



Public Adaptation to Climate Change



THE COSTS OF CLIMATE CHANGE ADAPTATION FOR THE AUSTRIAN FEDERAL BUDGET

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Abstract

This paper investigates current costs for public adaptation to climate change in Austria. Focusing on the federal level, we include all adaptation actions that are funded or realized by the federal government. To estimate the expenditures for different categories of the Austrian overall budget, we develop and employ two methods: (i) a top-down approach based on the federal government's budget plan and realization report 2016 (remitted funds in 2014) and (ii) a bottom-up approach based on the specific measures of the Austrian strategy for adaptation to climate change. The top-down approach seeks to find out which federal expenditures are adaptation-relevant and what shares thereof are adaptation costs. It builds on results from expert interviews with ministerial officials and combines them with the OECD DAC Rio markers for adaptation and the EU common methodology. The aim of the bottom-up approach is to identify which costs are caused by implementing the adaptation measures of the Austrian national adaptation strategy, considering only those adaptation measures that are currently in place and are funded by the federal government. The results show expenditures of € 488 million per year for the top-down approach and € 385 million per year for the bottom-up approach. The difference between the results essentially lies in the divergence of coverage, which however overlaps: while the top-down approach covers all adaptation activities that are currently in place and are funded by the federal budget, the bottom-up approach accounts for those activities that are part of the Austrian strategy for adaptation to climate change, no matter its state of implementation..

1. Introduction

The Austrian Adaptation Strategy was released in 2012 (BMLFUW 2012a), with the main objective of preparing the population and the economy for future changes and providing possibilities for protection against negative consequences (BMLFUW 2012b). The development process of the Austrian Adaptation Strategy was initiated by the Austrian Ministry of Agriculture, Forestry, Environment, and Water Management (BMLFUW) in response to the outcome of the “Survey of the Current State of Adaptation to Climate Change in Austria” by Gingrich et al. (2008), that recommended a national adaptation strategy. The strategy has been set up by national and international experts from various sectors and contains 132 measures to adapt to climate change in 14 different activity fields. In 2015 also the progress report on the state of implementation of the measures has been passed which discusses qualitatively the current situation of adaptation in Austria (BMLFUW 2015a). In addition, part 1 of the strategy -the context- requested an estimation of resource needs (in euro) for the implementation of adaptation measures, based on scientifically sound evaluations (BMLFUW 2012b).

The aim of this paper is therefore the assessment of federal spending on public climate change adaptation. Difficulties in costing of public adaptation are manifold: which ministerial activities and corresponding expenditure groups contain adaptation and which not; how to deal with actions that are part of the adaptation strategy but are not yet implemented or partially implemented; and how to deal with adaptation actions that are undertaken in practice but which are not part of the adaptation strategy.

To deal properly with these challenges, we employ a twofold approach: a) screening the public budget for adaptation-relevant spending (top-down approach); and b) costing the specific measures of the adaptation strategy and aggregating these costs (bottom-up approach). These approaches build on the Rio markers of the Organisation for Economic Cooperation and Development (OECD) and are further refined to fit the purpose.

Section 2 describes the international context of adaptation tracking and summarizes existing methods. Section 3 gives an overview of the study outline and research approach, defining the data set and method for both the top-down and the bottom-up approach. Results and differences in the results of the two approaches are presented in section 4. In section 5, we discuss future development trajectories of federal spending on public adaptation with the depiction of an indicative adaptation scenario up to 2050. Section 6 summarizes key findings and concludes.

2. International context

At the Conference of Parties in Copenhagen in 2009, developed countries committed to the goal of mobilizing finance for mitigation and adaptation to address the needs of developing countries. The commitment to provide support was reaffirmed in the recent Paris Agreement (UNFCCC 2015). To track progress towards these targets, a method was developed to report expenditures on climate mitigation and adaptation by the Organisation for Economic Cooperation and Development (OECD) and developed further by the European Commission. This method builds on the Rio markers of the OECD, with new guidance for climate change adaptation added in 2010 (OECD DAC 2016a). This method provides 'climate markers' for tracking finance by distinguishing between expenditure where adaptation is the "principal" (primary) objective, a "significant" objective, or does not target the objective. Alongside these international initiatives, there is also an increasing mobilisation of European and national finance for mitigation and adaptation.

The European Union has agreed that at least 20% of its budget for 2014 to 2020 – as much as € 180 billion – should be spent on climate change related action (European Council 2013). To deliver this commitment, the Commission is increasing climate investment into the five European Structural and Investment Funds (ESIF) and mainstreaming into relevant policies. The European Commission also applies the OECD DAC markers for tracking progress against the 20% EU-target and has published guidance for the application of the method to the ESIFs. This guidance applies a 100% climate marker when adaptation is the primary objective and a 40% marker when it is a significant objective (European Commission 2016). The climate tracking methodology and markers were used as the starting point to undertake a detailed analysis of adaptation expenditures in the national public budget of Austria.

3. Study outline and approach

This study has set out to estimate today's federal spending on public climate change adaptation for Austria. For this assessment, public adaptation is defined as all measures that are undertaken or motivated by public authorities because public authorities are in the role of the owner or are responsible for its management, because significant social organization is required, or because adaptation undertaken by private actors needs to be facilitated by the provision of public goods (Eakin and Patt 2011).

Investigating the actors for the different activity fields listed in the Austrian National Adaptation Strategy, Knittel and Bednar-Friedl (2016) find that the activity fields water resources and water management, energy, construction and housing, protection from natural hazards, disaster risk management, health, ecosystems and biodiversity, transportation- infrastructure, spatial planning and

cities – urban green and open spaces heavily rely on public funding for implementation. For the federal case study we only focus on those activity fields that are within the competence of the federal government and no other public authorities such as cities. As a consequence, the following activity fields have been investigated regarding their budgetary consequences: agriculture, forestry, water resources and water management, protection from natural hazards, disaster risk management, health, ecosystems and biodiversity and transportation infrastructure.

For the analysis, two alternative approaches were used to identify adaptation expenditures, contrasting a) a top-down approach based on the federal government’s budget plan and realization report 2016 (remitted funds in 2014) and b) a bottom-up approach based on the specific measures of the Austrian strategy for adaptation to climate change. The initial step was to identify all adaptation-relevant expenditures, irrespective of whether adaptation was the primary or secondary objective. The subsequent step was to allocate how much of these total relevant expenditures were adaptation costs and finally the collected costs were attributed to specific adaptation measures.

When distinguishing between adaptation-relevant expenditures and adaptation costs, we refer to the following: Adaptation-relevant costs are expenditures aimed at avoiding or reducing the impacts of current climate variability (adaptation deficit) and future impacts of climate change for ecological, social and economic systems as well as realizing potential opportunities. Any activity supporting this aim is considered relevant for adaptation and the resulting expenditures are called “adaptation-relevant expenditures”. Adaptation costs, however, are only the share that is explicitly attributed to adaptation. Public expenditures and programs that pursue climate change adaptation as a primary goal are classified as having 100% adaptation costs by the EU method. But since expenditures on adaptation are usually a by-product of existing programs and actions with different goals such as health or energy supply, the adaptation cost share will be somewhere below 100% as Figure 1 roughly shows.

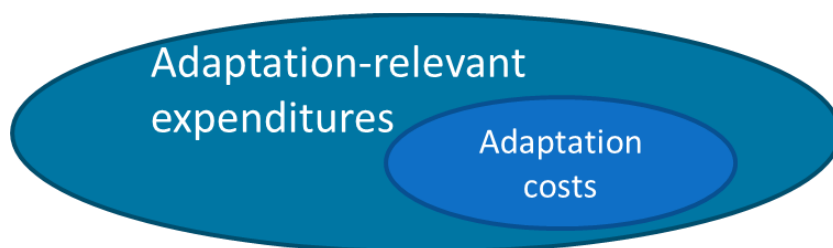


Figure 1: Adaptation costs are a share of adaptation-relevant expenditures

3.1. Data and method: the federal budget (top-down approach)

The first data set -for the top down approach- is based on the Austrian federal budget. Through a budget law reform in Austria, the representation and the structure of public budgets changed towards increased transparency, and this has allowed a detailed analysis of the current adaptation expenditures. The budget law reform was carried out in two stages (BMF 2015b): the first part was implemented on 1 January, 2009 and the second on 1 January, 2013. The intention of the reform was to introduce the effect-oriented planning which allows the comprehension of goals of the expenditures (BMF 2015b). Figure 2 shows the legal organization of Austria's budget planning process (BMF 2015b).

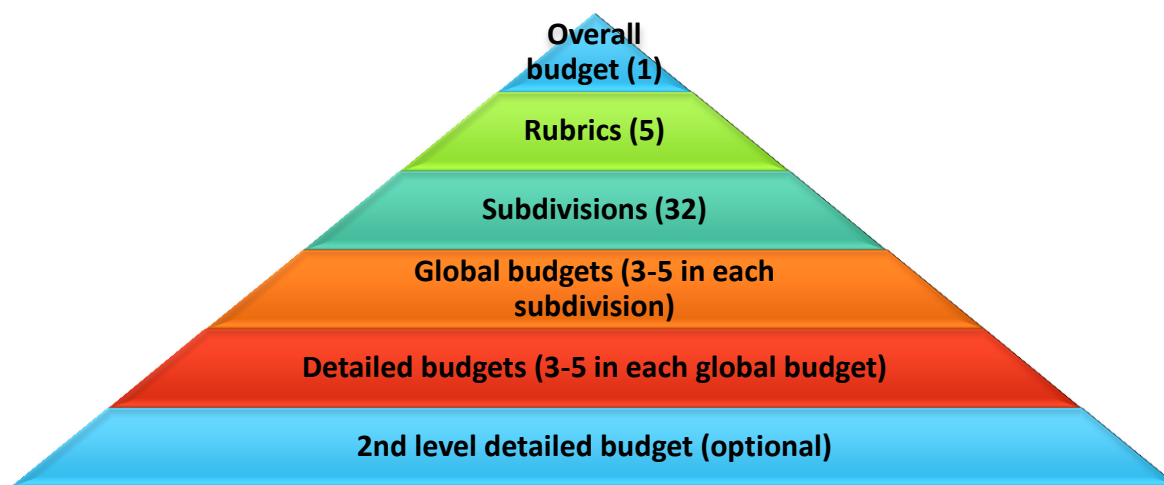


Figure 2: Representation of the organizational structure in Austria's budget (Number in brackets denotes quantity of considered units)

Source: BMF (2015b) and own representation

The highest aggregate of the federal government budget is the overall (total) budget and which includes the resource allocation of all subsequent levels. The overall budget is divided into five rubrics that cluster around similar policy areas, and are then further grouped into 32 subdivisions (SD) (BMF 2015b). A subdivision is a professionally associated budget area that is exclusively allocated to one federal ministry. Subdivisions range from SD₀₁ presidential chancellery to SD₁₁ internal affairs, SD₄₀ economics, SD₄₁ transport, innovation and technology, SD₄₂ agriculture, forestry and water management, SD₄₃ environment and SD₄₄ financial compensation to SD₅₈ financing, currency barter agreement (BMF 2015b). The subdivisions in turn are divided into global budgets, based on a set of pragmatic and coherent criteria that reflect their main focus (e.g. SD₄₂ is split into its three parts agriculture, forestry and water management). Global budgets are further separated into detailed budgets which are closely monitored by one authority only enabling the delegation of budgetary responsibility. The ceiling of detailed budgets has no binding effect on a legal but on an internal

administrative basis (Republik Österreich 2015). Several detailed budgets are further broken down into 2nd level detailed budgets with even more specific descriptions, which is however not compulsory. To derive adaptation expenditures, the method then followed the graphical depiction in Figure 3.

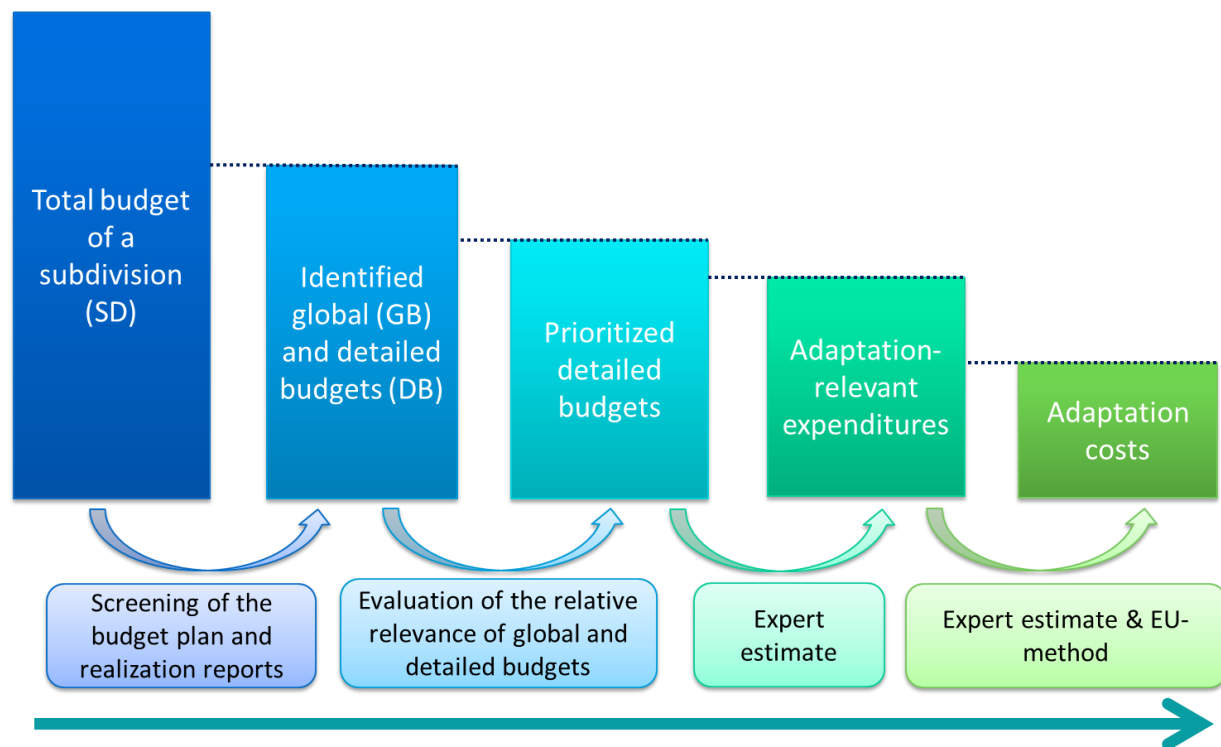


Figure 3: Methodology for the top-down approach A subdivision (SD) consists of multiple global budgets (GB), which in turn consists of one or more detailed budgets (DB)

Step 1:

At the first stage the federal government’s budget plan and realization reports were screened at the level of subdivisions (SD). After a first review of the subdivisions, we excluded those that appeared irrelevant from further analyses, such as SD01-presidential chancellery, SD51-cash department, SD58-financing, currency barter agreement, etc. Several subdivisions, such as SD 43 (environment), were identified to be relevant for adaptation. Then we examined the remaining subdivisions with respect to their “mission statement” and their “envisaged impact target”, both of which are described within the first pages of each federal government’s budget plan and realization report. The mission statement describes the general objective of the specific subdivision and explains what it stands for. The envisaged impact targets are more specifically stating the targets for the considered time period. As a result of the budget law reform we were able to analyse the detailed budgets with regard to their verbally announced targets. Due to the difficulty in differentiating between adaptation and mitigation on a

political level, we took a cautious approach and selected more detailed budgets for further processing. Throughout the selection procedure in the budget plans of the different subdivisions, we searched for key words such as “environment”, “energy efficiency”, “constructional measures”, “climate change”, “flood”, “preventive measures”, or optimally, “adaptation”. Additionally, every subdivision or lower levelled budget that is anyway related to environmental protection was investigated, because to date, no exact definition on adaptation is used in the budget forming process. In addition, we analysed subdivisions that we expected to contain adaptation expenditures due to the description of some measures of the Austrian Adaptation Strategy. Finally, those global and detailed budgets were identified that potentially include adaptation-relevant expenditures. As an example of the procedure see Box 1 for picking the detailed budget 42.03.02 Water.

Box 1: Selection procedure for "water"

42.03.02 Water

Mission statement of subdivision 42-agriculture, forestry and water management (BMF 2015b, p.5):

- ✓ *We stand for environmentally compatible development, protection of living spaces in urban and rural areas, effective protection of natural hazards as well as for the greening of Austria's riverine landscapes.*
- ✓ *Our main topics are the sustainable production of secure and high-quality food, renewable energy resources as well as the conservation of a sustainable agriculture, forestry and water economy. We support these topics on the national, European and international level.*
- ✓ *In partner-like dialogues we elaborate innovative concepts to increase employment and value in vital rural regions. We ensure the protection of nature and the sustainable use of rural areas through coordinated measures and programmes of agricultural and environmental funding. It is important to us that social, ecological and economical interests are equally considered.*

Envisaged impact targets (BMF 2015b, pp.5-11):

- ✓ *Reinforcement of the protection of population and living spaces against floods, avalanches, mudslides, rock fall and landslides*
- ✗ *Sustainable development of vital rural areas with equal development opportunities for women and men*
- ✓ *Securing of the nationwide agricultural production, the domestic and foreign sales markets, sustainable food and the supply of domestic high-quality products*
- ✓ *Sustainable protection of water resources as a basis of life and the living areas of men and nature*
- ✓ *Sustainable reinforcement of the practical, protective, welfare and recuperative effect of the forest habitats*

Targets expressed in the detailed budget 42.03.02 (BMF 2015b, p.68):

- ✓ *Target 1: Updating of the national water management plan (2.NGP) and the programme of measures*
- ✓ *Target 2: Installation and preservation of flood protection measures including planning based on the Floods Directive imposed by the European Union*
- ✓ *Target 3: Water management according to international guidelines regarding water quality and floods*
- ✓ *Target 4: Adaptation of the water resource management to climate change*
- ✓ *Target 5: Consciousness raising and public participation in the water management sector*

Note: A check mark in front of the argument indicates a possible signal for adaptation to be contained, whereas arguments with a cross mark are rather negligible. Since a cautious approach was taken, one check mark is sufficient for a budget position to be included into the list of relevant budget positions.

Step 2:

Based on the budgetary importance of selected global and detailed budgets, a number of budget positions were subjected to closer inspection. Table 1 presents the list of selected global and detailed budget with the according subdivision, title, remitted funds in 2014 and the share that was discussed with ministerial staff.

Table 1: List of identified detailed budgets with according expenditures in 2014 and the discussed share

SD	Title	Global budget	Title	Detailed budget	Title	Expenditures in 2014, in € mio	Budget discussed		
11	Internal affairs	11.02	Security	11.02.05	National Crisis and Disaster Protection Management	7.72	100%		
12	Foreign affairs	12.02	Foreign policy measures in the European and international framework	12.02.01	Development coordination and foreign disaster fund	83.03	0%		
24	Health	24.01	Governance and services	24.01.02	Shareholdings and transfers (AGES and GÖG)	67.26	0%		
				24.03	Health provision and consumer health	24.03.01	Health support, provision and measures against drug abuse	59.82	0%
						24.03.02	Veterinary, food and gene technological affairs	6.43	0%
31	Science and research	31.03	Research and development	31.03.01	Projects and programs	51.85	0%		
				31.03.02	Core funding of institutions	389.29	0%		
34	Transport, innovation & technology (research)	34.01	Research, technology and innovation	34.01.03	Funding of research, technology and innovation	291.04	0%		
40	Economics	40.02	Transfer payments to the economy	40.02.01	Economic funding	128.48	0%		
41	Transport, innovation & technology	41.01	Governance and services	41.01.02	Austrian Climate and Energy Fund	37.33	0%		
				41.02	Transport and communication	41.02.02	Rail	2789.82	100%
						41.02.04	Streets	22.74	10%
						41.02.06	Water	79.94	2%
42	Agriculture, forestry & water management	42.02	Agriculture and rural areas	42.02.01	Rural development	765.08	40%		
				42.02.02	Market organization measures and fishery	755.83	0%		
				42.02.03	Research and other measures	78.8	10%		

43	Environment	42.03	Management of forests, water resources and natural hazards	42.02.04	Offices/Agriculture	93.87	0%
				42.02.05	Offices/Wine	17.82	0%
		43.01	General environmental protection policy	42.03.01	Forest	149.34	94%
				42.03.02	Water	120.79	30%
		43.01	General environmental protection policy	43.01.02	Domestic and foreign environmental support	190.59	0%
				43.01.03	Austrian Climate and Energy Fund	50	100%
				43.01.05	Sustainable protection of nature and environment	61.62	0%
		43.02	Waste and waste water management	43.02.02	Site remediation	64.39	0%
				43.02.03	Waste water management	345.03	100%
		44	Financial compensation	44.02	Disaster fund	44.02.01	Disaster fund, variable

Step 3:

The third stage included expert estimates by employees in several departments of the ministries to define adaptation-relevant expenditures. 20 experts were interviewed either in their offices or on the phone after being sent informational material and a condensed version of the questionnaire (see Appendix). Interviews lasted between 30 and 90 minutes with a majority of around 75 minutes and were conducted by either one or two of the authors. Interviews were semi-structured to allow experts to bring in information about discipline-specific behavioural patterns with respect to climate change adaptation planning, processing and funding. For every interview, we noted the amount of budget that could be discussed according to the information and responsibility of the interviewees and the amount that is adaptation-relevant following the above definition. Information obtained during the interviews was supplemented by additional investigation in documents such as the Green Report 2015 (BMLFUW 2015b) or the strategy report 2016-2019 by the ministry of finance (BMF 2015a).

Step 4:

The final step to assigning adaptation expenditures also uses experts estimates with the relevant federal ministry staff estimating the actual adaptation cost, i.e. the proportion of the expenditure directly relevant for adaptation. However, in some cases experts were not able to estimate these adaptation cost shares. Therefore, the final step was complimented by the methodology of the OECD DAC/EC for

climate finance tracking (2016b) and the methodology of the EC (European Commission 2016) using climate markers (100% for primary goal 40% for significant goal) (the 'EU method').

Table 2 presents examples for the attribution of programs, projects or expenditure categories to the different adaptation cost shares. For some projects, expert estimates and the EU-method agree on an adaptation cost share of 100%, such as education, training and public awareness related to climate change, its impacts and the role of adaptation. If adaptation is not the primary goal, but a significant goal only, the EU-method would assign a cost share of 40% no matter the specific content of the program. The expert estimate instead can assign a cost share of between 1 and 99%, that is in practical terms 10, 20, 30% and so forth up to 90%. So, the advantage of the expert estimate is that it can be a lot more accurate in representing the true cost shares. For some programs also the EU-method acknowledges for the possibility of adaptation being the primary or the secondary goal and therefore adaptation cost shares can be again 40 or 100%, as it is for example the case for flood protection measures, where it largely depends on whether sociodemographic changes or climate variability or change are the primary driver. Again, the expert estimate can vary between a very low and a very high adaptation cost share. For the case of flood protection measures for example, expenditures were divided into expenditures for grey, green and soft measures and the adaptation cost shares were estimated only thereafter, with the result that 60% of adaptation-relevant expenditures on grey flood protection measures were assigned to adaptation costs, 80% of green flood protection measures and 100% of soft flood protection measures. This more precise attribution to adaptation costs based on expert estimation reflects the purpose of expenditures better than a simple 40 or 100%- assignment.

Table 2: Adaptation cost shares for different adaptation types

Adaptation goal	Illustrative examples	Adaptation cost share
Adaptation as the primary goal	<ul style="list-style-type: none"> • Restoring natural flood areas, combined with land-use planning to reduce exposure to future floods • Education, training and public awareness related to climate change, its impacts and the role of adaptation • Sustainable climate-resilient agricultural and forestry practices 	100% (expert estimate) or 100% (EU-method)
Adaptation as a significant goal	<ul style="list-style-type: none"> • Changing to water-saving technologies to reduce the vulnerability to water shortages • Considering climate variability and climate change impacts in the planning of transport infrastructure • Improvement of water quality and quantity for existing water resources including climate risks • Health programme to adapt to heat stress and climate change related diseases 	1-99% (expert estimate) or 40% (EU-method)
Adaptation as the primary or a significant goal	<ul style="list-style-type: none"> • Forecasting, early warning and monitoring systems • Flood protection measures • Increase diversity of varieties in agriculture to enhance climate resilience 	1-100% (expert estimate) or 100% or 40% (EU-method)

3.2. Data and method: the Austrian national adaptation strategy (bottom-up approach)

The second data set – for the bottom-up analysis - is based on the Austrian strategy for adaptation to climate change (BMLFUW 2012a). This strategy contains 132 measures to adapt to climate change and is structured into 14 fields each representing an area, such as protection from natural hazard or health, or a sector, such as agriculture or tourism, which is vulnerable to climate change.

In looking at the process of implementation of these options, it is clear that there are different actors involved. Providing some disaggregation therefore delivers additional insights on the lead actor, i.e. whether public (federal, state or municipal) or private, noting for this study that only federal expenditure is being assessed. The adaptation process is disaggregated into the following steps: initiation, financing, implementation, and who benefits from the measure (Knittel and Bednar-Friedl

2016). We define public adaptation as all measures that are publicly funded or implemented, but include only those adaptation measures in our analysis that are funded and/or implemented by the federal government (see the Appendix for list of measures).

According to this definition, 67 measures are funded or implemented by the federal government (Figure 4), namely in the following impact fields: agriculture, forestry, water resources and water management, protection from natural hazards, disaster risk management, health, ecosystems and biodiversity and transportation infrastructure. Only health measures could not be covered due to limited information on expenditures and costs in this field.

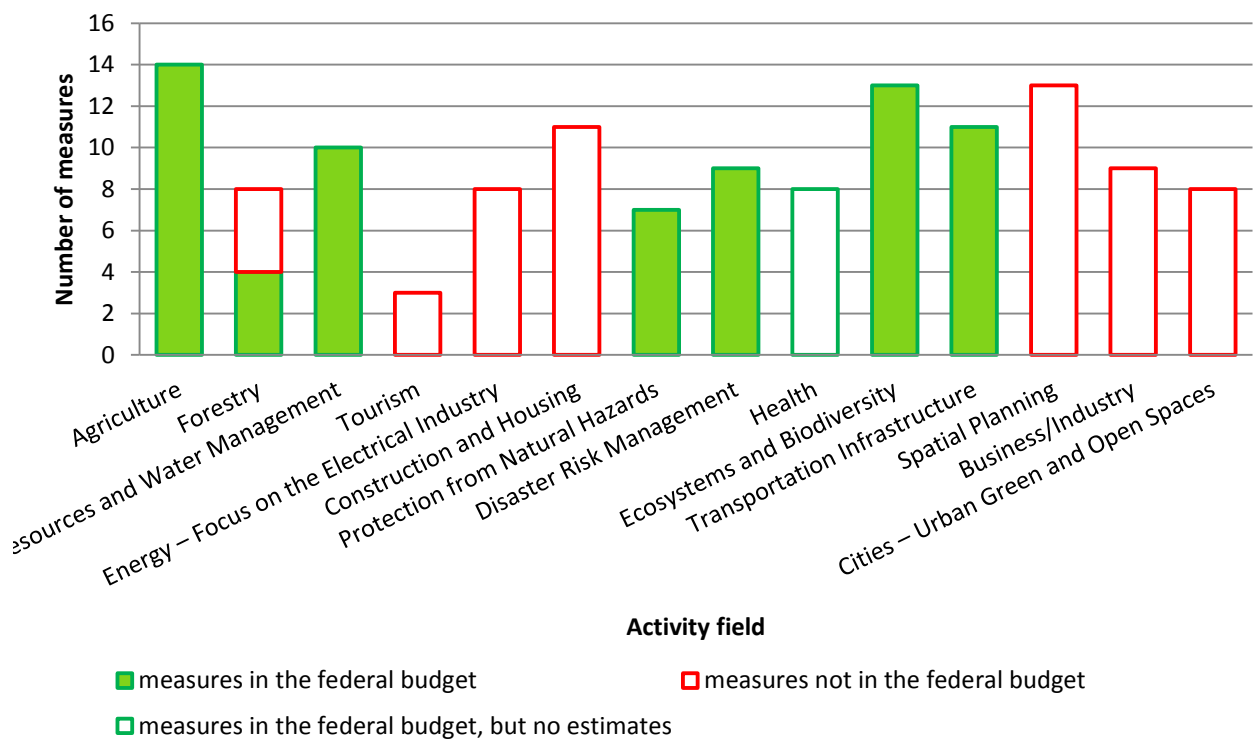


Figure 4: Estimate coverage of the adaptation measures of the Austrian strategy to adapt to climate change through the applied methodologies

The aim of the bottom-up approach is to identify the current costs of implementing the adaptation measures of the Austrian strategy to adapt to climate change. When conducting this analysis, the approach has aimed to allow a consistent and comparable aggregation of costs for measures funded by the federal budget. It again used expert interviews to elicit the adaptation costs for each listed measure in the national strategy (for the public planned activities). A mapping exercise was also undertaken to map the budget estimates (from the top-down approach) to the strategy.

Costs were estimated by asking experts to identify the indicative costs based on the following classifications: below € 0.5 mio., € 0.5 - 1 mio., € 1 - 5 mio., € 5 - 10 mio., € 10 - 20 mio., € 20 - 30 mio., € 30 - 40 mio., € 40 -50 mio., € 50 - 60 mio., € 60 mio. and higher. The first draft was provided by the authors based on the information of the interviews. Experts then commented on the estimates and offered suggestions for improvement. After revising the cost assignment, a group of experts and the authors met to jointly discuss assigned costs. Thereafter, the averages of the classes were used to calculate costs across different dimensions, such as activity field or the type of adaptation measure (technical/grey, informative/soft or green measures).

4. Results

4.1. *Funding for public adaptation in the current federal budget (top-down approach)*

Adaptation-relevant federal expenditures have been assessed for the subdivisions SD 41 (transport, innovation and technology), SD 42 (agriculture, forestry and water management) and SD 43 (environment). These subdivisions cover seven activity fields: agriculture, forestry, water resources and water management, protection from natural hazards, disaster risk management, ecosystems and biodiversity and transportation infrastructure.

It should be noted that SD11 internal affairs and SD24 health and women have also been included in the investigation, however, they are primarily engaged in organizational and coordinative tasks and as a result, personnel, rather than financial resources, matter. These subdivisions correspond to the activity field "health" and to individual measures in the activity fields "protection from natural hazards" and "disaster risk management". Further adaptation-relevant expenditures are expected in SD44 financial compensation, but have not been investigated due to time restrictions.

In 2014, adaptation-relevant expenditures in SD 41, SD 42 and SD 43 amounted to € 2.1 billion including climate change adaptation as primary or secondary goal. Considering only the share that constitutes adaptation explicitly, an amount of € 488 million identified as adaptation costs. Figure 5 presents the results step by step according to the top-down methodology depicted in Figure 3. It is shown that out of about € 6 billion total budget, € 2.1 billion are adaptation-relevant and € 488 million are adaptation costs.

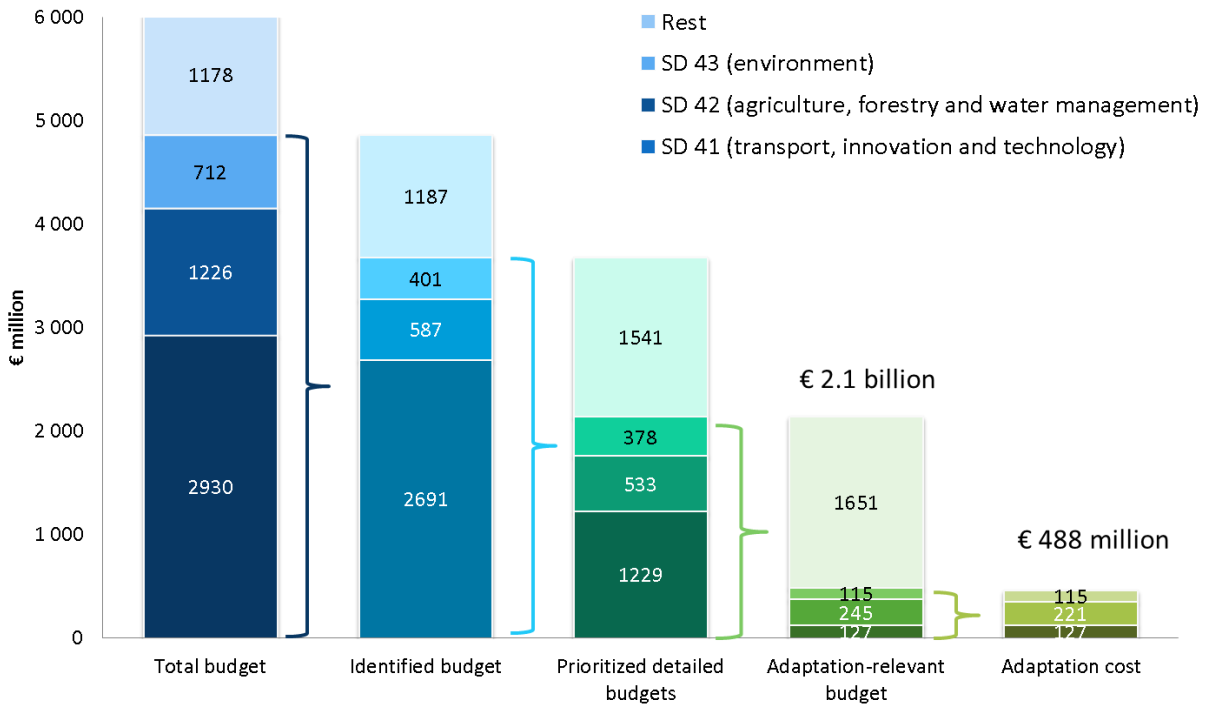


Figure 5: The top-down method and estimated Federal public adaptation costs

When looking closer into adaptation-relevant expenditures, Figure 6 presents which type of adaptation measures are funded by each of the three evaluated subdivisions. The majority of adaptation-relevant expenditures in the current Federal public budget is for technical measures that improve protection from natural hazard or climate-induced damages, such as flood protection measures. Note, however, that the Austrian adaptation strategy primarily includes soft measures that aim to increase adaptation capacity and enhance the knowledge base by providing information and education, but also planning measures. This is one reason why the two methods applied in this paper identify different adaptation activities and different levels of expenditure. Also importantly noted is that expenditures in SD 41 almost exclusively represent rail infrastructure, since road infrastructure in Austria is outsourced to the ASFINAG, the Austrian Autobahn and High Way Financing Stock Corporation.

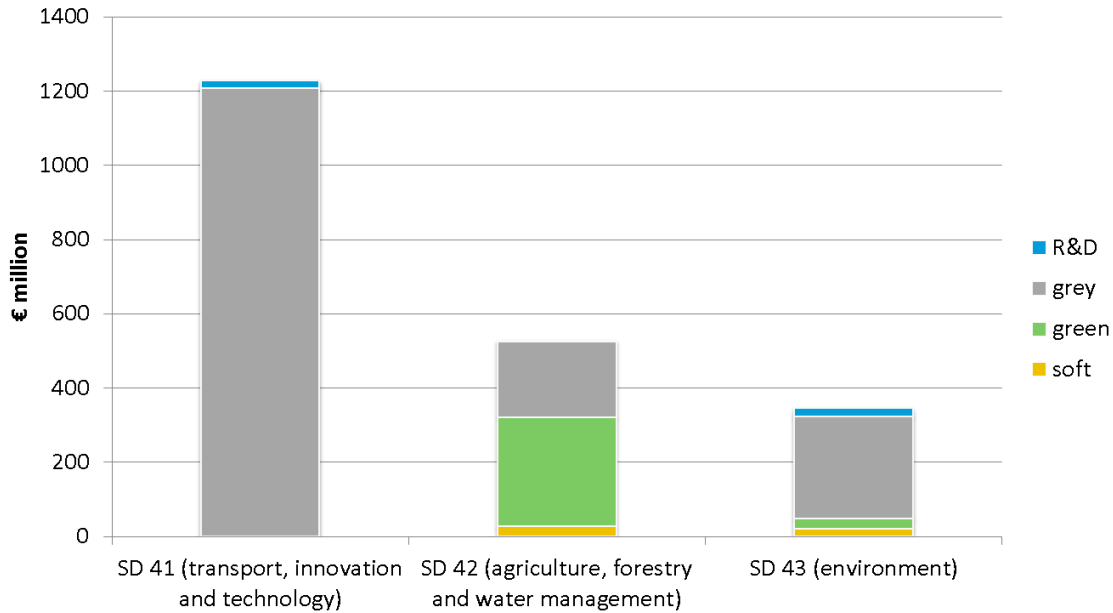


Figure 6: Different types of Federal public adaptation measures funded by SD 41 (transport, innovation and technology), SD 42 (agriculture, forestry and water management) and SD 43 (environment), divided into grey, green, and soft measures

In contrast to the picture that is delivered by Figure 6, Figure 7 presents how different types of adaptation measures are distributed across activity fields in the Austrian Adaptation Strategy. Clearly, soft measures (e.g. early warning systems) prevail across all activity fields. Mixed measures are typically very broad measures that include many different steps of action and are usually associated with high costs. Grey measures (e.g. flood protection dams), prevailing in current expenditures of the federal budget, play a minor role in the Adaptation strategy. Green measures (e.g. flood retention areas) are mainly undertaken by SD 42 (agriculture, forestry and water management) and are represented more strongly in the activity field ecosystems and biodiversity.

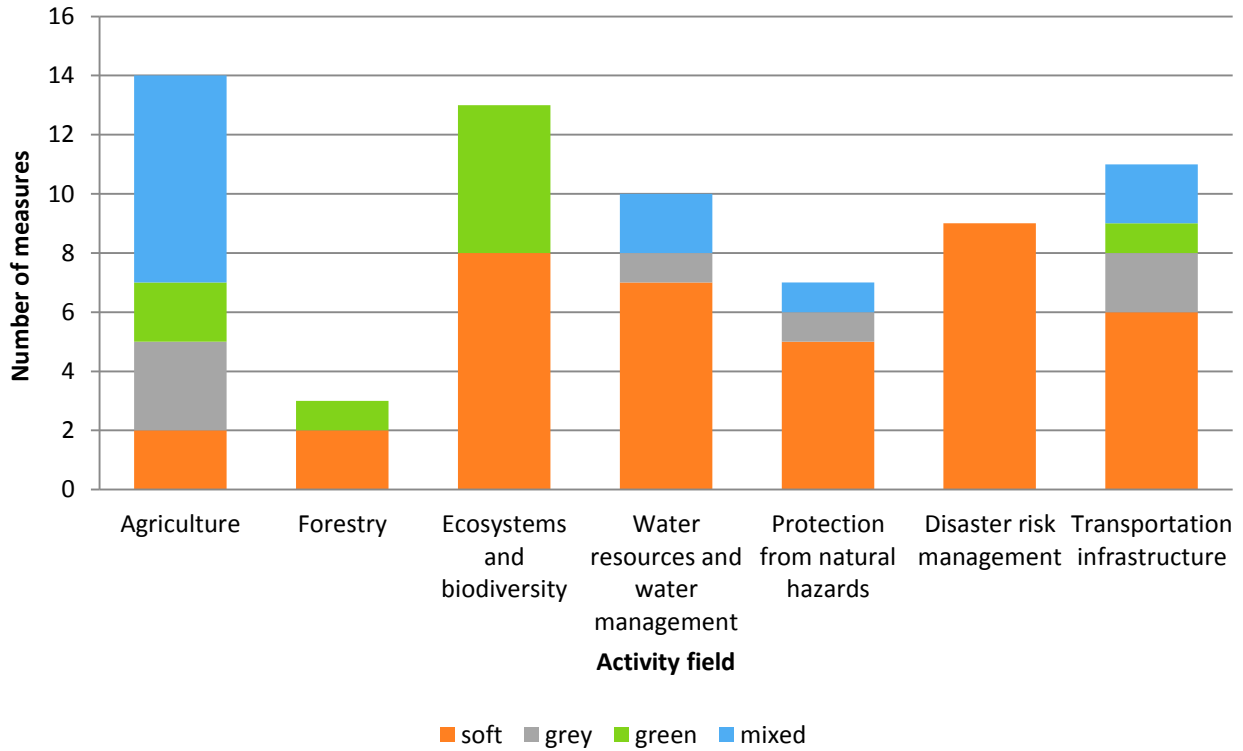


Figure 7: Different types of measures distributed across the relevant activity fields

Considering adaptation costs, Figure 8 shows how these costs are distributed across activity fields as well as other measures that support adaptation, but are not stated within the list of measures in the Austrian adaptation strategy. Other measures mainly include expenditures on flood protection constructions by the Federal Water Engineering Administration (Bundeswasserbauverwaltung) and the Torrent and Avalanche Control (Wildbach- und Lawinenverbauung), as well as expenditures in the forestry sector for education, information provision, awareness raising campaigns and consulting services, as well as for silviculture such as afforestation.

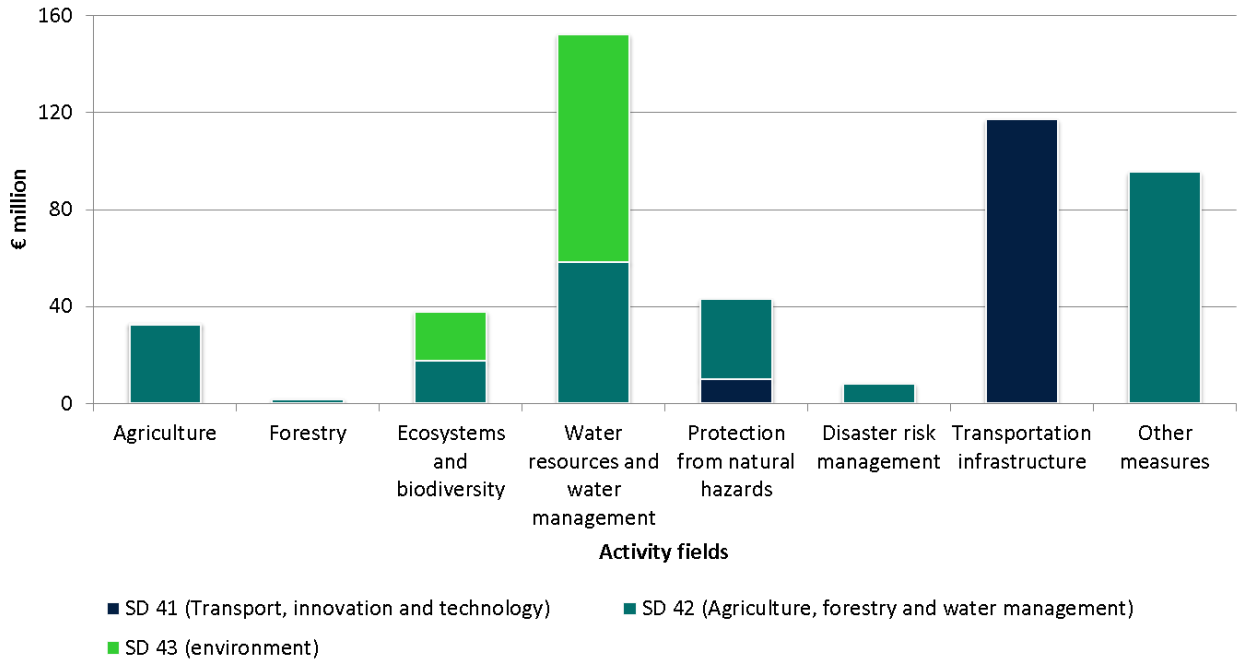


Figure 8: Current annual Federal public adaptation costs in SD 41 (transport, innovation and technology), SD 42 (agriculture, forestry and water management) and SD 43 (environment) for activity fields in € million (2014), top-down approach

4.2. Cost estimates of the Austrian strategy for adaptation to climate change for the federal budget (bottom-up approach)

The bottom-up approach estimates the aggregate current costs of adaptation measures that are listed in the Austrian adaptation strategy and are funded by the federal government. This approach used the interviews with the respective divisions of the federal ministries, as detailed in section 3.2 above. The majority of measures were assigned to the lowest cost class (up to € 5 mio. per measure). More expensive measures arose from infrastructural measures connected to future water provision and green measures that require the purchase of retention areas (protection from natural hazards), as well as very broad measures such as safeguarding the functionality of the transport infrastructure. Figure 9 presents the detailed information on how cost classes per measure are distributed across the activity fields of the Adaptation Strategy.

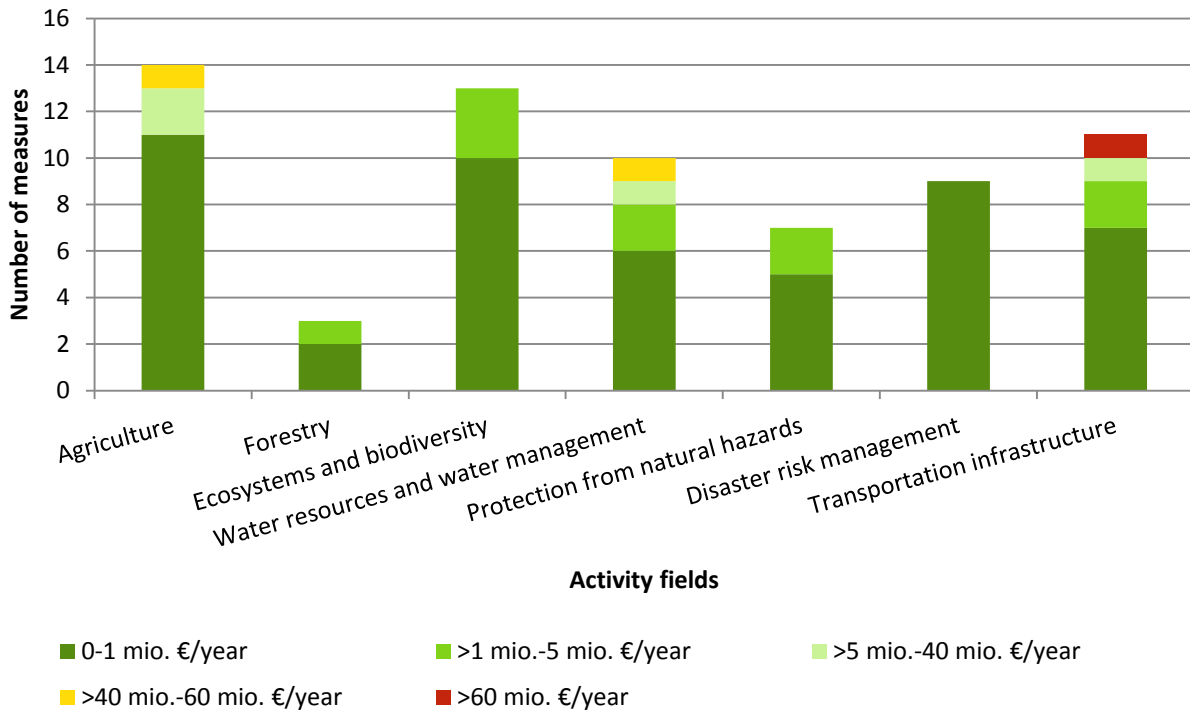


Figure 9: Distribution of cost classes per measure across activity fields

As shown in Figure 10, total average annual adaptation costs amount to € 385 million (with a range of variation from € 286 million to € 485 million). It is important to note that several measures are not yet fully implemented, which means that increasing effort might come along with higher costs.

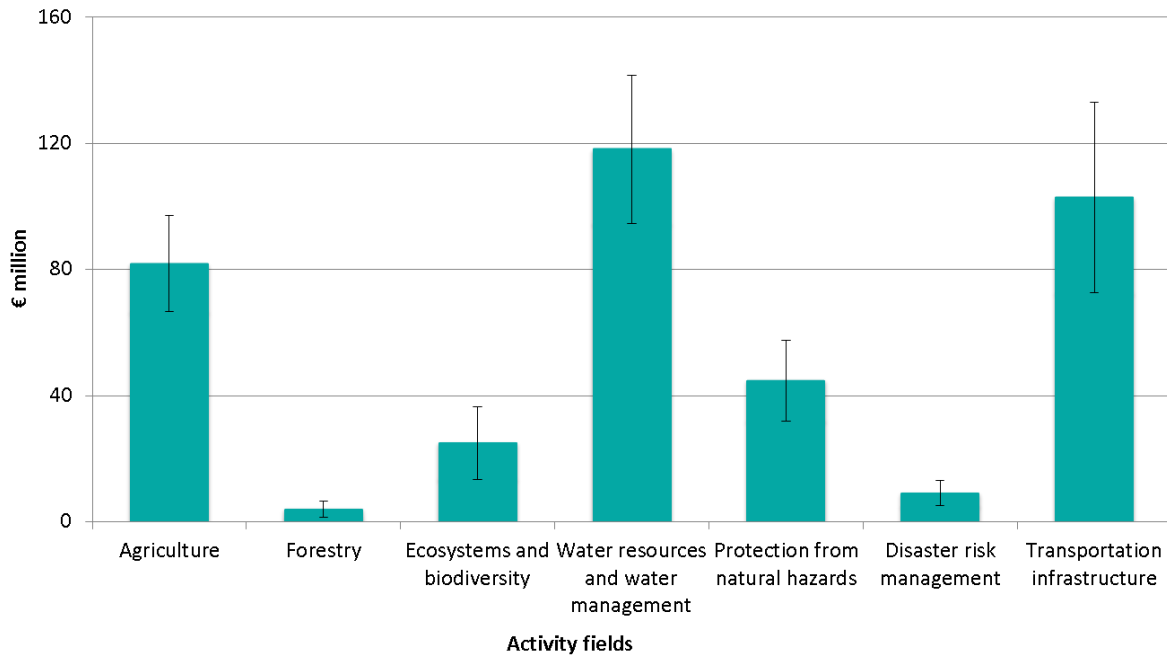


Figure 10: Annual Federal public adaptation costs for activity fields in € million (current), bottom-up approach
Bandwidth shows minimum and maximum values.

The results of this analysis also provide some insights on the average adaptation costs for the different types of adaptation measures. This is shown in Table 3, though it is highlighted that these are Austrian and context specific.

Average costs per measure are lowest for soft measures and highest for mixed measures. Mixed measures cannot be attributed to one specific type because they typically include a broad variety of needed action, which tends to result in higher costs. The costs for grey and green measures are determined by the specific options outlined in the Austrian strategy to adapt to climate change, and this influences the costs. For example, the green measures identified include the purchase of retention areas to ensure protection from natural hazards, which increases costs (but are required as conventional protection measures cannot be extended any more). The grey measures considered do not include conventional protection measures, but are rather small –politically easier to realize– measures, such as information provision, which biases the costs downwards.

Table 3: Adaptation costs per measure across different types of adaptation measures

Annual Federal Public Adaptation costs per measure in € mio. (current)				
		Average	Range	Number of measures funded by the federal budget
Type of adaptation measure	Soft	1.26	0.6-1.92	39
	Grey	7.57	6.14-9.00	7
	Green	11.97	9.22-14.72	9
	Mixed	14.60	11.33-17.88	12

Looking into the different types of measures across activity fields, Figure 11 presents how expenditures from the bottom-up approach are distributed. In agriculture and in ecosystems and biodiversity most of the costs accrue to green measures, while in water resources and water management and transportation infrastructure the costs mainly support mixed and grey measures. Despite the large number of soft measures in the Adaptation Strategy (see Figure 7), costs for soft measures make up only a small share of total costs (Figure 11). This is due to their cost structure as shown in Table 3. As a consequence, also costs in the field disaster risk management are low even though there are nine measures financed or implemented by the federal government.

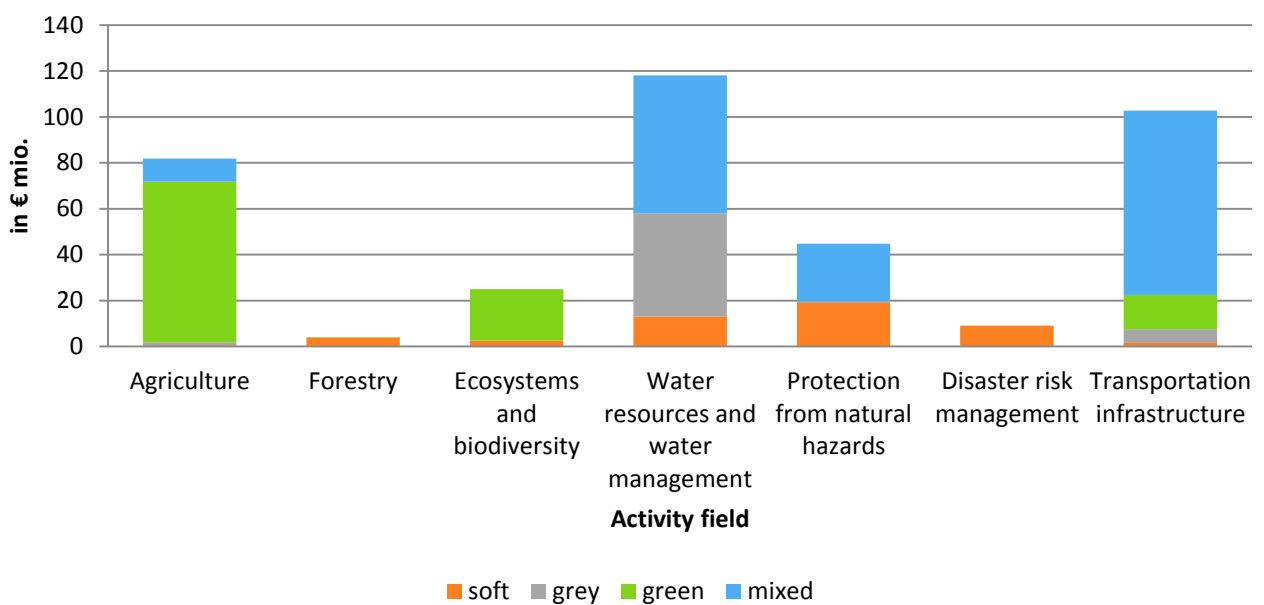


Figure 11: Adaptation costs across different types of measures and activity fields, bottom-up approach

4.3. Comparing the cost estimates

Table 4 summarizes the differences in the coverage of the top-down and bottom-up approaches. It is stressed that these costs only include federal level spending on public adaptation: they do not include expenditures at the state or municipal level, or in the private sector, and thus represent a sub-total of total adaptation costs. The results are presented relative to other government spending in Figure 12, including a comparison with the Austrian disaster fund payments: a national reserve fund, which provides annually investment in disaster risk management as well as payments to compensate for major natural disasters such as floods.

Table 4: Differences between top-down and bottom-up estimates

	Top-down approach	Bottom-up approach
Coverage of adaptation measures in the Austrian strategy for adaptation to climate change	partial*	complete
Further adaptation-relevant spending**	yes	no
Public annual adaptation-relevant expenditures (today)	€ 2.1 billion	-
Public annual adaptation costs (current)	€ 488 million	€ 385 million

* 67 out of 132 adaptation measures in the activity fields agriculture, forestry, water resources and water management, protection from natural hazards, disaster risk management, ecosystems and biodiversity and transportation infrastructure were analysed in detail.

** Current expenditures cover additional measures that foster adaptation, but are not stated in the Austrian strategy for adaptation to climate change, such as flood protection measures.

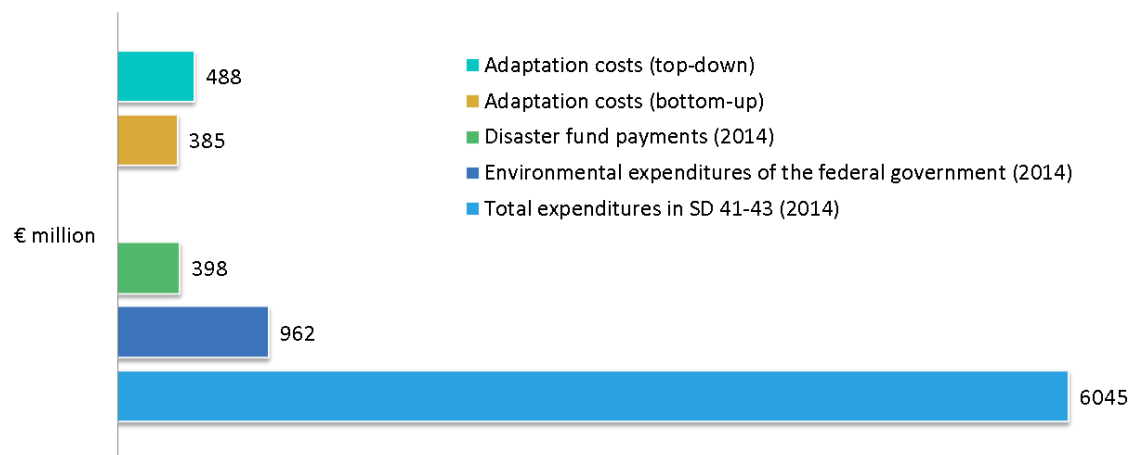


Figure 12: Annual Federal adaptation costs compared to other public expenditures

5. Future development trajectories of federal spending on public adaptation

Initial work in PACINAS has indicated that future adaptation needs are likely to rise rapidly in the next two decades due to climate change, This will have important implications on the Federal budget and the public finances. There is expected to be higher expenditures on reactive adaptation to extreme events (forecasting, early warning and monitoring) and also increasing expenditures to scale-up anticipatory (pro-active) adaptation to address new and future risks. This is likely to increase pressure on the Federal budget. Based on interviews with the relevant Ministries, Figure 13 presents three alternative ways that federal ministries (with increasing adaptation needs) could cope with the additional expenditures: they could shift resources within the department; they could seek additional resources from outside; or they could shift responsibility to other public authorities or private actors.

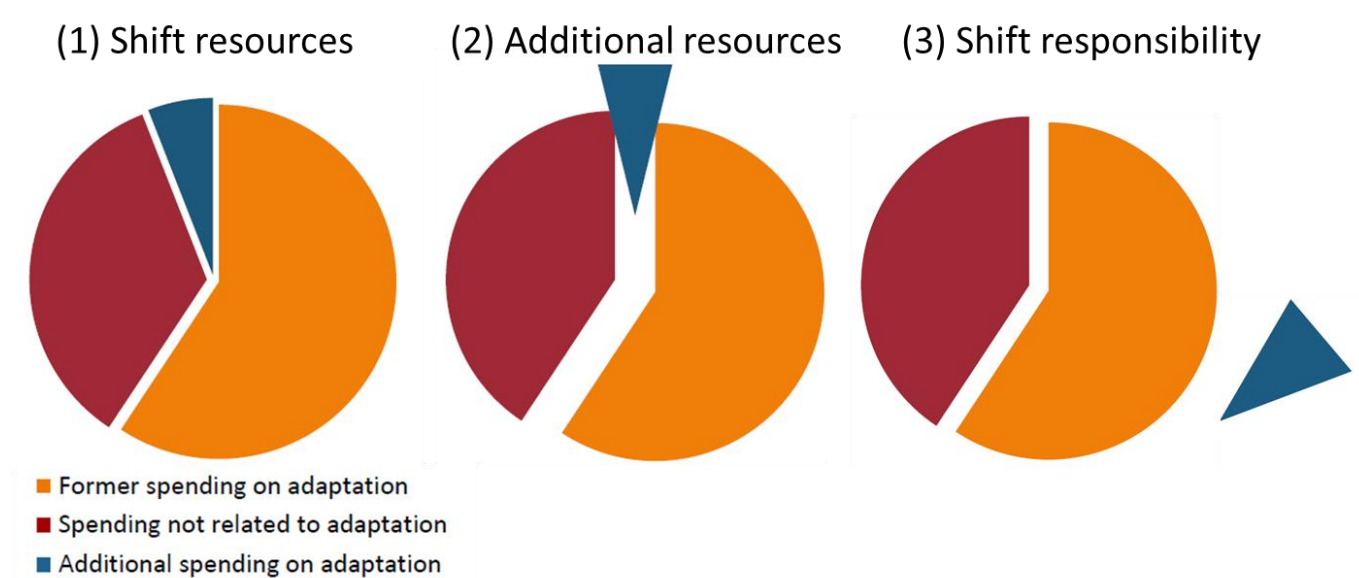


Figure 13: Options for Federal Ministries to meet additional public adaptation expenditures

Based on today's adaptation-relevant expenditures, we developed an indicative scenario for adaptation-relevant expenditures up to 2050 for those impact fields with the highest costs of inaction. These impact fields are Agriculture, Forestry, Water and Catastrophe Management (Bachner et al. 2015). The scenario combines expert judgment on the additional resources needed for single adaptation measures (e.g. on soft measures such as monitoring systems), international recommendations on the useful timing and phasing of grey, green, and soft measures (Watkiss et al. 2014), and the midterm budget forecast for the Federal State (BMF 2015). Figure 14 illustrates this indicative pathway in terms of expenditures, separated by (i) type of measure (grey, green or soft), (ii) impact field in which adaptation is funded and (iii) impact field in which the benefit from adaptation materialized (indicated by the "→" symbol). Note,

that in many cases adaptation also reduces impacts in the impact field Catastrophe Management and not exclusively in the own impact field.

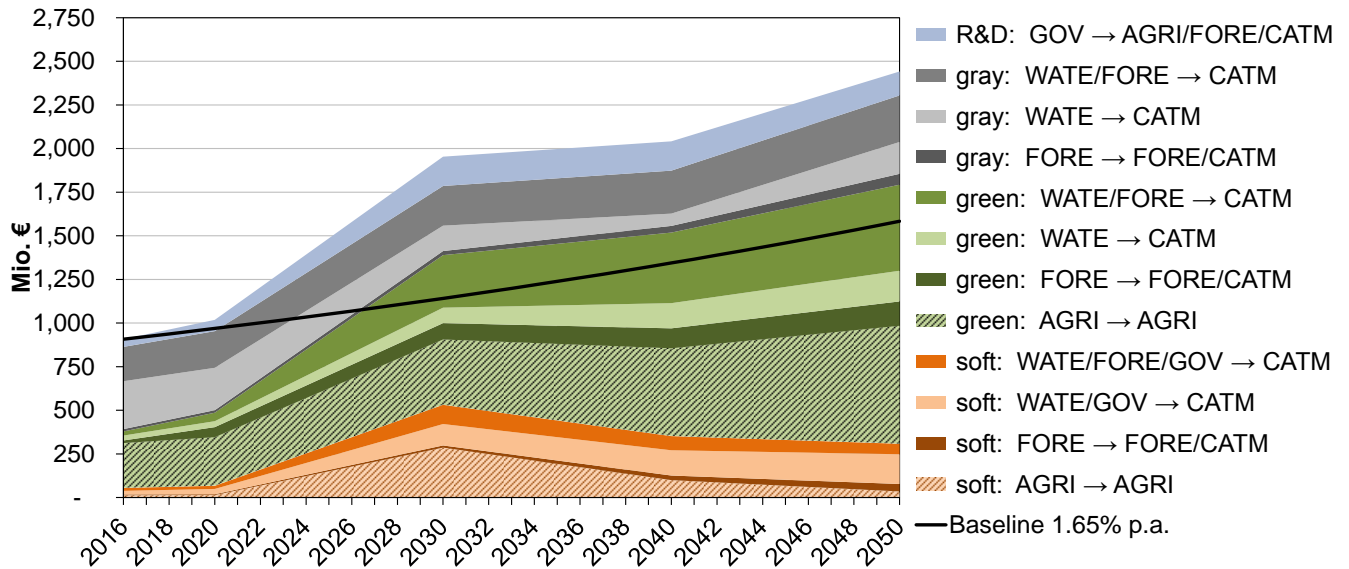


Figure 14: Indicative scenario for adaptation-relevant expenditures in public budgets (sub-classifications UG₄₁₋₄₃) for impact fields Agriculture (AGRI), Forestry (FORE), Water (WATE) and Catastrophe Management (CATM) as well as for Research and Development (R&D) for the period 2016-2050

As can be seen in Figure 14, expenditures on grey measures such as flood protection dominate in the current period up to 2020. However, this is because there is an ongoing investment cycle in the refurbishment of the water and wastewater network: an interesting finding in itself. This is planned to be completed by 2020, thus the scenario foresees a decline in investment in this category in the period 2020 to 2040; with a resurgence of investment from 2040 when the next investment cycle begins. This also highlights that there will be windows of opportunity for adaptation investment, i.e. cycles when it is easier to include adaptation. In the current budget, expenditures on soft measures such as information provision and early warning systems are small compared to other categories, as they do not involve large capital expenditure. Nonetheless, they represent an early priority for investment and we assume a large increase in this category in period 2020 to 2030 to increase adaptive capacity and scale up low-regret adaptation to the increasing climate change signal. The analysis also assumes a transition from grey to green measures after 2030, in line with anticipated increase in the expansion of retention areas, measures for rural development (Austrian Agri-Environmental Programme "ÖPUL") and forest management. Expenditures on Research and Development contribute to all impact fields and are assumed to increase up to 2030, to provide the evidence, learning and early planning for new challenges, and are projected to stay at this level thereafter. In total, expenditures of this indicative

climate and adaptation scenario rise by 3% per year over the period 2016-2050. In comparison, other public expenditures are assumed to grow at the average economic growth rate of 1.65%.

6. Conclusion

The top-down analysis of the federal budget finds that the estimated annual adaptation-relevant expenditures amount to at least € 2.1 billion currently. The share that can be explicitly attributed as adaptation is estimated at € 488 million. It is stressed that this only considers Federal costs and is therefore a sub-total of all relevant expenditures: it excludes state and municipal expenditures and all costs in the private and household sectors. These adaptation costs are 8% of the investigated budget positions (the three SDs) and 0.65% of the total federal expenditures in 2014. When the annual costs of the Austrian disaster fund are added (some expenditures thereof are already covered in the top-down approach), the adaptation and damage costs rise to € 886 million, which is 1.2% of the total federal budget.

The alternative bottom-up approach using expert elicitation has estimated that the current costs of the Austrian strategy for adaptation – for the areas relevant for the Federal government - are € 358 million annually. The difference between the top-down and bottom-up approaches results from the varying coverage: while the top-down approach covers all adaptation activities that are currently implemented by the federal budget, the bottom-up approach only accounts for those activities that are part of the Austrian strategy for adaptation to climate change.

Neither of the two approaches is more correct to measure adaptation expenditures than the other; both cover different, but relevant aspects of adaptation. To some extent the two approaches measure what is done versus what should be done. Thus, the top-down approach is limited to measures that are already implemented but need to be fostered, while the bottom-up approach could also entail new measures that are not yet implemented. However, the interviews revealed that most stakeholders in the development of the national adaptation strategy explicitly or implicitly assumed that no additional budget for adaptation may be generated; this provided an incentive to identify measures which are already implemented.

Furthermore, there is a remarkable difference between the distribution of grey, green and soft measures when comparing the results from the bottom-up and top-down assessment. In the top-down assessment, grey measures play a prominent role because large infrastructure projects are usually associated with large expenditures, hence their implementation constitute a significant share of current

adaptation expenditures. In contrast, these expenditures are not found in the bottom-up assessment which is restricted to the measures of the national adaptation strategy that has a strong focus on soft measures.

In both assessments, there is a bias towards investment costs, costs for subcontracts, and cost of maintenance (when there is a clear relationship between maintenance and investment costs as is for example the case for flood protection measures, water and waste water networks). Costs of labour usually show up on higher levels of aggregation than the departments of the ministries and it is therefore difficult to attribute these costs to specific adaptation actions. The costs of soft measures (providing information, education or early warning systems), which tend to be more labour intensive than hard measures such as technical constructions, are thus likely to be underestimated. One exemption from that rule however are contracting activities to e.g. civil engineering bureaus which are subcontracted to generate flood inundation or other natural hazard maps.

Regarding additional resources, some policy areas are likely to need additional resources (water monitoring systems; torrent control) for instance because the current budget for monitoring systems is too low already. Some other policy areas might accommodate higher expenditures on adaptation by a shift in resource within the resort. Also, there is a risk that too little resources are devoted towards data collection, monitoring, as a prerequisite for informed decisions on public and private adaptation. While specific projects have been initiated, a continuation and expansion is required, particularly for data monitoring.

Another aspect revealed by this study is that due to the mainstreaming of adaptation in many policy areas, it is important to keep in mind that also the cost part which was identified as non-adaptation-relevant has to be financed. Spending just the adaptation-relevant part is likely generating a lower level of adaptation than intended. Further work to develop more sophisticated methods for assessing adaptation expenditures and costs, such as component and outcome based budget analysis would be useful. The separation of damage costs, reactive expenditures and proactive adaptation would also be useful to provide additional information and raise awareness. The analysis has primarily identified reactive adaptation, but importantly some examples of anticipatory adaptation have also been captured.

Finally, initial work in PACINAS has indicated that future adaptation expenditures are likely to rise rapidly in the next two decades due to climate change. This will have important implications on the

Federal budget and public finances. It would be useful to start developing more detailed forward projections on likely adaptation expenditures under climate change and to consider the implications on the Federal budget. It would also be useful to repeat this budget expenditure analysis in a few years time, to investigate ex post how much expenditures have been rising, and to undertake ex ante analysis to look in more detail at the impact on future public budget.

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Appendix

Appendix A: Costs of measure in €/year and implementation status by measure

Agriculture

Nr.	Title	Objective	Costs of measure in €/year
3.1.4.1	Sustainable soil composition and protection of soil fertility, structure, and stability	Protection of natural soil functions; Construction and long-term stabilization of optimal humus content in soils; Conservation of aggregate stability, promotion of soil life, and safeguarding of adequate water intake and water retaining capacity; Prevention of damage (especially soil compaction and erosion) and conservation of soil productivity through sustainable and site-adapted land use and a conservation tillage method.	0-1 mio. €/year
3.1.4.2	Enhanced establishment and promotion of water-saving irrigation systems and improvements in irrigation planning	Efficiency improvements in irrigation and water use through the introduction of modern technological developments permitting the optimization of irrigation in terms of timing and amount of water.	0-1 mio. €/year
3.1.4.3	Breeding and targeted use of water-saving, heat-tolerant plants (species/ varieties) within the meaning of a regionally adapted management	Use of species and new varieties of plants that can tolerate changing climatic conditions. Especially heat-tolerant and water-saving crops and grasses and species with low susceptibility to pests shall be favoured.	0-1 mio. €/year
3.1.4.4	Adjustment of fertilizer management to seasonal weather patterns	Need-based and site-specific plant nutrition as a contribution to plant quality, plant health, and yield security.	0-1 mio. €/year
3.1.4.5	Provision of scientific advice on potential new agricultural diseases and pests	Improvement in the state of knowledge regarding emerging diseases and pests, in order to enable a quick and efficient response in case of need and optimization of plant protection measures.	0-1 mio. €/year
3.1.4.6	Environmentally sound and sustainable use of plant protection products (pesticides)	Optimization of plant protection measures through changes in the timing and method of application and/or spectrum of pesticides and establishment of a systematic monitoring, with the goal of fostering environmentally friendly and sustainable agricultural practices.	>5 mio.-40 mio. €/year
3.1.4.7	Review of site suitability based on changing climatic conditions and development of recommendations for the selection of a site-adapted crop	Selection of suitable crops for the respective site conditions.	0-1 mio. €/year
3.1.4.8	Risk minimization and the development and extension of risk sharing instruments	Reduction of weather-related production risks and the development and extension of additional insurance models.	0-1 mio. €/year
3.1.4.9	Integrated landscaping for soil protection and the improvement of agricultural ecology, including the conservation and management of landscape features	Improvement of the agro-ecological situation and conservation of natural biodiversity by reducing wind-exposed areas/wind speed and soil erosion and improving water retention.	>40 mio.-60 mio. €/year

Nr.	Title	Objective	Costs of measure in €/year
3.1.4.10	Preservation of existing pastures and revitalization of abandoned pastures	Maintenance of the protective and recovery function, of feed production and the targeted revitalization and rehabilitation of abandoned pastures under consideration of nature conservation aspects.	>5 mio.-40 mio. €/year
3.1.4.11	Optimization of greenhouse cultivation in terms of energy, water, and cooling supply strategies	Efficiency improvements in energy and water consumption in greenhouse and plastic-sheet cultivation, in particular with regard to increasing heat stress in summer and potentially more frequent natural disasters.	0-1 mio. €/year
3.1.4.12	Promotion of animal welfare and animal health under changing climatic conditions	Expansion of knowledge and evaluation of the effects of climate change on animal health, and the development of preventative measures and, if need be, necessary veterinary measures as a basis for decision-making of authorities and farmers.	0-1 mio. €/year
3.1.4.13	Consideration of future requirements for the cooling of stables due to increasing thermal stress	Reduction of thermal stress on farm animals, appropriate and stress-free livestock rearing, and reduction of harmful pollutants in stables.	0-1 mio. €/year
3.1.4.14	Optimization of adaptation and combat strategies for new diseases and pests	Further optimization and, if needed, extension of existing warning systems, improvement of information and data transfer (e.g., between meteorological units, science, and farmers), and the nationwide monitoring of potentially harmful organisms; Designation of particularly endangered areas and the development and adjustment of decision-making aids for measures.	0-1 mio. €/year

Forestry

Nr.	Title	Objective	Costs of measure in €/year
3.2.4.1	Modification in the selection of tree species and provenance, including targeted promotion of diversity through appropriate silvicultural management and rejuvenation of over aged stock	Increase of stability and reduction of vulnerability of forest ecosystems to pests and diseases; Increase in diversity at all levels (genetic, species-specific, structural, diversity of habitat, etc.) adapted to the respective site-specific conditions; Increase of stability and reduction of susceptibility to disturbances, e.g., through the timely introduction of rejuvenation measures.	0-1 mio. €/year
3.2.4.6	Establishment of preventative measures with regard to the potential increase in forest fires	Development of preventative measures and systems for forest-fire monitoring and early-warning in order to minimize the risk of forest fires; Elaboration or revision of emergency plans to combat forest fires.	0-1 mio. €/year
3.2.4.7	Forest pollution control - Integrated forest inventory and pollutant monitoring	Nationwide inventory of Austrian forests through improving the forest inventory with remote sensing methods (laser scanning, multi-spectral satellite imagery) for enhanced system knowledge, and the establishment of a pollution monitoring system.	>1 mio.-5 mio. €/year

Water Resources and Water Management

Nr.	Title	Objective	Costs of measure in €/year
3.3.4.1	Analysis of existing data and promotion of further data collection on water resources	Reduction of knowledge deficits regarding the effects of climate change on water resources and their use.	>1 mio.-5 mio. €/year
3.3.4.2	Improving coordination/information concerning water consumption and water demand	Data collection to the greatest possible extent on actual water consumption by various users as a basis for the management of water supply and its safeguarding.	0-1 mio. €/year
3.3.4.3	Securing future water supply	Increasing qualitative and quantitative security of the water supply in areas threatened by water scarcity by means of planning and technological measures.	0-1 mio. €/year
3.3.4.4	Mindful use of water resources	Protection of water resources in areas threatened by water shortages by means of the encouraged use of efficient water-saving technologies and through targeted awareness-raising.	0-1 mio. €/year
3.3.4.5	Promotion of management of water resources when water supplies are low	Ensuring the achievement of water management objectives in periods of low water.	0-1 mio. €/year
3.3.4.6	Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater)	Achieving and ensuring the good ecological and chemical status of water bodies (including groundwater) or the good ecological potential.	>40 mio.-60 mio. €/year
3.3.4.7	Intensification of water management planning for groundwater resources	Reducing the risk of the consequences of climate change affecting groundwater bodies and groundwater-dependent ecosystems, in order to contribute to the preservation of a good quantitative, chemical, and hygienic status of groundwater bodies.	0-1 mio. €/year
3.3.4.8	Adaptive flood management with robust measures	Prevention of an increase in peak runoffs and damages.	>5 mio.-40 mio. €/year
3.3.4.9	Greater emphasis on water temperatures in water management measures	Reduction of the influence of higher water temperatures on the use and protection of water bodies.	0-1 mio. €/year
3.3.4.10	Installation of industrial water management instruments	Ensuring industrial water supply for various areas for action: agriculture (irrigation), energy industry (cooling), irrigation of golf courses and football fields, lumber yard sprinkling, industry and commerce, and in air conditioning and cooling systems.	>1 mio.-5 mio. €/year

Protection from Natural Hazards

Nr.	Title	Objective	Costs of measure in €/year
3.7.3.1	Promotion of hazard and risk awareness, self-sufficiency of the population, and the development of consulting models	Incorporation and strengthening of responsible behaviour in coping with risks from natural hazards, and the development of a “one-stop shop” for public concerns on the subject of climate change adaptation in the area “Protection from Natural Hazards”.	0-1 mio. €/year
3.7.3.2	Promotion of sustainable spatial development strategies, including increased consideration of hazard zone mapping and risk presentation	Keeping areas potentially affected by natural hazards free from uses for residential, commercial, or infrastructure purposes, or targeted control of such use.	0-1 mio. €/year
3.7.3.3	Promotion of water retention in the catchment and the reactivation of natural flood plains, particularly as a contribution to precautionary land use	Reduction of peak flows by ensuring water retention in the catchment.	>1 mio.-5 mio. €/year
3.7.3.4	Promotion of research on the impact of climate change on extreme events and on changes in the natural environment and human use thereof	Provision of decision-making bases using the state of the art in science and technology.	0-1 mio. €/year
3.7.3.5	Promotion of risk management with inclusion of appropriate risk transfer mechanisms (risk partnerships)	Raising awareness of the need for insurance-based personal provision.	0-1 mio. €/year
3.7.3.6	Promotion of technological property protection measures (permanent and temporary) as a contributing factor to self-sufficiency	Prevention of damage to buildings and property related to the effects of natural hazards.	0-1 mio. €/year
3.7.3.7	Promotion of forecasting, (early-) warning, and measuring systems	Expansion of the scope of data and information on hazardous natural processes and the resulting possibility of (early-)warning.	>1 mio.-5 mio. €/year

Disaster Risk Management

Nr.	Title	Objective	Costs of measure in €/year
3.8.3.1	Continuous review, modification, and implementation of the SKKM Strategy 2020 (Strategy for National Crisis and Disaster Protection Management), taking into account the effects of climate change	Timely and forceful implementation of the SKKM Strategy	0-1 mio. €/year
3.8.3.2	Establishment of a national multi-sectoral communications platform for disaster risk reduction	Improvement of knowledge transfer between the actors in disaster risk management and the promotion of a broad-ranging dialogue.	0-1 mio. €/year

Nr.	Title	Objective	Costs of measure in €/year
3.8.3.3	Creation and maintenance of appropriate frame conditions for volunteer engagement in the field of disaster risk management	Creation of appropriate frame conditions for volunteer resources in the field of disaster risk management in order to ensure continued qualified self-sufficiency.	0-1 mio. €/year
3.8.3.4	Increasing the flexibility of financing and funding instruments in the field of disaster risk management	Creation of a financing mechanism for short-, medium-, and long-term activities of an integrated disaster risk management on the basis of defined criteria.	0-1 mio. €/year
3.8.3.5	Improving risk communication in the field of disaster prevention	Exposure to natural disasters is recognised by the general public and adequate precautionary measures are set.	0-1 mio. €/year
3.8.3.6	Increase in training offers in the field of disaster risk management	Improvement in training and increasing competencies of the actors in disaster risk management.	0-1 mio. €/year
3.8.3.7	Uniform methodology for performing risk analysis	Development and implementation of a uniform method for assessing disaster risks as the basis for a coordinated, integrated, risk-based, and cost- and benefit-oriented planning of measures in Austria.	0-1 mio. €/year
3.8.3.8	Development of participatory methods to integrate all actors in the field of disaster risk management	Development and implementation of methods designed to accelerate the involvement of all concerned actors in opinion-forming-, decision-making and implementation processes in terms of an integrated disaster risk management.	0-1 mio. €/year
3.8.3.9	Focus on research activities related to disaster risk management	Research activities and the establishment of complementary research programmes whose contents are derived from the SKKM Strategy 2020 or its implementation.	0-1 mio. €/year

Health

Nr.	Title	Objective	Costs of measure in €/year
3.9.4.1	General public relations and specific work on preparing for extreme events or outbreaks of infectious diseases	Raising awareness and informing the public, and improving the capabilities of coordinated emergency services and the responsible institutions in order to prevent or minimize health risks and lower fatal casualties in cases of extreme events or outbreaks of infectious diseases.	not assessed
3.9.4.2	Dealing with heat and drought	Reducing heat stress and preventing additional climate change-related negative health effects in the population in especially heat-prone areas (e.g., urban areas affected by the heat-island effect).	not assessed
3.9.4.3	Dealing with floods, mudslides, landslides, avalanches, and rockfalls	Maintaining supply functions of central services in cases of disaster and preventing fatal casualties for acute, chronic, physical, and mental health effects.	not assessed

Nr.	Title	Objective	Costs of measure in €/year
3.9.4.4	Advancement of knowledge and preparation for handling pathogens/infectious diseases	Improving the knowledge base on climate change-related alterations in the establishment and spread of pathogens and infectious diseases; Suppression of the establishment and spread of pathogens, infectious diseases, and disease carriers (vectors); Improving the early recognition, diagnosis, and therapies for “new and emerging diseases”.	not assessed
3.9.4.5	Risk management with regard to the spread of allergenic and toxic species	Prevention/reduction of adverse health effects due to allergenic and toxic plants and animals.	not assessed
3.9.4.6	Dealing with pollutants and ultraviolet radiation	Prevention/reduction of adverse health effects due to new exposure to pollutants resulting from extreme events and climate change.	not assessed
3.9.4.7	Establishment of monitoring and early-warning systems	Preparation of the general public, Health Care, and aid organizations for climate change-related effects and emergency situations in order to reduce/prevent health consequences through the development of a common, coherent monitoring structure, in particular by linking existing systems. This structure should be adjustable for the respective risks (e.g., floods, heat, cold, pathogens/infectious diseases).	not assessed
3.9.4.8	Training and further education of doctors and personnel in medical, therapeutic, and diagnostic health professions (MTDG) in consideration of climate-relevant topics	Increasing the competence of doctors and health care personnel in handling climate-relevant health topics.	not assessed

Ecosystems and Biodiversity

Nr.	Title	Objective	Costs of measure in €/year
3.10.4.1	Improving the knowledge base through research on the effects of climate change on ecosystems/biodiversity	Advancement of knowledge on the effects of climate change on ecosystems and biodiversity as a basis and support for the implementation of potential measures.	0-1 mio. €/year
3.10.4.2	Increased consideration of climate change in existing monitoring systems and further establishment of monitoring and early-warning systems	Continuation, adjustment, extension, and consolidation of existing or evolving environmental monitoring networks with the overall aim of identifying the effects of climate change on species, habitats, and ecosystem services and applying this information in early-warning systems.	0-1 mio. €/year
3.10.4.3	Integration of climate change into nature conservation concepts	Consideration of the effects of climate change and representation of potential needs for action in nature conservation concepts.	0-1 mio. €/year
3.10.4.4	Strengthening of knowledge transfer on the importance of biodiversity and ecosystems for climate change adaptation in training and increased public relations efforts	Increased integration of the importance of biodiversity for adaptation to climate change of society in education and accelerated public relations efforts.	0-1 mio. €/year

Nr.	Title	Objective	Costs of measure in €/year
3.10.4.5	Perpetuation of extensive land use in mountainous and Alpine elevations and in selected locations	Protection of the traditional cultural landscape as a sanctuary for respective species.	0-1 mio. €/year
3.10.4.6	Adjustments of offers for leisure and vacation activities	Management and adjustment of leisure activities that threaten biodiversity in favour of sustainable activities.	0-1 mio. €/year
3.10.4.7	Adjustment in the design of public and private open spaces in residential areas to objectives of nature conservation and climate change effects	Creation of areas of retreat for animal and plant species (including rare and threatened species), improvement of the local climate in populated areas, increase in water retention, adjustment of the design of green spaces to climate change (e.g., selection of species and varieties).	0-1 mio. €/year
3.10.4.8	Strengthening of threatened populations and species	Reducing the hazardous situation of species threatened by climate change through restocking or ex-situ conservation (including seed and gene banks).	0-1 mio. €/year
3.10.4.9	Maintenance and facilitating the embedding and connectivity of protected areas and habitats	Facilitating the connectivity of habitats and protected areas through the integration of buffer zones and corridors to increase the probability of survival of populations and species, and conservation of the natural value of protected areas under conditions of climate change.	>1 mio.-5 mio. €/year
3.10.4.10	Protection of wetland habitats by ensuring the quality and quantity of groundwater and by raising the water storage and retention capacity of landscapes	Protection of wetland habitats by ensuring adequate groundwater quality and quantity under conditions of climate change, and increasing the water storage and retention capability through runoff-retarding measures.	>1 mio.-5 mio. €/year
3.10.4.11	Promotion of restoration of waters, reinforcement of an integrated watershed management, and prevention of substantial warming of water bodies	Combined flood and biodiversity protection through restoration and a comprehensive treatment of water bodies, as well as the prevention of substantial warming.	>1 mio.-5 mio. €/year
3.10.4.12	Conservation of ecosystem services in sustainable land use and nature conservation	Awareness-raising regarding ecosystem services in all affected areas under the precondition of sustainable land use and in nature conservation (e.g., contribution to water retention, flood protection, biodiversity, drinking-water formation, CO ₂ binding, etc.) to promote sustainable land use and strengthen nature conservation.	0-1 mio. €/year
3.10.4.13	Consideration of ecosystems/ biodiversity issues in a global context	Reduction of indirect negative effects on biodiversity worldwide.	0-1 mio. €/year

Transportation Infrastructure

Nr.	Title	Objective	Costs of measure in €/year
3.11.4.1	Further expansion of informational and early-warning systems	Implementation of the precautionary principle for transportation infrastructure with regard to extreme weather events.	0-1 mio. €/year
3.11.4.2	Safeguarding a functional transportation system	Adjustment of the transportation infrastructure to safeguard a functional and climate-friendly transportation system and accommodation of public needs.	>60 mio. €/year
3.11.4.3	Safeguarding thermal comfort through the reduction of thermal loads	Reduction of thermal loads in residential areas, in modes of transport, and in industrial buildings.	>1 mio.-5 mio. €/year
3.11.4.4	Reduction of potential heat stress for passengers and personnel in public transportation through appropriate air conditioning	Increase operational safety in terms of heat stress in public transportation (safety of people and equipment).	>1 mio.-5 mio. €/year
3.11.4.5	Review and (if necessary) amendments of legal standards to account for climate change in the construction and operation of transportation infrastructure	Amendments of laws, standards, and guidelines to the effects of climate change.	0-1 mio. €/year
3.11.4.6	Consideration of micro- and mesoclimatic conditions in urban and open space planning	Ensuring thermal comfort through adapted infrastructure planning as part of urban and open space planning.	0-1 mio. €/year
3.11.4.7	Reduction in the increase of permanently sealed surfaces for transportation infrastructure as flood protection	Reduction of excessive sealing areas of transportation infrastructure to reduce/prevent local flooding.	>5 mio.-40 mio. €/year
3.11.4.8	Research on adaptation to the consequences of climate change in the area of transportation infrastructure	Improving the knowledge base with the goal of optimized adaptation to the consequences of climate change.	0-1 mio. €/year
3.11.4.9	Pilot projects on climate-change adapted transportation infrastructure	Demonstration of the feasibility of climate-change adapted transportation infrastructure.	0-1 mio. €/year
3.11.4.10	Improved public relations	Manufacturing acceptance of necessary actions and dissemination of knowledge on the subject of adaptation to climate change in the transport sector.	0-1 mio. €/year
3.11.4.11	Training and further education on adaptation to the consequences of climate change in the area of transportation infrastructure	Advancement of knowledge on adaptation to the effects of climate change through the inclusion of relevant information in training and further education.	0-1 mio. €/year

Appendix B: Questionnaire

Beitrag zur österreichischen Strategie zur Anpassung an den Klimawandel: Abschätzung derzeitiger und zukünftiger Ausgaben der öffentlichen Hand

Fragenblock 1 „Einleitung“:

1. Für welche Detailbudgets sind Sie (mit)verantwortlich? Gibt es hier Zufinanzierungen von anderen Stellen?
2. Konnten Sie in den letzten Jahren eine Veränderung der Relevanz des Klimawandels für die Budgetplanung beobachten oder können Sie erwarten, dass es in Zukunft so sein wird?

Fragenblock 2 „Einschätzung mit Fokus auf heutige Maßnahmen“:

3. Kennen Sie anpassungsrelevante¹ Projekte und Maßnahmen (z.B. Hochwasserschutzbauten, Informationsangebot „Unser Wald im Klimawandel“ oder „Biber Berti“), die in Ihrem Ressort umgesetzt werden (Zeitraum ca. 2013 bis 2016)? Wenn ja, welche sind das, wie hoch sind deren Ausgaben in Summe (grobe Abschätzung) und wie groß ist der anpassungsrelevante Anteil in etwa in Prozent?

Typ *	Projekte / Maßnahmen	Gesamtausgaben (in Mio. Euro)	Anpassungsrelevanter Anteil (in %)
Informative/ weiche Maßnahmen			0% - 20% - 40% - 60% - 80% - 100%
Grüne Maßnahmen			0% - 20% - 40% - 60% - 80% - 100%
Graue Maßnahmen			0% - 20% - 40% - 60% - 80% - 100%

*) Informative bzw. weiche Maßnahmen setzen v.a. auf Bewusstseinsbildung, „grüne“ Maßnahmen sind z.B. die Renaturierung eines Gewässers; „graue“ Maßnahmen sind z.B. technische Hangstabilisierungen oder technischer Hochwasserschutz.

Basierend auf der Beschreibung der 132 Handlungsempfehlungen der österreichischen Strategie zur Anpassung an den Klimawandel, deren weitere Schritte und der Beschreibung der Wirkungsorientierung der Budgets, haben wir 55 Handlungsempfehlungen Ihrem Ressort zugeordnet. Uns würde nun Ihre Einschätzung dazu interessieren.

4. Welchen Handlungsempfehlungen der österreichischen Anpassungsstrategie entsprechen die von Ihnen angeführten Projekten/Maßnahmen? (Siehe Seiten 6-13)
5. Welche der zugeordneten Handlungsempfehlungen fallen in das Budget Ihres Ressorts, werden aber derzeit noch nicht umgesetzt?
6. Welche der zugeordneten Handlungsempfehlungen fallen nicht oder nur teilweise in das Budget Ihres Ressorts?

Fragenblock 3 „Einschätzung mit Fokus auf zukünftige Maßnahmen“ (bis 2030):

7. Für die bereits heute umgesetzten Handlungsempfehlungen, wie werden sich die Kosten in Zukunft entwickeln? (Abnahme, Zunahme, gleichbleibend) Wird sich der anpassungsrelevante Anteil verändern? (Abnahme, Zunahme, gleichbleibend)
8. Welche Mehrkosten würden Sie für die Finanzierung von Handlungsempfehlungen der Anpassungsstrategie, die heute noch nicht umgesetzt werden, erwarten? (in % des momentanen bzw. fortgeschriebenen Detailbudgets)

Vielen herzlichen Dank für Ihre Mithilfe und wir freuen uns auf ein persönliches Gespräch!

¹ Jegliche Aktivität, die darauf abzielt potentielle Folgen und Auswirkungen der aktuellen Klimavariabilität sowie des zukünftigen Klimawandels zu reduzieren bzw. zu vermeiden, oder etwaige sich ergebende Möglichkeiten und Vorteile zu nutzen, ist „**anpassungsrelevant**“ und die damit verbundenen finanziellen Aufwendungen sind „**anpassungsrelevante Kosten**“.