civil protection" and "spatial, regional and physical development planning" as cross-sectional topics.	Cutting across all fields	BMI/BBK, BBSR, THW, BMVI/DWD, BMU/UBA	Permanent task since 2007	No extra funding requirement	
7 Public awareness, communication, information (education, guidance)							
6.	12	**Action-oriented information materials, planning tools and recommended actions regarding options in urban and open space planning to reduce heat and UV exposure** Key starting points for possible adaptation measures in dealing with heat and UV exposure, especially in larger cities, include the protection and preservation of open spaces and greenspaces, urban greening (e.g. tree planting and maintenance, roof and façade greening), the preservation and creation of fresh air corridors, the use of "blue" infrastructure and the increase/decrease of the albedo effect (BBSR 2016, 29).	Spatial planning, regional and urban development, Human health	BMI		To be determined	GE-01 BAU-04 BAU-05
6.	13	**Further development of risk communication with citizens regarding weather-related hazards** Existing information services, e.g. on heat and heavy rain events, are to be further developed and embedded in comprehensive risk communication concepts. This includes target group-specific preparation of information as well as its dissemination through various channels, both in relation to specific events and on an ongoing basis. Vulnerable groups are to be given special consideration in the development of materials and will be addressed effectively by means of newly established networks. The aim of this measure is to strengthen the population's capacity to protect itself and thus to reduce individual exposure to weather-related hazards.	Civil protection	**BMI**/BBK	Ongoing	Funding ensured from BBK budgetary resources	GE-01 GE-04 BAU-02 BAU-03 BAU-05

6.	14	**Structural engineering solutions / Climate-adapted construction** A variety of publications and research projects jointly aim at compiling individual vulnerabilities of structural infrastructure (buildings and properties) to the various impacts of climate change in order to successively develop structural engineering solutions to address such vulnerabilities.	Physical development planning, Civil protection	**BMI / BBSR**	Ongoing	Departmental funding	BAU
8 Miscellaneous							
6.	15	**Development of recommendations for the cooperation of spontaneous and volunteer responders in the context of extreme weather events** Evaluation of experiences with civic engagement during severe weather events and testing the application of ISO 22319:2017 (Security and resilience – Community resilience – Guidelines for planning the involvement of spontaneous volunteers) in Germany. The aim of the measure is to improve the interaction between spontaneous and volunteer responders in the context of extreme weather events and thus to improve the management of such events by civil protection authorities.	Civil protection	**BMI/**BBK	In preparation	Funding ensured from BBK budgetary resources	

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"Cross-cutting" cluster – actions effective across all fields							
7.	1	**Promoting the consideration of climate change in standardisation** The BMU and DIN jointly finance DIN's Environmental Protection Helpdesk (DIN EPH). Adaptation to climate change is one of the Helpdesk's priorities. Activities within this priority seek to bring about improved consideration of climate change in standards, in an approach involving broad stakeholder participation. Efforts are under way, in dialogue with the individual standards committees, to analyse and adjust individual standards as pilot projects in a collaborative approach. Standards that have become internationally recognised in the meantime form a key framework. These include, in particular, DIN EN ISO 14090 (Adaptation to climate change – Principles, requirements and guidelines), DIN EN ISO 14091 (Adaptation to climate change – Guidelines on vulnerability, impacts and risk assessment) and CEN/CENELEC Guide 32 (Guide for addressing climate change adaptation in standards). These standards were established with active input from the Helpdesk and DIN's Standards Committee Principles of Environmental Protection (NAGUS).	Cutting across all fields	**BMU / UBA, DWD**	Permanent task since 2016	No extra funding requirement; KU receives ongoing funding from BMU	
7.	2	**Climate-proofing existing rules and technical standards** The IMAA members and their subordinate institutions facilitate within the scope of their capabilities the systematic consideration of climate change impacts in existing technical rules and standards (especially in sub-statutory law and in standards, directives and rules). In accordance with the federal government's vulnerability study, a particular focus is on human health, infrastructure and urban areas, incl. urban planning and buildings. The action comprises specific departmental research (e.g. EBA on rail infrastructure, BaSt on road infrastructure, and the UBA "Adaptation Standard" research project), active involvement in relevant bodies at DIN, VDI, CEN, DWD, TRAS and others (e.g. through DWD, EBA, BaSt, BMG, BSG, WSV, UBA) and integration in statutory provisions and consideration in federal government tendering procedures (for which the ministries are responsible).	Cutting across all fields	**BMVI,** BMI, BMWI, BMU, BMG, BMEL	Permanent task	Departmental research funding	GE-01 BAU WW-02
7.	3	**Review of the need for and practicability of integrating climate change adaptation in technical laws**	Cutting across all fields	BMU / UBA	2020-2023	ReFoPlan €330,000	
4 Funding and incentives							
7.	4	**Review of the further development of the DAS adaptation grant programme**	Cutting across all fields	**BMU**	Permanent task	Current volume of grant programme: approx. €10 million per annum	

7.	5	**Using European structural and investment funds to facilitate adaptation to climate change in *Länder* and municipalities** The new Multiannual Financial Framework (MFF) of the European Union becomes effective from 2021 onwards. The EU prescribes that from 2021 to 2027 at least 25% of all funding is to be deployed for climate-relevant measures (mitigation and adaptation). The partnership agreement between the German government and the EU establishes the framework for the utilisation of European structural and investment fund resources in Germany. To achieve the MFF climate quota, the European Commission has proposed climate quotas for individual funds, from the ERDF: the goal is to invest 30% of funding for climate-related purposes, channelled by requirements upon the thematic concentration of funding. According to these requirements, in Germany at least 85% of ERDF resources are to be allocated to political goals 1 (innovation, R&D, SMEs) and 2 (climate mitigation and adaptation, and environmental protection), whereby at least 60% are to be channelled to goal 1.	Cutting across all fields	**BMWi (EFRE), BMEL (ELER/GAP),** BMU, BMVI	2019-2027	25% of EU funding to be earmarked for climate mitigation and adaptation actions in accordance with COM proposal for the Multiannual Financial Framework (MFF, to be confirmed)	
7.	6	**Funding programme for climate adaptation in welfare institutions** This programme aims to help social welfare institutions to cope with the impacts of climate change such as heat stress which are already becoming noticeable. The funding programme is a part of the federal government's stimulus package and was adopted by the federal cabinet on 17 June 2020 together with the supplementary budget.	Human health, Building industry, Cutting across all fields	**BMU**	2020-2023	€150 million	BAU BAU-05 GE GE-01
		5 Research and monitoring					
7.	7	**JPI Climate** In concert with 13 other European partner countries and the European Commission, the JPI Climate joint programme planning initiative will set up a research programme on Climate Services. Its aim is to facilitate improved management of the risks and opportunities of climate change and variability, and to develop practically effective solutions for a competent handling of complex and broad-based knowledge about climate change. Climate information will be processed or specifically generated in such a manner that it can be analysed together with other factors key to decision-making and can supply a concrete basis for planning, investment and policy processes.	Cutting across all fields	**BMBF**	2017-2021, ongoing	Departmental funding approx. €63 million / BMBF €10 million	
7.	8	**Mainstreaming core products of the German Adaptation Strategy (DAS)** The following core products are indispensable elements in the further development and implementation of the DAS: 1. Monitoring report 2. Climate and vulnerability analysis 3. Evaluation report 4. Progress report and adaptation action plan This action safeguards the mainstreaming of these cross-cutting products as a permanent task. The expert updating of the core products is coordinated and organised by KomPass in the Federal Environment Agency (UBA). Evaluation is performed externally. Federal ministries and their associated scientific authorities contribute to the updating of core products in their fields of competence via the federal authority climate adaptation network. Data and (preliminary) products from the individual federal departments are integrated into the process. These products will also make key contributions to the KlimAdapt adaptation services. DAS reporting and products: The IMAA will review the scheduling and interplay of the reporting elements relating to the German Adaptation Strategy (monitoring report, climate impact and vulnerability analysis, evaluation report, progress report and adaptation action plan).	Cutting across all fields	**BMU/UBA,** further technically responsible federal departments and higher authorities	Permanent task	Ongoing departmental funding	

7.	9	**Institutionalisation and operationalisation of international reporting duties and of reporting under the EU Governance Regulation** The EU Governance Regulation will impose a comprehensive and new reporting duty upon Germany. For instance, data previously lacking about the costs of damage and of adaptation actions, as well as information at *Länder* and municipal level, will (have to) be collected, processed and reported. To this end, Germany will need to create the institutional and methodological conditions for submitting a report on adaptation to climate change to the European Commission every two years. To harness synergies, this work will be conducted in close cooperation with UBA's DAS monitoring coordination office and will be agreed upon with the IMAA.	Cutting across all fields	**BMU/UBA,** all IMA departments	Permanent task	Departmental funding	
7.	10	**The economics of climate change** The goal of this supporting action is to explore sustainable and realisable transformation pathways towards a carbon-neutral society, to assess the effectiveness and efficiency of various climate policy tools and measures, and to make contributions towards an improved handling of the remaining climate risks. This work primarily adopts a macro-economic perspective. It considers both the national and the international level. The "Handling climate risks" priority is concerned primarily with the consequences and costs of climate change and the associated risks, and with economic aspects of adaptation. With regard to consequences and costs, a comprehensive assessment of the direct and indirect impacts is performed, and potential synergies and co-benefits are considered. The assessments also cover transboundary climate impacts, long-term effects, impacts upon ecosystems and ecosystem services, and social impacts and distributional effects. With regard to adaptation, possible actions are identified and comprehensively assessed. The work is concerned not only with the costs and benefits of adaptation actions and their distributional effects, but also with institutional actions and conditions relating to climate risk preparedness and management.	Cutting across all fields	BMBF	2018-2022, ongoing	Departmental funding €25 million	
7.	11	**Climate resilience through urban and regional actions** In transdisciplinary and implementation-focused projects, academics and practitioners elaborate innovative actions to cope with climate change. These boost adaptive capacity and improve response capacities at municipal level. The projects formulate new approaches towards resilient and sustainable development, illustrate development trajectories and clarify the effects of different measures. An overarching scientific project assists methodology development and application with relation to monitoring adaptive capacity and adaptation action outcomes.	Cutting across all fields	BMBF	2017-2022, ongoing	Departmental funding €30 million	
7	12	**Continuation and expansion of the German Climate Preparedness Portal (KLiVO)** The KLiVO Portal is the central public awareness-raising provision of the federal government on climate services and adaptation services. It comprises quality-assured, free-of-charge climate preparedness services provided by federal authorities, *Länder* authorities and state-funded third parties (municipalities, federations etc.). Climate preparedness services address the federal level, the *Länder*, district and municipal authorities, civil society and industry. The KLiVO Portal is expanded continuously, building on the findings of utilisation and effectiveness analyses.	Cutting across all fields	**BMU / UBA, BMVI / DWD**, all IMA departments	Permanent task	Departmental funding	
7.	13	**Continuation and expansion of the system of services for adaptation to climate change (KlimAdapt)** KlimAdapt is a module of the KLiVO Portal. The KlimAdapt office is located at the KomPass Competence Centre – Climate Impacts and Adaptation in Germany at the Federal Environment Agency (UBA). The goal of KlimAdapt is to assemble, process, provide and refine products, inputs and tools (climate adaptation services) for adaptation to climate change. The accompanying KlimAdapt supplier-user network promotes user-focused further development and application of the climate adaptation services and of the KLiVO Portal. By means of appropriate departmental research and funding of this permanent task, the responsible federal institutions will sustain KlimAdapt and the KLiVO Portal and will promote it through their participation.	Cutting across all fields	**BMU/UBA, all IMA departments**	Permanent task	Departmental funding	
7.	14	**Pilot initiative: Local climate and environmental models for cities and regions of the future, Module 1 – Urban climate under change** The supporting action aims to develop an urban climate model capable of capturing all relevant urban climate processes. This model shall deliver substantial added value compared to the urban climate models currently available. Current models are highly specialised and only capture selected parameters such as wind or individual air pollutants. There is at present no model capable of covering an entire city of the size of Berlin. The new model shall make it possible to recognise urban-climate linkages and apply these to sustainable urban planning. It may also permit statements about the climatological effects a conurbation has upon its region.	Cutting across all fields	BMBF	Ongoing since 2016; 2nd phase 2019 to 2022	Departmental funding 1st Phase €15 million 2nd Phase €13 million	

7.	15	**Pilot initiative: Local climate and environmental models for cities and regions of the future, Module 2 – Regional information for climate action (RegIKlim)** This supporting action shall lay the groundwork for the next generation of climate information services. It shall develop information and assessment tools that allow a sound and efficient handling of the risks associated with climate change. It is geared to reliability, relevance and applicability for municipal and regional planning processes and actions. The information and assessment tools will initially be developed in and for concrete model regions. These regions will be supported by projects serving regional climate modelling and scientific coordination.	Cutting across all fields	BMBF	2020-2023 (1st Phase)	Departmental funding €18 million	
7.	16	**Pilot initiative: Local climate and environmental models for cities and regions of the future, Module 3 – Local environmental models** Building upon the two supporting actions – "Urban climate under change" and "Regional information for climate action" – a third module of the pilot initiative shall compile and link data on a broad range of local environmental aspects together with projections of climatic developments. In scientific terms this calls for interdisciplinary linkages between climate research and environmental sciences (in a broad sense). From the outset, the development process will be guided by the concrete requirements and demands of users so that the data and tools produced do indeed advance urban adaptation to climate change and the handling of environmental issues. The aim is to link in an intelligent manner the capabilities of (model-based) big data with the practical logic and requirements of users.	Cutting across all fields	BMBF	2021-2023	Departmental funding (planned)	
7.	17	**Utilising Copernicus data and services** Copernicus data and services can contribute substantially to DAS monitoring and climate impact and vulnerability analysis (KWVA) and are to be trialled. The CAMS atmospheric service can supply radiation data to improve evaporation calculations. The CLMS land service provides data that can be assimilated in hydrological forecasting systems (e.g. soil moisture, water equivalent of snow cover). The C3S climate service provides numerous types of climate data and indicators that can be used to underpin regional assessments in the DAS context. The CMS marine service provides sea-surface temperatures and more. The EMS crisis and emergency management service offers information products concerning flooding, for instance. Furthermore, the Sentinel satellite fleet provides information at short intervals (1-5 days) about land-surface and water-surface changes and atmospheric data. The findings benefit – insofar as practical usefulness is verified – the DAS "Climate and water" open service.	Cutting across all fields	**BMU / UBA, BMVI / DWD, BfG**		No information	
7.	18	**Climate change and extreme events (ClimXtreme)** It is to be expected that climate change alters the frequency, intensity and spatial distribution of extreme weather events. These changes are of vital significance to society, industry, policy-makers and public administrations in Germany. The overarching goal of this action is therefore to gain an improved understanding of extreme weather events and the associated changes and uncertainties. The focus will be placed on events such as heat waves, heavy rainfall events, floods and storms.	Cutting across all fields	**BMBF, BMVI/DWD**	2019-2022	Departmental funding €14.5 million	
7.	19	**SME innovation in energy efficiency and climate action** The goal of this supporting action is to promote industrial research projects and pre-competitive development projects designed to boost the innovative capacity of small and medium-sized enterprises (SMEs) in Germany, with a focus on energy efficiency and climate change mitigation and adaptation. In the field of adaptation, innovative services and products fostering adaptation will be supported.	Cutting across all fields	BMBF	Since 2007, adaptation to climate change since 2015, no time limit	Departmental funding	
7.	20	**Marine research** The oceans store and convey climate-relevant trace gases and heat. They are thus of great importance to the climate. At the same time, the climate affects marine currents, sea levels and marine life. Understanding the interplay and predicting potential consequences are key goals of marine research. National, bilateral and international projects use observations and models to gain a more comprehensive understanding of the global climate system and regional changes.	Cutting across all fields	**BMBF**	2012-2023	Departmental funding €69.6 million	WW 09; FI 01, FI 02; BD 03, BD 04

7.	21	Through its **"Coastal research in the North and Baltic Seas – KÜNOII" and "Costal engineering research"** grant lines, the German Research Ministry BMBF promotes research on the sustainable use of Germany's coastal regions under global change, notably climate change and its impacts on natural environments, economic spaces and habitats on coasts and in territorial seas. A range of projects was funded from 2016 to 2020 and continues to be funded. These projects seek to develop novel approaches in flood protection and in the construction and maintenance of coastal protection and waterway infrastructure, with a focus on the impacts of climate change (storm surges, sea-level rise). Via the "Costal engineering research" grant line, the BMBF provides ongoing support, in collaboration with the sectoral authorities of the federal government and the coastal *Länder* in the field of coastal engineering, to projects serving coastal and flood protection, coastal drainage, and the construction and maintenance of waterways and ports. Adaptation to climate change is increasingly becoming a focus of these activities.	Cutting across all fields	**BMBF**	2016-2022	Departmental funding €10.2 million	KUE 01, KUE 02, KUE 03, Bau 01 (coastal protection structures)
7.	22	**MARE:N** is the federal government's research programme that currently forms the basis for research funding in the field of coastal, marine and polar research. In two Agenda processes, current research goals were defined in 2019, which were then to be pursued via calls for proposals. Against the backdrop of the current IPCC Report on the Ocean and Cryosphere in a Changing Climate, the 2030 Agenda and the United Nations Decade of Ocean Science for Sustainable Development, topics linked to climatic changes will gain major relevance. A) With the planned notice of call for proposal (May 2019) **"Coastal marine research in North and Baltic Seas – Changing coasts – KüNO III"** the BMBF will call for project proposals in the fields of climate and coastal dynamics, ecosystemic coastal protection and changes in biodiversity and material flows. Activities are to focus on changes arising in the course of climatic and other anthropogenic impacts upon coastal systems, and the derivation of suitable strategies for action and management. The envisaged term is from 2020 to 2026. B) With the planned notice of call for proposal (June 2019) **"Blue ocean" (Blauer Ozean)** the BMBF will address the research fields and cross-cutting tasks defined in the concept paper. The "Changing ocean dynamics", "Ecosystems under stress" and "Ocean governance and social change" research fields are of particular relevance to the German Adaptation Strategy DAS.	Cutting across all fields	**BMBF**	2020-2026	Departmental funding KüNO III €2.5 million per annum; Blauer Ozean €5 million per annum	KUE 01 KUE 02 KUE 03, Bau 01, F 01 F 02 F 03, WW09 (coastal, marine and polar regions), VE (new shipping routes) BD (marine areas)
7.	23	**Polar research** The polar regions are undergoing particularly rapid change due to global warming. Their geopolitical, geo-economic and geo-ecological importance gives them a key role in Germany's marine and climate research. The principal goal of polar research is to participate in international activities to solve global problems. Bilateral research programmes and national projects contribute to answering urgent global questions: in addition to predictive models for polar and European climate and fisheries research, the release of gas hydrates in the Arctic and of trace gases in the Antarctic Ocean are researched, and the monitoring of polar ice masses by means of remote sensing is promoted.	Cutting across all fields	**BMBF**	Ongoing	Departmental funding €13.4 million (BMBF)	WW09, KUE-02, FI-01 FI 02, BD-03 BD 04 (marine areas), VE (new shipping routes)
7.	24	**"Classification of extreme meteorological events for risk prevention against heavy rainfall for civil protection and urban development" (KlamEx) research project under the aegis of the "Climate change adaptation" strategic alliance of public authorities** Statistical evaluation of heavy rainfall events and index-based analysis of individual events, together with the integration of further meteorological and non-meteorological data, shall address the project's key questions: • How to characterise, in both qualitative and quantitative terms, the connections between extreme weather events and emergency response activities. • Which quarters and settlement types were particularly affected by heavy rainfall in the years since 2001. • Which meteorological and non-meteorological effects determine the spatially differentiated impacts of a heavy rainfall event. • Which measures can promote preparedness for heavy rainfall risks in civil protection and urban development.	Cutting across all fields, especially: Civil protection, Spatial planning, regional and urban development	**BBK, DWD**, BBSR, THW, UBA	2019-2020	Budgets of the participating authorities (€235,000)	WW-02 BAU-02 VE-05 BO-01 IG-02 FiW-02

7.	25	**Establishment of a climate damage register** The goal is to register, long-term and systematically, the damage and the costs of damage attributable to climate change. First a methodology shall be developed by which to record climate-change-related damage and costs systematically and promptly across all fields of action. This shall take account of insured damage and of non-insured, monetary and extended types of damage (e.g. to ecosystem services). Distinguishing climate change from other determinants is a particular issue here. An important aspect relevant to the establishment of a climate damage register is that several APA III actions pursue similar objectives, e.g. actions 2.28and 7.10. It is key that these actions involve the development or refinement of comparable methodologies, so that the outcomes can interlock consistently. Action 7.25provides a framework within which to concretise and clarify cross-departmental and inter-agency cooperation. The action(s) moreover contribute(s) to an improved classification of public expenditure with regard to climate adaptation.	Cutting across all fields	**BMU/UBA**, BMVI / DZSF / EBA / BfG	2020-2023 (ff)	Departmental funding (€500,000 BMU ReFoPlan)	
6 Networks and cooperation arrangements							
7.	26	**Continuation and further development of the Deutscher Klimadienst (DKD) German climate service** The DKD, with a secretariat hosted by the German Meteorological Service (Deutscher Wetterdienst DWD), is a component of the federal government's overall provision for climate change adaptation. The DKD is Germany's national implementation of the Global Framework for Climate Services (GFCS) and serves as the interface to the international GFCS. By establishing the Deutscher Klimadienst, the German government ensures that provision of climate information and climate services at the national level is scientifically sound, tailored to the users' needs, coherent and reliable, while duplication of work is avoided in order to make best use of limited resources. The Interministerial Working Group on Adaptation to Climate Change (IMAA) establishes linkage with the German Adaptation Strategy (DAS) and the associated Adaptation Action Plans (APAs). Various other activities at federal and *Länder* level with also be integrated into the DKD. The partners cooperating in the DKD provide the climate information and services required to implement the DAS and its action plans. A climate service is understood to mean the regular and reliable provision of science-based and objective information about the climate system of the past, present and future. Such information can be framed in general terms or processed specifically for certain user groups and/or sectors. It facilitates the decision-making processes of individuals and organisations.	Cutting across all fields	**DWD/**BMVI	Permanent task since 2015	DWD budget	
7.	27	**Permanent establishment of the federal authority climate adaptation network** The network was mandated in 2017 by the Interministerial Working Group on Adaptation to Climate Change (IMAA). As a network of federal authorities and institutions, it assists IMA in implementing the German Adaptation Strategy (DAS). It is primarily concerned with the expert elaboration and coordination of scientific content of relevance to DAS reporting duties and evaluations, taking account of the findings of completed and ongoing research projects (monitoring, climate impact and vulnerability analyses, evaluations, federal action plans). Coordinated by the Federal Environment Agency (UBA), 28 authorities currently collaborate in the network.	Cutting across all fields	BMU/**UBA, Involved: 27 further authorities representing further federal departments**	Permanent task since 2017	Departmental funding	
7.	28	**BMVI expert network** Seven departmental research institutions and specialist agencies of the Federal Ministry of Transport and Digital Infrastructure (BMVI) formed the BMVI expert network in 2016. Its purpose is to address urgent transport issues of the future by means of innovation in the fields of climate adaptation, environmental protection and risk management, and digitalisation and renewable energies.	Cutting across all fields	**BMVI**	2016-2025	BMVI departmental funding	all WW KUE FI BAU VE BD IG

7 Public awareness, communication, information (education, guidance)							
7.	29	**Operation of the anpassung.net online portal as information, communication and cooperation system to promote climate adaptation in Germany**	Cutting across all fields	**BMU / UBA**	Permanent task	Departmental funding	
7.	30	**German climate portal (Deutsches Klimaportal)** The portal facilitates the rigorous, nationwide networking of climate service providers and climate information users. It is a key element of national implementation of the Global Framework for Climate Services (GFCS) in Germany. The portal gives access to climate competence across Germany, assembled in a spirit of partnership. It is devised specifically to match Germany's structures. It provides the *Länder* as well as the sectors identified in the German Adaptation Strategy with services tailored to their needs.	Cutting across all fields	**DWD** various institutions and authorities, full list at www.deutsch-esklimaportal.de	Permanent task since 2012	DWD budget	
7.	31	**Regional climate atlas provided by the Helmholtz Association of German Research Centers HGF** The atlas provides information about potential changes brought about at regional level by climate change. Future climate scenarios for Germany's regional states (*Länder*) are publicly accessible since February 2010 at www.regionaler- klimaatlas.de Users can select various climate elements such as temperature, precipitation and wind, and can have potential future changes displayed at selected times of the year in the individual *Länder*.	Cutting across all fields	**BMBF / HGF**	Ongoing	BMBF / HGF	
7.	32	**Climate navigator** The Climate Service Center developed the climate navigator (Klimanavigator) together with partner organisations such as DKK: a national web portal acting as pilot to climate and environmental information in Germany. The portal assembles and points the way to the climate knowledge available in academia and to knowledge about adaptation options, e.g. about the relevant organisations and facilities. www.klimanavigator.de	Cutting across all fields	BMBF / HGF together with numerous relevant institutions	Permanent task	BMBF / HGF	
7.	33	**Data provision and advice on climate adaptation as cross-cutting DAS field of action** The German Meteorological Service (Deutscher Wetterdienst DWD) is the national service responsible for the territory of the Federal Republic of Germany. In this function, it operates the national meteorological infrastructure to generate meteorological data and products. With its weather and climate information it provides services necessary for the protection of life and property. Its ground-based network of measuring stations in Germany delivers the basic climatological data for national climate advice. An integrated measuring network comprising 17 weather radar stations records precipitation nationwide. Satellite data supplement ground-based measurements. These data provide the basis for DAS evaluations of climate indicators such as extreme rainfall or hot days. In close consultation with its clients, the DWD compiles climate information to be used to plan adaptation actions with due regard to climate variability and climate change. It continuously refines these information products and offers user-specific technical advice. This is done on the basis of cause-effect models which permit statements relevant to the various fields of action: human health (e.g. with regard to heat exposure, pollen counts, UV exposure), urban development, agriculture, civil protection, soil, woodland and forestry, water management. Further DAS fields of action supported by DWD services include building industry, transport, spatial and regional development, coastal protection and tourism.	Cutting across all fields	DWD	Permanent task	DWD budget	
7.	34	**DAS "Climate and water" open service** Adaptation to climate change and the associated policy advice require ongoing objective and robust decision-making foundations for Germany and central Europe. This applies particularly to the adaptation of the transport system, but ultimately also to all adaptation decisions in all DAS fields of action. Building upon the many years of experience available in the relevant departmental research facilities, the DAS "Climate and water" open service will be set up step-by-step as a permanent task in the BMVI portfolio. It will provide an up-to-date and comprehensive collection of data for climatological, oceanographic and hydrological parameters and services. Using datasets for the past as well as climate forecasts and projections over periods ranging from seasons over decades through to centuries, all activities to mitigate climate change impacts and extreme weather events can be derived. The outputs of the DAS "Climate and water" open service assist not only the federal authorities in their essential adaptation responses, but also the *Länder*, municipal authorities and the private sector. This action is linked to the BMVI Rhine low-water action plan.	Cutting across all fields, planned for all fields of action, but successive activation	**BMVI, DWD, BSH, BfG, BAW**		From 2020: first permanent components	

7.	35	**PROWAS-DE projection service for waterways and shipping (Projektionsdienst für Wasserstraßen und Schifffahrt)** This is a pilot project of the DAS "Climate and water" open service for the purposes of the BMVI and WSV. Moreover, offers of data provision are already being made for other fields of action, namely the water regime and water management, transport and transport infrastructure, and industry and commerce, which will feed into the 2021 climate impact and vulnerability analysis, for instance. PROWAS-DE provides climatological, oceanographic and hydrological projection data and associated advisory services with respect to the rivers (Rhine, Elbe, upper Danube, Weser, Ems) and coastal areas (North and Baltic Seas) utilised as waterways and the corresponding catchments and marine areas (or is in the process of preparing such provision).	Water regime Water management, Transport, Transport infrastructure, Trade and industry	**BMVI** BfG DWD BSH BAW	2017-2021	BMVI departmental funding	WW-02 WW-03 WW-06 WW-07 WW-08 WW-09 VE-04 KUE-01 KUE-02 KUE-03
7.	36	**Consultation process for the German Adaptation Strategy DAS** Dialogue with the stakeholders who perform implementation (such as municipal and *Länder* representatives, federations of industry and commerce, associations and foundations) is an important part of the further development of the DAS policy process. Regular events (such as stakeholder dialogues and national dialogues) involve key players in the various DAS fields of action in a continuous dialogue process.	Cutting across all fields	**BMU / UBA** BMVI/ BfG	Permanent task	Estimate in BMU budget: €140,000 per annum	
7.	37	**Blue Compass (Blauer Kompass) awards** The Federal Environment Agency (UBA) recognises local and regional climate adaptation lighthouse projects through its Blue Compass (Blauer Kompass) awards. The purpose of this competition is to identify innovative actions and publicise them nationwide in order to demonstrate what climate change adaptation might look like in practice. Within the DAS framework, it is a key communication tool for promoting self-provision in relation to climate risks, showcasing excellent actions in Germany.	Cutting across all fields	**UBA/BMU**	Permanent task	2-year estimate in BMU budget: €250,000 per round of competition (€125,000 per annum)	
		8 Miscellaneous					
7.	38	**Development and establishment of a system for analysis of the effectiveness of actions and mechanisms** Systematic analysis of the effectiveness of actions and mechanisms is highly important for the targeted continued development of the strategy process. Appraisal of the extent to which actions deliver the intended results (e.g.: Does information provision and activation provided in connection with the action plan lead to stronger self-provision?) makes it possible to set priorities when selecting and implementing activities. The action proposed here develops an integrated toolbox of ex-ante and ex-post methods of empirical social research (incl. modelling, questionnaires, focus groups) and mainstreams this in the DAS updating process. There is often interplay among adaptation actions and policy instruments, especially when they are in the same issue area or field of action. When determining effectiveness it is therefore additionally important to analyse such interactions in order to prevent negative effects and promote positive ones. An analysis and assessment of interactions must consequently be an obligatory step when determining the effectiveness of actions. Overall, this improves the coordination of sectoral strategies, e.g. for coping with sea-level rise or drought events.	Cutting across all fields	**BMU/UBA**, all IMA departments	Permanent task	Departmental funding	

Annex 2

Adaptation Action Plan III

International Actions

Last updated: 21 October 2020

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
International responsibilities							
1 Cross-sectional activities (e.g. climate services, risk analyses, reporting/M&E, research, adaptation planning)							
1.	1	**Support for national adaptation planning and action:** Promoting integration of climate adaptation into national development planning and budgeting, support for enhancing national adaptation planning processes (NAP processes), e.g. through bilateral projects or the **NAP Global Network**.	Information and knowledge management, capacity building	**BMZ; BMU; GIZ Partners:** NAP Global Network; NAP Global Support Programme (UNDP, UN Environment); FAO	2011 – present	63 countries	**NAP Global Network financing** BMZ: EUR 1,046,000 BMU: EUR 546,808.36
1.	2	**Support for evidence-based decision-making in partner countries through climate risk analyses** • **AGRICA:** Climate risk analyses and climate risk profiles for identifying and weighing adaptation strategies in sub-Saharan Africa.	Information and knowledge management	**BMZ; GIZ Partner:** PIK	09/2018 – 12/2023	Ghana, Ethiopia, Tanzania, Burkina Faso, Côte d'Ivoire, Mali, Kenya, Niger, Chad, Mauritania, Uganda, Madagascar	EUR 1,541,115
1.	3	• **EPICC:** Forecasting of disruptive weather phenomena, scientific training on climate risks to anticipate impacts on hydrology and water resources, agriculture and climate migration patterns.	Capacity building	**BMU; GIZ Partners:** PIK; DWD; TERI	01/2018 – 02/2021	India, Peru, Tanzania	EUR 4,881,951.15

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
1.	4	• **WASCAL/SASSCAL:** Strengthening scientific training and research capacities on climate change and adaptive land management in Southern and West Africa	Capacity building	**BMBF**	2010 – 2023	WASCAL: Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Mali, Niger, Nigeria, Senegal, Togo SASSCAL: Angola, Botswana, Namibia, South Africa, Zambia	WASCAL: approx. EUR 70,000,000 SASSCAL: approx. EUR 65,000,000
1.	5	**South-South cooperation on climate information and services:** Development of a platform for knowledge management and joint learning for the Philippines and the Climate Vulnerable Forum	Capacity building, information and knowledge management	**BMU** **Partners:** Climate Change Commission – Philippines; Department of Science and Technology – Philippines	05/2019 – 04/2022		EUR 5,000,000
1.	6	**Germany's contribution to the Intergovernmental Panel on Climate Change (IPCC):** Germany is one of the IPCC's most important supporters. In the IPCC, scientists from around the world review the latest climate research and, with reference to reliable scientific literature, assess the current state of knowledge about climate change. In 2018 and 2019, the IPPC published three Special Reports in total: the *Special Report on Global Warming of 1.5 °C*, the	Cross-sectional	**BMBF; BMU** **Partners:** BMVI/DWD	Ongoing	/	EUR 17,400,000 2016-2022

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
		Special Report on Climate Change and Land and the *Special Report on the Ocean and Cryosphere in a Changing Climate*. The key role of adaptation is recognised in all three reports.					
1.	7	**Global Initiative on Disaster Risk Management (GIDRM):** **Phase I:** Collaboration with regional partners to identify risks and develop risk-reducing systemic approaches for more effective DRM. **Phase II:** Supporting actors to achieve agenda coherence (Sendai Framework, Paris Agreement, Agenda 2030, Habitat III) with regard to planning, implementing and reporting on DRM. **Phase III:** Positioning of risk-informed development in the nexus between climate change adaptation, infrastructure and fragile contexts. Strengthening risk governance capacities and promoting cross-sectoral cooperation.	Comprehensive guidance, information and knowledge management, capacity building	**BMZ; GIZ** **Partners**: Asian Disaster Preparedness Center (ADPC), Latin American Network of National Systems of Public Investment (Red SNIP), Southern African Development Community (SADC), Coalition for Disaster Resilient Infrastructure (CDRI)	05/2013 – 11/2023	Global	EUR 26,250,000
2 Activities in the "Spatial Planning and Civil Protection" cluster (e.g. urban resilience, nature-based approaches)							
2.	1	**Strengthening ecosystem-based adaptation (EbA) in planning and decision-making processes:** • **Global Project "Mainstreaming EbA":** Supporting the sharing of lessons learned in order to promote EbA	Information and knowledge management	**BMU;** **GIZ**	07/2015 – 05/2022	Brazil, Colombia, Ecuador, Grenada, India, Indonesia, Ka-	EUR 7,900,000

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
		and its dissemination and mainstreaming in policy and practice.				zakhstan, Kyrgyzstan, Mali, Mexico, Peru, Philippines, South Africa, Tajikistan, Thailand, Viet Nam	
2.	2	**Building urban climate change resilience** • **Urban Climate Adaptation in Central America**: Educating the population in dealing with climate risks and adaptation; protection against flooding and landslides by grey and green infrastructure, thus improving living conditions in affected regions.	Capacity building	**BMZ; KfW**		Honduras	EUR 23,000,000
2.	3	• **FAO project on climate resilience for food security in urban regions:** Developing and implementing adapted strategies to enhance climate resilience in city region food systems in pilot countries.	Capacity building	**BMEL; FAO**	12/2018 – 11/2021	Rwanda, Madagascar and Viet Nam	EUR 1,600,000
2.	4	**Sustainable development of urban regions:** Research projects with local stakeholders to increase the resilience of cities and urban regions; integrated urban planning, expandable and resilient infrastructure systems, risk management in extreme weather conditions.	Research, capacity building, some ecosystem-based approaches	**BMBF**	02/2019 – 03/2025	China, Viet Nam, Philippines, Cambodia, Thailand, Indonesia, Myanmar	EUR 40,000,000
3 Activities in the "Water" cluster (e.g. water regime, flood risk management, coastal protection, fisheries)							

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
3.	1	**Information and capacity building in water resources management and resilience** **Water Security and Climate Adaptation in Rural India (WASCA):** Developing innovative approaches and instruments, strengthening the knowledge and capacity of public and private institutions and stakeholders to improve the planning and increase financing of climate-proof water security at the national, federal and local levels.	Information and knowledge management, capacity building	**BMZ; GIZ**	04/2013 – 03/2022	India	EUR 11,500,000
3.	2	**Sustainable financing and support of water resource management in Peru:** Establishing water management structures and long-term financing mechanisms in Peru in order to improve the adaptability of population groups most at risk from the impacts of climate change while improving their resilience to climate-driven disasters; protection of at-risk ecosystems.	Information and knowledge management, capacity building, ecosystem-based approach	**BMU;** The Nature Conservancy (TNC)	03/2017 – 10/2021	Peru	EUR 2,100,000
3.	3	**Operation of the Global Water Quality database and information system** (GEMStat) at the GEMS/Water Data Centre of the International Centre for Water Resources and Global Change (ICWRGC): Support for UNEP's Global Environment Monitoring System for Freshwater (GEMS/Water), e.g. through the collection, quality assurance and provision of water quality monitoring data from national monitoring programmes and research institutes; development and delivery of water quality data products and indicators, including SDG Indicator 6.3.2.; development of inland water quality monitoring and evaluation capacities at partner institutions.	Information and knowledge management, capacity building	**BMU; IC-WRGC/BfG** **Partners:** UNEP; WHO; WMO; UCC; GEMS/Water partner countries	2014 – 2024	Global	EUR 5,000,000

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
3.	4	**Global Precipitation Climatology Centre, operated by DWD under the auspices of the WMO:** Global acquisition, verification and homogenisation of precipitation data from meteorological and climate observation networks. Calculation of gridded area-mean monthly and daily precipitation and derived indices for drought and weather extremes for the Earth's landsurface, publication on DWD's open data server.	Information and knowledge management, capacity building	**BMVI; DWD** **Partners:** GCOS, WMO/GEWEX, FAO, UNEP, GEO, CLIVAR, IPCC, UNESCO, global water data centres	Ongoing since 1989	Global	Approx. EUR 1,000,000 p.a.
3.	5	**Coordination of the Global Terrestrial Network for Hydrology (GTN-H) at ICWRGC to support the Global Climate Observing System (GCOS) and the WMO.** GTN-H links the existing global water data centres for integrated observations of the global water cycle.	Networking Capacity building	**ICWRGC** **Mandated by WMO**	Ongoing since 2017	Global water data centres	n.a.
3.	6	**FAO project to strengthen water governance processes:** Development of a ready-to-use methodology for fairer and more sustainable water governance.	Information and knowledge management	**BMEL;** FAO	12/2018 – 12/2021	Rwanda, Senegal, Sri Lanka	EUR 3,000,000
3.	7	**Blue Action Fund – innovative fund to protect coasts and oceans:** The Fund, which was founded by Germany, supports projects by national and international non-governmental organisations aimed at the conservation and sustainable management of marine biodiversity**.**	Finance	**BMZ; KfW**	Since 2016	Partner countries in Africa, Latin America and small island states	EUR 123,000,000
3.	8	**Support for sustainable fisheries and coastal protection** Empowering small-scale fishers to build their adaptive capacities and improve their food and livelihood security while enhancing coastal resilience.	Capacity building	**BMU;** RARE	09/2018 – 01/2022	Indonesia, Philippines and Micronesia	EUR 5,500,000

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
			Ecosystem-based approach				
3.	9	Analysis of the impacts of climate change scenarios on various marine and coastal areas in the Caribbean Sea, support for the designation of new protected areas	Information and knowledge management, capacity building	**BMU; GIZ**	01/2019 – 06/2023	Colombia	EUR 5,000,000
4 Activities in the "Infrastructure" cluster (e.g. building industry, energy industry, transport infrastructure)							
4.	1	**Enhancing Climate Services for Infrastructure Investments (CSI)**: Provision and promotion of climate services (climate information and advice; related services) in partner countries to support infrastructure investment planning.	Information and knowledge management Capacity building	**BMU; GIZ** **Partners:** DWD; World Federation of Engineering Organizations (WFEO)	03/2017 – 02/2020	Brazil, Burundi, Costa Rica, Democratic Republic of the Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, South Sudan, Tanzania, Uganda, Viet Nam	EUR 5,300,000
4.	2	**Improving flood protection and drainage in medium-sized coastal towns and cities to help them adapt to climate change:** Improving capacity and building awareness of risk-mitigating and climate-sensitive strategies for adaptation to more frequent and severe urban flooding in the wake of climate change.	Capacity building	**BMZ; GIZ**	10/2012 – 10/2020	Viet Nam	EUR 11,200,000

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
4.	3	**Urban Infrastructure Insurance Facility:** Climate risk insurance for cities in Latin America, aimed at improving protection of critical infrastructure and climate-vulnerable population groups against the impacts of extreme weather events.	Finance	**BMZ; KfW**	2021 – 2024	Latin America	EUR 12,500,000
4.	4	**Kerala Roads Project:** The aim is to make the region's road infrastructure more resilient to future extreme weather events by introducing climate-resilient elements, e.g. putting roads at higher elevations, equipping them with adequate drainage and stabilising adjacent slopes to prevent landslides.	Financing of infrastructure	**BMZ; KfW**	2019 commitment	India	EUR 170,000,000 (loans) EUR 3,000,000 (grant)
5 Activities in the "Land" cluster (soil, biodiversity, agriculture, woodland and forestry)							
5.	1	**Advancing the knowledge exchange platform for the agriculture and land sector under climate change (CL-Hub 2):** An FAO project to strengthen the capacities of developing countries to implement climate change adaptation and mitigation actions in agriculture, forestry and other land uses (AFOLU).	Capacity building, information and knowledge management	**BMEL; FAO**	08/2019 – 08/2022	Global	EUR 1,962,363
5.	2	**Towards Sustainable Bioeconomy Guidelines (SBG):** Guidelines to improve sustainable biogenic resource use that contributes to climate protection by replacing fossil-based products with sustainably manufactured bio-based goods and enhancing the climate resilience of the biogenic resource base through sustainable resource management.	Capacity building: Bioeconomy – sustainable biogenic resource use	**BMEL; FAO**	03/2017 – 12/2021	Global	EUR 2,472,177

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
5.	3	**Supporting the implementation of the Koronivia Joint Work on Agriculture roadmap (Boosting Koronivia):** Improving countries' capacities to take urgent action on mitigating climate change and its impacts and making agriculture, forestry and fisheries more productive and sustainable.	Developing institutional frameworks, capacity building, information and knowledge management	**BMEL; BMZ; FAO**	06/2019 – 06/2020	Global	EUR 3,016,778
5.	4	**Projects based on agroecological practices aimed at protecting soils and building resilience in agriculture**					
		Soil Protection and Rehabilitation (supraregional programme): Agroecological practices for the protection and rehabilitation of agricultural soils, including maintaining and building up organic matter, with a focus on food security and enhanced resilience. The programme has protected or rehabilitated 664,000 hectares of agricultural land and increased yields by an average of 36% and by as much as 200% for some crops/regions. Contributions to climate change adaptation and mitigation are measured using a monitoring system.	Agriculture-based approach, information and knowledge management, capacity building, improved institutional frameworks	**BMZ; GIZ; co-funding from BMGF** **CGIAR research centres, national and international NGOs, national and German research institutes, think tanks**	11/2014 – 06/2023	Benin, Burkina Faso, Ethiopia, India, Kenya, Madagascar, Tunisia	EUR 152,552,927
5.	5	**FAO** project – Soils for Nutrition: Identification and dissemination of nutrition-sensitive soil management practices.	Information and knowledge management	**BMEL;** FAO	12/2018 – 11/2021	Burkina Faso, Cambodia, Malawi	EUR 1,300,000
5.	6	**Pollinator resilience:** Introduction of a methodology to measure the income gain that can be achieved by improving habitat conditions for pollinators; this also serves as an incentive for farmers and policy-makers to protect these	Information and knowledge management	**BMU**; ICARDA		Algeria, Egypt, Jordan, Morocco, Palestinian National Authority, Tunisia	EUR 6,600,000

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
		insects. Climate change poses a major threat to pollinators and reveals the high dependence on wild pollinators.					
5.	7	**Bioeconomy International 2016: Phenological and Social Impacts of Temperature Increase – Climatic Consequences for Fruit Production in Tunisia, Chile and Germany** Provision of climate and ecophysiological information, enabling fruit farmers to build more resilience into their operations. Differences between the study areas – in terms of geography, climate threat and socioeconomic conditions – are utilised to make statements about expected climate impacts and to develop adaptation strategies.	Sustainable agricultural development	**BMBF** **Partners:** University of Munich (LMU), University of Bonn, Institut National Agronomique de Tunesie, Olive Institute Tunisia, Pontificia Universidad Católica de Valparaíso	10/2017 – 03/2021	Tunisia, Chile	EUR 1,300,000
5.	8	**Bioeconomy International 2013: DeltAdapt – Sustainable Adaptation of Coastal Agro-Ecosystems to Increased Salinity Intrusion** The project investigates the socio-ecological sustainability of the coastal agro-ecosystems in the Mekong and Red River deltas in Viet Nam and aims to identify options for adaptation to increased salinity, climate change and population growth.	Sustainable agricultural development	**BMBF** **Partners:** University of Bonn, United Nations University, Forschungszentrum Jülich, University of Würzburg, Helmholtz Centre for Environmental Research, TerrAquat Consultants	09/2014 – 03/2018	Viet Nam	EUR 1,542,700

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
5.	9	**Bioeconomy International 2016: Mapping of Grapevine Genetic Loci for Resistance to Downy Mildew and to Anthracnose** Facing climatic changes, German breeders wish to integrate resistance to anthracnose into the gene pool.	Sustainable agricultural development	**BMBF** **Partner:** Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants	02/2018 – 01/2021	Brazil	EUR 258,400
5.	10	**Bioeconomy International 2017: VCFCSAI – Financing climate-smart technologies in agriculture through cooperation along the value chain** Due to rapid population growth in India, pathways for promoting agricultural development and environmental sustainability must be identified. This requires an increase in productivity and adaptation to climate change in order to reduce production risks. To this end, farmers have access to efficient and resilient climate-smart technologies that mitigate the negative environmental impacts of agriculture.	Sustainable agricultural development	**BMBF** **Partner:** Technical University of Munich	02/2020 – 01/2023	India	EUR 302,900
5.	11	**Bioeconomy International 2017: TEOSINTE – Comprehensive sequencing and comparative genomics of a large number of Teosinte accessions with the aim of generating knowledge in order to support maize breeding, particularly with regard to climate change** Wild relatives of crop plants are important sources of genetic diversity, with great potential for breeding programmes, particularly those focusing on adaptation to extreme environmental conditions. Teosintes – wild relatives of maize – have a broad ecogeographical distribution in	Sustainable agricultural development	**BMBF** **Partner:** Forschungszentrum Jülich	07/2020 – 06/2023	Mexico	EUR 337,900

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		Mexico and are able to withstand extreme precipitation and temperature conditions.					
5.	12	**Forest Landscape Restoration:** Restoration of the ecological and productive functions of degraded forest landscapes in five provinces of Afghanistan, sustainably enhancing the rural population's resilience to natural disasters and economic crises.	Ecosystem-based approach, capacity building	**BMZ; GIZ**	04/2019 – 12/2022	Afghanistan	EUR 10,500,000
6 Activities in the "Health" cluster (risk communication and prevention, social protection)							
6.	1	**Adaptation to climate change in sub-Saharan African humanitarian situations:** The project, which is implemented jointly by four UN organisations, strengthens the capacities of displaced and vulnerable populations to adapt to climate change.	Information, knowledge management, capacity building	**BMU;** WFP	09/2018 – 08/2020	Burundi, Sudan, Chad	EUR 3,500,000
6.	2	**Social Protection Programme (SPP):** The intervention improves risk coverage and promotes independent livelihoods for poor and vulnerable groups; this includes coverage of risks relating to extreme weather events or natural disasters. The project also develops schemes for labour market integration of people with disabilities.	Capacity building	**BMZ; GIZ**	06/2010 – 12/2021	Indonesia	EUR 20,598,409
7 Activities in the "Economy" cluster (trade and industry, financial services industry, tourism)							
7.	1	**InsuResilience Global Partnership:** Expanding the use of climate and disaster risk finance and insurance, facilitating	Comprehensive strategies, capacity building, finance	**BMZ; GIZ** (secretariat);	11/2017 – 2025		EUR 520,000,000

Ref. no.		Title and brief description of the mechanism/action	Fields of action in development co-operation	Lead organisation(s)/ partner(s)	Period	Country	Funding/ funding provider
		a more timely, reliable and cost-effective post-disaster response, e.g. via the **Global Risk Financing Facility** (GRiF) and **InsuResilience Solutions Fund** (ISF). Other initiatives include:		a total of 80 members, including AfDB; ADB; GEF; GCF; IDB; ILO; OECD; World Bank; UNDP; UNFCCC; WFP			(BMZ's contribution)
7.	2	**InsuResilience Investment Fund (IIF):** Promotes the development and distribution of extreme weather insurance, combining debt and equity investments.	Capacity building, finance	**BMZ, KfW**	2015 – 2029	All developing countries	Approx. EUR 74,800,000
7.	3	**Natural Disaster Fund (NDF):** Insurance protection adapted to the needs of developing countries, based on scientific weather models, actuarial methods and risk transfer mechanisms	Capacity building, finance	**BMZ; KfW** Global Parametrics; reinsurance company Hannover RE	From 2020	All developing countries	EUR 37,000,000
7.	4	**ARC Replica**: Complements the drought insurance provided by African Risk Capacity (ARC), reaching additional beneficiaries (2019: approx. 5 million), with more contingency planning and implementation. Insurance protection for, currently, six countries is enhanced by replica insurance policies purchased by humanitarian organisations (WFP, Start Network).	Capacity building, finance	**BMZ, KfW**	2018 – 2020	African countries participating in the Replica programme	EUR 10,000,000
7.	5	**Sustainable Industrial Production:** Support for efficient, environment-friendly and climate-friendly industrial development, with an emphasis on industrial waste water management. The focus is on the modernisation of waste water treatment facilities and on the subsequent reuse of	Information and knowledge management Capacity building	**BMZ; GIZ**	02/2015 – 02/2022	India	EUR 9,500,000

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		waste water, improved resource efficiency at production level (e.g. more efficient use of chemicals), more intensive environmental monitoring, infrastructure expansion and training for site operators.					
7.	6	**Ecosystem-based Adaptation to Climate Change in cooperation with the private sector in Mexico:** Support for the integration of biodiversity into economic development, decision-making processes and sector investments. Climate change impacts and their links with ecosystem services are analysed to this end and key stakeholders are trained to use the ecosystem-based adaptation (EbA) approach. The project also strengthens inter-sectoral cooperation for the integration of EbA into sector investments and identifies financing mechanisms.	Information and knowledge management Capacity building Ecosystem-based approach	**BMU; GIZ**	09/2017 – 08/2021	Mexico	EUR 4,000,000