

THE ROLE OF PUBLIC AUTHORITIES IN AUSTRIA'S NATIONAL ADAPTATION STRATEGY

Nina Knittel¹ & Birgit Bednar-Friedl^{1,2}

¹ *University of Graz, Wegener Center for Climate and Global Change, Graz, Austria*

² *University of Graz, Department of Economics, Graz, Austria*

February 2016

Abstract

In this paper, we investigate the role of public authorities in providing adaptation measures by developing a categorization method to distinguish between public and private measures. In particular, we distinguish four steps representing the sequence cascade of adaptation decision-making and implementation, and differentiate them with respect to governance levels and private actors. We find that, in contrast to the common understanding that a lot of adaptation is private, adaptation measures in Austria strongly rely on public action. Considering initiation, public actors are required to start the sequence cascade for 95% of all measures. In financing, public authorities are required to provide financial means for 96% of measures (42% of measures are financed by public and private actors jointly). Similarly, public actors are involved in the implementation step of almost all measures (95%), in 46% as single implementer. The beneficiaries are predominantly public, which means that most of the measures create public goods. We further conclude that the weight of public actors decreases with advancing the sequence cascade. While initiation is primarily a task for public authorities, financing and even more implementation also require private actors to contribute. It follows that good collaboration between public and private actors will be needed especially in the implementation step.

1. Introduction

The purpose of this paper is to investigate the Austrian National Adaptation Strategy (NAS) and to present it from various perspectives in order to have an idea to what extent the public sector will be affected by and involved in its implementation. The analyses aim at clarifying (1) which public-private collaboration, coordination or even cooperation is needed for a successful implementation of the NAS, (2) how this setup differs across fields of activity, and (3) where there is scope for improvement. Section 1 provides an introduction to adaptation strategies in the European Union. In section 2, we present an overview of the Austrian NAS, explaining its structure and providing a detailed list of measures. Section 3 describes the methods that have been applied to obtain the results, which are presented and discussed in section 4. Section 5 concludes.

Up to now, there is no EU level adaptation strategy, but with the start of the second phase of the European Climate Change Programme (ECCP) in October 2005, a discussion on a policy framework has started (CIRCLE, 2008). However, according to the European Environment Agency (EEA) (2014) European countries are well aware of the need for adaptation to climate change and started to form adaptation strategies on a national level. Capriolo et al. (2014, p.1) state that member states of the EU have widely agreed on National adaptation strategies providing suitable tools to “assess climate change vulnerabilities, mainstream climate risks, and address the issue of climate adaptation”. In 21 countries a NAS has been adopted and 12 countries have developed a national adaptation plan (NAP), which are more specific for vulnerable sectors or regions, such as flood risk or heat wave plans. The EEA report 04/14 further mentions that more than half of European countries have advanced in identifying and assessing adaptation options, and 13 countries state that they are already implementing or even monitoring adaptation options (EEA, 2014).

The literature provides several reasons for individual countries to initiate the adaptation planning process (Biesbroek et al., 2010; Swart et al., 2009). Fig. 1 shows the preliminary conditions that must be satisfied for a NAS to emerge. Biesbroek et al. (2010) therefore distinguish between key drivers that are motivators and key factors that are required to facilitate the development processes of a NAS. The motivating factors include ongoing international climate negotiations, EU policies, such as the EU Green and White papers on adaptation, experience of extreme weather events, examples of adaptation actions in other countries, economic costs of inaction or, in some cases, recognition of the opportunities presented by climate change (Tompkins and Amundsen, 2008). Facilitating factors consist of the will of political decision-makers, or other active people with expertise taking the lead in advancing the forming process, the sufficient availability of human and other resources, such as knowledge, and a good cooperation between the ministries (Biesbroek et al., 2010).

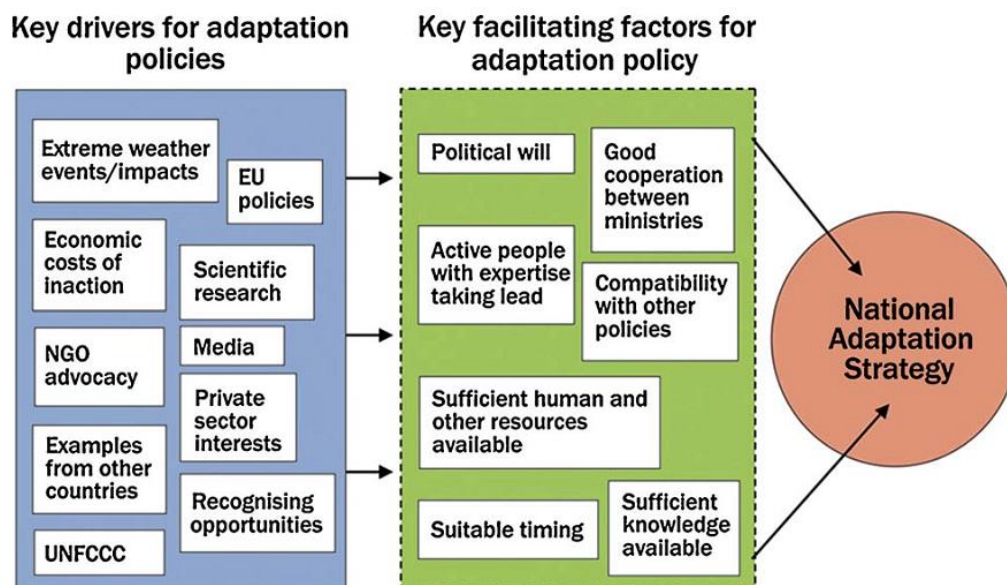


Figure 1: Key drivers and facilitating factors for the development of a NAS

Source: Biesbroek et al. (2010), p.442

Biesbroek et al. (2010) further stress that the above described motivating and facilitating factors affect the timing of the planning process and if a strategy is adopted. Other determinants, however, are responsible for the design of the strategies that can differ across countries in prioritization, implementation and adaptation measures.

This paper addresses the **Austrian** Adaptation Strategy (BMLFUW, 2012a) that has been set up by national and international experts from various sectors. In 14 different activity fields it contains 132 measures to adapt to climate change. The development process of the Austrian Adaptation Strategy was initiated by the Austrian Ministry of Agriculture, Forestry, Environment, and Water Management (BMLFUW¹) 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 (BMLFUW, 2012b). Starting in September 2007 and collecting recommendations for adaptation in 14 different fields in the period from June 2008 to November 2011, the process ran through multiple stages. Stakeholder workshops for example enabled the specification of adaptation measures, and suggestions by experts concerning the implementation of measures were included. The first draft of the strategy was published in July 2009 as a political position paper followed by a second draft in October 2010 (BMLFUW, 2010) (BMLFUW, 2012b). The participatory process helped revising, expanding and developing the policy paper towards the Austrian National Adaptation Strategy that was finally released in 2012 (BMLFUW, 2012a). The main objective of the National Strategy consists, on the one hand, in preparing the population and the economy for future changes and, on the other hand, in providing possibilities for protection against negative consequences (BMLFUW, 2012b). The BMLFUW (2012b) states that adaptation activities

¹ Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft

within the context of the NAS seek to reduce vulnerability to climate change. Moreover they seek to increase resilience and to take advantage of potential opportunities presented by changing climatic conditions (BMLFUW, 2012b).

According to the classification made by the EEA (2014) for country surveys, the forming process of an adaptation strategy after being initiated runs through the following stages:

- “agenda-setting (i.e. adaptation is politically recognized as important),
- formulation (i.e. responsible actors respond by formulating adaptation policies),
- decision (i.e. policymakers have adopted an adaptation policy),
- implementation (i.e. measures foreseen in the policy are being implemented),
- monitoring and evaluation (i.e. review and updates of policy/actions).” (EEA, 2010, p.10)

The Austrian NAS is somewhere between the decision and implementation stage, which means that the strategy has passed the parliament, but that adaptation measures either have been put into practice only partly or not at all (BMLFUW, 2012a).

2. Overview

The general form of the Strategy 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 the Austrian NAS these fields are called activity fields and consist of the following (numbers in brackets denote the number of adaptation measures within the specific field of activity) (BMLFUW, 2012a):

1. Agriculture (14)
2. Forestry (8)
3. Water Resources and Water Management (10)
4. Tourism (3)
5. Energy – Focus on the Electrical Industry (8)
6. Construction and Housing (11)
7. Protection from Natural Hazards (7)
8. Disaster Risk Management (9)
9. Health (8)
10. Ecosystems and Biodiversity (13)
11. Transportation Infrastructure (11)
12. Spatial Planning (13)
13. Business/Industry (9)
14. Cities – Urban Green and Open Spaces (8).

For each of the fourteen activity fields the adaptation strategy offers a general description of the field followed by an assessment of its vulnerability, since again according to the BMLFUW (2012b) adaptation activities within the NAS context seek to reduce vulnerability and to increase resilience, as well as to take advantage of potential opportunities (BMLFUW, 2012b). Being aware of potential climate impacts for each specific field, the Adaptation Strategy then elaborates measures to counteract these effects. The measures are presented and described according to the following structure (Goal and Actors are included in Tab. 1 to 14; the other criteria can be found in the original document (BMLFUW, 2012a)):

- *Goal*
- Significance
- References to other activity fields
- References to existing instruments
- State of implementation
- Recommended further steps
- Possible need of resources
- Conflict potential
- *Actors*
- Time horizon

In case of the first activity field agriculture for example, changes in the international agricultural market through scarcity of water, strongly fluctuating crops, increasing transport costs, increasing costs of production factors such as energy, water etc., longer dry and precipitation periods, hail and heavy rainfall events, as well as changing distribution of precipitation and changed temperature conditions are identified as the specific risks that must be reacted to (BMLFUW, 2012a).

We now provide the full list of adaptation measures (132) presented by the Austrian Ministry of Agriculture, Forestry, Environment, and Water Management in "Part1- Context" of the NAS (BMLFUW, 2012b). In the later description of the methodology as well as when presenting the results of the analyses, we refer to single measures of the NAS to render explanations traceable.

Table 1: Description of measures in the activity field Agriculture

Nr.	Title	Objective	Key Actors
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.	Federal and state governments, interest groups (advice, information), academic and non-academic research institutions, farmers, Bio-Austria, b4 Corporate Soil Competence (AGES, BFW, Environment Agency Austria, BAW), agricultural schools, rural training institutes, apprenticeship and specialized training units
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.	Federal and state governments, municipalities, interest groups, academic and non-academic research institutions, farmers, industry
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.	Federal government (research funding), building and use of national and European networks, plant breeders, academic and non-academic research institutions, AGES, LFZ Raumberg-Gumpenstein, federal state experimental institutes, agricultural training institutes, farmers (implementation – changes in varieties)
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.	Federal government, academic and non-academic research institutions, interest groups, AGES, LFZ Raumberg-Gumpenstein, Committee for Soil Fertility and Soil Conservation, farmers
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.	Federal and state governments, interest groups, AGES, academic and non-academic research institutions, farmers, industry (producers)
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.	Federal and state governments, interest groups, AGES, academic and non-academic research institutions, Committee for Soil Fertility and Soil Conservation, agricultural trade, farmers, industry
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.	Federal and state governments, water management authorities, AGES, LFZ Raumberg-Gumpenstein, interest groups, natural hazard insurance companies, academic and non-academic research institutions

Nr.	Title	Objective	Key Actors
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.	Federal and state governments, water management authorities, AGES, LFZ Raumberg-Gumpenstein, interest groups, natural hazard insurance companies, academic and non-academic research institutions
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.	Federal and state governments, interest groups (advice, information), farmers, nature conservation associations, tourism associations
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.	Federal and state governments (funding of pasture management), interest groups, Almwirtschaft Österreich (Austrian Pasture Management), potentially tourism associations, farmers
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.	Federal and state governments, academic and non-academic research institutions, interest groups, Bundesgemüsebauverband Österreichs (Austrian Vegetable Growers Association), municipalities, producer associations, industry, farm managers
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.	Federal and state governments, research, veterinary authorities, AGES, interest groups, LFZ Raumberg-Gumpenstein, farmers, Austrian Animal Health Service (TGD) and animal health services of the federal states
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.	Federal and state governments, interest groups, (funding for stable adjustments), farmers, academic and non-academic research institutions (in particular, LFZ Raumberg-Gumpenstein, BOKU, VMU), municipalities
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.	Federal and state governments, academic and non-academic research institutions, interest groups, AGES, LFZ Raumberg-Gumpenstein, insurance companies, farmers

Table 2: Description of measures in the activity field Forestry

Nr.	Title	Objective	Key Actors
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.	Forest owners, interest groups, academic and non-academic research institutions, federal and state governments, EU (responsibility lies with all listed)
3.2.4.2	Soil-protective cultivation	Preservation of the physical functions of the soil, in particular in terms of water retention and nutrient supply.	Forest owners, felling companies, authorities, interest groups, research institutions, federal and state governments, EU, water management, foresters, municipalities, forest leaseholders
3.2.4.3	Reduction of damage caused by game animals	Reduced damages caused by game animals for safeguarding rejuvenation and stock stability.	Hunters, forest owners, state governments (hunting legislation), federal government, interest groups
3.2.4.4	Development of an advisory concept for foresters with regard to adaptation of forests to climate change	Improvements in consulting, training, and further education of forest owners taking into account latest research results.	Federal government, forest authorities, Chamber of Agriculture and other advisory institutions, academic and non-academic research institutions
3.2.4.5	Adjustment and improvement of crisis and calamity management	Mitigation of damage from harmful events such as windfalls or bark beetle calamities.	Federal and state governments, forest authorities, further authorities (e.g., water authorities), interest groups, forest owners, forestry unions (forest management collaborations (WWGs), forest associations), transport industry, wood and paper industries, EU
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.	Federal and state governments, municipalities, interest groups, forest owners, forest management collaborations (WWGs), forest associations, academic and non-academic research institutions, EU
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.	EU, federal and state governments, Federal Research and Training Centre for Forests, Natural Hazards, and Landscape (BFW), Environment Agency Austria
3.2.4.8	Development of modified and innovative techniques for wood processing taking into account potential changes in wood quality and tree species	Development of efficient, innovative techniques for wood processing in order to increase the value added in the wood use chain.	Researchers, wood-working and -processing industry, interest groups, Cooperation Platform Forestry-Wood-Paper (FHP), federal government, EU (Forest Technology Platform)

Table 3: Description of measures in the activity field Water Resources and Water Management

Nr.	Title	Objective	Key Actors
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.	Federal and state governments, districts, municipalities, academic and non-academic research institutions, water suppliers (water consumption/use and demand)
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.	Federal and state governments, interest groups, regions, municipalities
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.	EU, state governments, municipalities, water utility companies
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.	State governments, municipalities, water utility companies, water users, academic and non-academic research institutions
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.	Federal and state governments, municipalities, academic and non-academic research institutions
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.	Federal and state governments, municipalities, EU, and other actors such as power suppliers, water suppliers, industry, flood associations, AGES, etc.
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.	Federal and state governments, municipalities, EU, nature conservation organizations
3.3.4.8	Adaptive flood management with robust measures	Prevention of an increase in peak runoffs and damages.	EU, federal and state governments, municipalities, academic and non-academic research institutions
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.	Municipalities, federal and state governments, EU, and other actors such as energy suppliers, water companies, fisheries, industry
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.	EU, federal and state governments, factory operators

Table 4: Description of measures in the activity field Tourism

Nr.	Title	Objective	Key Actors
3.4.4.1	Consideration of climate change in tourism strategies	Intensification of strategic considerations on issues of climate change and tourism as frame conditions for the implementation of adaptation measures.	State governments, federal government, actors such as mobility providers, international actors, etc. Furthermore, extensive networking between the various administrative levels (vertical) and between the areas for action (horizontal) is desirable.
3.4.4.2	Development of climate-friendly adaptation measures based on tourism strategies	Increased consideration of adaptation measures that best contribute to the reduction of greenhouse gas emissions and provide added value for businesses.	Federal and state governments, regions, municipalities, local tourism organizations, Association of Towns and Municipalities, interest groups, individual entrepreneurs, advisory institutions and services, incoming & outgoing trade, networks (e.g., RegioNext (Styria) and Planungsverband (planning association, Tirol))
3.4.4.3	Development, provision, and improvement of regional data as the basis for decision-making for adaptation measures	Minimization of existing uncertainties and the elaboration of a robust decision-making basis by using regional data bases, particularly through the integration of regional climate scenarios.	Alpine clubs, destinations With regard to the creation of new data bases (e.g., regional climate scenarios, information on new offers) the input of both the federal government and the states is required.

BMLFUW (2012b, p.109)

Table 5: Description of measures in the activity field Energy – Focus on the Electrical Industry

Nr.	Title	Objective	Key Actors
3-5.4.1	Optimization of network infrastructure	Avoidance of foreseeable energy shortages and overcapacity.	Federal and state governments, electricity industry, e-control, network operators, EU, academic and non-academic research institutions ,
3-5.4.2	Promotion of decentralized energy generation and grid feed-in	Use of regional renewable resources to increase the security of supply (even in a crisis situation) and public awareness-raising with regard to energy issues.	Federal government (BMWfJ, BMLFUW, BMVIT, BMF), state governments, electricity industry, e-control, network operators, EU
3-5.4.3	Increased research on potential methods of energy storage	Relief of the balancing function of the networks for differences between generation and consumption.	Academic and non-academic research institutions (research funds, universities, research institutions such as Industries of Technologies ATI), energy industry
3-5.4.4	Stabilization of the transport and distribution network through appropriate climate-adapted system planning	Reduction of the susceptibility of transportation networks to interference and the prevention of overload or supply shortages arising from the expected climatic changes.	Federal and state governments, energy industry, local residents
3-5.4.5	Optimization of the interaction between generation (from various sources) and consumption in the power supply system under varying supply and demand	Avoiding critical peak loads in the case of shortages; relieving the transport network during peak loads; optimization of the decentralized network feed-in.	Network operators, EU, federal and state governments, municipalities, energy industry, e-control, industry (producers/generators of devices), customers
3-5.4.6	Consideration of the effects of climate change in energy sector decision-making and research activities, e.g., in view of a further diversification of the energy supply	Increasing security of supply through more diversified energy sources structures and far-reaching avoidance of negative consequences for other areas and their adaptive capacity.	Energy suppliers, federal government (BMWfJ, BMVIT, BMLFUW, BMF), state governments, municipalities, energy service providers, interest groups, NGOs (e.g., Biomasseverband, Photovoltaik)
3-5.4.7	Reduction of demand by means of increasing end energy efficiency and reducing internal loads	Reduction of energy consumption through increases in efficiency and the improvement of thermal comfort by reducing internal loads.	Federal and state governments, EU, building occupants, real estate developers, building services planners, IT planners, device developers, academic and non-academic research institutions
3-5.4.8	Development of an energy supply strategy on the basis of a comprehensive forecast of power and heating demand that takes "adaptation scenarios" into account	Creation of a long-term strategy 2030–2050 as a planning instrument, taking into account potential future developments, and the elaboration of appropriate adaptation-relevant measures.	Federal and state governments, energy suppliers, network operators

Table 6: Description of measures in the activity field Construction and Housing

Nr.	Title	Objective	Key Actors
3.6.4.1	Implementation of structural measures (in new buildings and in renovations) to ensure thermal comfort	Ensuring thermal comfort indoors through structural measures, especially with regard to the increased incidence of hot days.	Federal and state governments, architects, planners, building owners, real estate developers, academic and non-academic research institutions
3.6.4.2	Encouraged use of passive and active cooling with alternative, energy-efficient, and resource-saving technologies	Ensuring thermal comfort inside new buildings, in renovations, and in existing buildings by means of passive and alternative ("active") cooling strategies.	Federal and state governments, (energy consultancy), environmental consultancy, architects, planners, building owners, real estate developers, research, technology providers
3.6.4.3	Climatological improvement of urban spaces, with particular emphasis on micro- and mesoclimatic conditions in urban and open space planning	Optimization of living conditions, conditions of human and wind comfort, as well as reduction in the heat-island effect through urban and open space planning.	State governments, municipalities, real estate developers, planners, microclimate experts, academic and non-academic research institutions, builders
3.6.4.4	Implementation of structural measures in buildings as protection from extreme weather events	Structural adaptation of buildings (new and existing buildings) for protection from extreme weather events.	Federal and state governments, architects, planners, building owners, real estate developers, technology providers, research institutions, microclimate experts
3.6.4.5	Increase of water retention	Prevention of local flooding through structural measures around buildings.	Federal and state governments, municipalities, planners
3.6.4.6	Revision of building standards and norms considering climate change	Consideration and integration of adaptation requirements in construction standards and norms.	Federal and state governments, Austrian Institute of Construction Engineering (OIB), Standards Institute
3.6.4.7	Evaluation and further development of funding instruments for the consideration of climate change aspects in new constructions and renovations	Increased emphasis on adaptation needs in the funding of new construction and the renovation of residential and non-residential buildings.	Federal and state governments, in part interest groups, municipalities, public-private partnerships, BMJ, BMWFJ
3.6.4.8	Research on adaptation to the consequences of climate change in the area of construction and housing	Improvement of the knowledge base with the goal of optimized adaptation to the effects of climate change and improvement of data bases.	EU, federal government, research funding bodies (Climate and Energy Fund, FWF, FFG), academic and non-academic research institutions
3.6.4.9	Pilot projects on "climate change-adapted architecture"	Demonstration of the feasibility and advantages of "climate change-adapted architecture".	EU, federal and state governments, research funding bodies (Climate and Energy Fund, FWF, FFG), academic and non-academic research institutions, innovative real estate developers/building developers, municipalities, microclimate experts, medical doctors, sociologists, psychologists, logisticians
3.6.4.10	Publicity and awareness raising on the subject of adaptation to the consequences of climate change in the area of construction and housing	Awareness raising and dissemination of knowledge on the subject of adaptation to the effects of climate change and the necessary adaptation measures.	Federal and state governments, municipalities, NGOs, interest groups
3.6.4.11	Training and further education on issues of adaptation to the consequences of climate change in the area of construction and housing	Creation of a sound knowledge base for the implementation of measures for adaptation to the consequences of climate change.	Federal government, training and education institutions, interest groups (chambers), academic and non-academic research institutions

Table 7: Description of measures in the activity field Protection from Natural Hazards

Nr.	Title	Objective	Key Actors
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".	Federal government (departments), state governments (departments), municipalities, tourism organizations, individuals, National Crisis and Disaster Protection Management (SKKM), ZAMG, Geological Survey of Austria, ÖROK, state school authorities
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.	Federal government (hazard zone maps, GZP), state governments, municipalities
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.	Federal and state governments, municipalities, infrastructure managers, land owners, water boards, ÖROK
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.	EU, federal and state governments, research institutions (public/private), cooperation among universities, national research programmes
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.	Public sector (federal and state governments, municipalities), insurance sector, individuals
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.	Federal and state governments, municipalities, association of insurers, science, developers, individuals, OIB (Austrian Institute of Construction Engineering), certification body
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.	Federal government (e.g., BMVIT), Torrent and Avalanche Control, state governments, municipalities, interest groups, scientific institutions, infrastructure managers, ZAMG, Geological Survey of Austria, emergency response organizations

Table 8: Description of measures in the activity field Disaster Risk Management

Nr.	Title	Objective	Key Actors
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	Federal and state governments, municipalities, science, industry, emergency response organizations
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.	Authorities at the federal level (BMI, BMLVS, BMVIT, BMLFUW, BMG) and at the state and local levels, emergency response organizations (fire service, Red Cross, etc.), industry (e.g., insurance, operators of critical infrastructure), science, general public
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.	EU, federal and state governments, municipalities, emergency response organizations, humanitarian organizations, volunteers, industry, trade unions
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.	Federal and state governments, emergency response organizations, (insurance) industry, science
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.	Federal and state governments, municipalities, emergency response organizations, (communications) industry, the media, research, (communications) science
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.	Actors in disaster risk management, educational institutions of disaster risk management, tertiary educational institutions
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.	Federal and state governments, municipalities, infrastructure managers, research institutions, insurance industry
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.	EU, federal and state governments, municipalities, industry, science, citizens
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.	SKKM working groups, federal and state governments, municipalities, industry (particularly operators of critical infrastructure), academic and non-academic research institutions, emergency response organizations

Table 9: Description of measures in the activity field Health

Nr.	Title	Objective	Key Actors
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.	BMG, BMASK, state governments (technical authorities), ÖÄK (Austrian Medical Chamber), Gesundheit Österreich GmbH, ÖGD, ÖGB, Chamber of Labour, the media, AGES, universities, schools, Adult Education Centres, national and EU-wide networking, BMLFUW, BMUKK, tourism organizations
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).	BMG, BMASK, ÖGD, BMWA, BMUKK, state governments, Gesundheit Österreich GmbH, ÖGB, cities, municipalities, aid organizations, trade unions, Chamber of Labour, Chamber of Commerce, Association of Towns and Municipalities, urban planners, ÖÄK, the media, NGOs, academic and non-academic research institutions
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.	Cooperation between federal and state governments, municipalities, aid organizations, Health Care, Disaster Protection Management, hospital operators, BMI, mental health services, emergency services, the army, ÖÄK, psychotherapy associations, hospitals, insurance companies, water utilities, BMG, ÖGD, BMLFUW, state governments, Gesundheit Österreich GmbH, AGES, ÖWAV, ÖVGW, NGOs, universities
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".	BMG, BMWF, BMLVS, BMFLUW, BMASK, state governments, academic and non-academic research institutions, AGES, Gesundheit Österreich GmbH, ÖÄK, EU (ECDC)
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.	BMG, AGES, BMLFUW, state governments, Chamber of Agriculture, Gesundheit Österreich GmbH, academic and non-academic research institutions, municipalities, gardeners, ÖÄK, the media
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.	BMLFUW, BMG, BMASK, state governments, Chamber of Agriculture, Gesundheit Österreich GmbH, ÖÄK, AGES, ÖGB, Chamber of Labour, municipalities, the media
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).	BMG, BMLVS, BMASK, state governments, universities, Gesundheit Österreich GmbH, ÖÄK (Austrian Medical Chamber), insurance companies, Statistics Austria, ZAMG, cities/municipalities, care services, retirement homes, nursing homes, hospitals, mental health services, Chamber of Labour, Disaster Protection Management, emergency services, civil defence associations, the media

Nr.	Title	Objective	Key Actors
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.	BMG, state governments, ÖÄK (Austrian Medical Chamber), training academies, hospital operators, academic and non-academic research institutions, Gesundheit Österreich GmbH, public health services, mental health services, the media

BMLFUW (2012b, p.114-115)

Table 10: Description of measures in the activity field Ecosystems and Biodiversity

Nr.	Title	Objective	Key Actors
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.	Federal government (BMWF, BMLFUW), state governments, academic and non-academic research institutions, ZAMG, Austrian Academy of Sciences, FWF, Climate and Energy Fund (ACRP, Austrian Climate Research Programme)
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.	BMWF, BMFLUW, state governments, NGOs, BFW, ÖAW, FWF, universities, Environment Agency Austria, Austrian Climate Research Programme (ACRP), Long Term Ecological Network (LTER), museums (e.g., Zobodat)
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.	State governments, BMLFUW
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.	State governments (nature conservation departments), land users, biodiversity research institutes, NGOs, Ministry of Science, universities, training facilities for the relevant interest groups (e.g., agricultural and forestry training institutions), nature park academies, associations
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.	EU, BMLFUW, state governments (nature conservation departments), land users, land owners, NGOs, interest groups, agricultural authorities, municipalities, LFZ Raumberg-Gumpenstein, tourism associations
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.	Associations, businesses, and professionals in the tourist industry, cable-car industry, land owners, protected area administrations, educational institutions, NGOs, interest groups, general public

Nr.	Title	Objective	Key Actors
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).	Building owners, municipalities, architects, garden owners, real estate developers, parks departments, educational institutions, Eco Counselling, "Aktion Natur im Garten", BMG, BMLFUW
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).	Land users, associations, conservation departments, protected area administrations, universities, botanical gardens, Environment Agency Austria
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.	BMLFUW, BMWF, state governments (nature conservation departments), protected area administrations, land owners, NGOs, interest groups, district agricultural authorities, ÖAW, academic and non-academic research institutions, Environment Agency Austria, NGOs, spatial planning authorities
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.	BMLFUW, state governments, land owners, energy producers, water suppliers, interest groups, agricultural authorities, spatial planning, NGOs, ÖBf, universities
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 their substantial warming.	BMLFUW, state governments (nature conservation departments), land owners, energy producers, water management associations, industry, interest groups (e.g., fisheries), NGOs, BOKU, Environment Agency Austria, state hydraulic engineering departments, Via Donau
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.	Federal and state governments (nature conservation departments), interest groups/associations, land users, NGOs, agricultural and forestry authorities
3.10.4.13	Consideration of ecosystems/ biodiversity issues in a global context	Reduction of indirect negative effects on biodiversity worldwide.	Federal and state governments, ADA, municipalities, industry, Global Responsibility – Platform for Development and Humanitarian Aid, ANRICA (Austrian Natural Resources Management and International Cooperation Agency)

Table 11: Description of measures in the activity field Transportation Infrastructure

Nr.	Title	Objective	Key Actors
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.	Federal and state governments, municipalities, operators of transportation infrastructure, universities, FH, meteorological institutions and companies (e.g., ZAMG, AustroControl)
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.	Federal and state governments, Federal Transport Agency, municipalities, operators of transportation infrastructure, planners, developers, businesses
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.	Real estate developers, IT planners, device developers, federal and state governments
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).	Federal government, public transport operators, educational institutions, state governments, municipalities, manufacturers of public transport
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.	Federal and state governments, standardization authorities, Austrian Institute of Construction Engineering (OIB), Austrian Association for Research on Road - Rail - Transport (FSV)
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.	State governments, municipalities, planners, meteorologists, transport users
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.	Federal and state governments, municipalities, operators of transportation infrastructure, developers, land owners
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.	EU, federal government, research funding agencies (e.g., Climate and Energy Fund, FWF – Austrian Science Fund, Austrian Research Promotion Agency (FFG)), academic and non-academic research institutions
3.11.4.9	Pilot projects on climate-change adapted transportation infrastructure	Demonstration of the feasibility of climate-change adapted transportation infrastructure.	EU, federal and state governments, research funding agencies (Climate and Energy Fund, FWF – Austrian Science Fund, Austrian Research Promotion Agency (FFG)), academic and non-academic research institutions, innovative real estate developers/builders
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.	NGOs, NPOs, federal and state governments, municipalities, schools, universities, interest groups, the media, individuals
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.	Federal government, training and further education institutions, interest groups (chambers)

Table 12: Description of measures in the activity field Spatial Planning

Nr.	Title	Objective	Key Actors
3.12.4.1	Development and provision of practice-relevant data and information bases, awareness-raising, and improved networking of actors	Generation, deployment, and transfer of improved spatial planning-relevant knowledge on climate impacts that is useful and useable in spatial planning decision-making processes; Increasing the willingness and ability to act among spatial planning actors and affected citizens in coping with climate change.	Federal government, ÖROK, state governments, municipalities, interest groups, research institutions, planners
3.12.4.2	Establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restrictions	Protection of residential areas from floods by securing and recovering natural flood plains and water retention areas; Improvement of water retention in the catchment areas of rivers; Protection from flood-related damage by reducing peak flows and slowing flood waves.	ÖROK, state governments, municipalities, planners, water protection management, Torrent and Avalanche Control
3.12.4.3	Increased legal interconnections between zoning and hazard mapping	Protection of residential areas and infrastructure from natural hazards; Reservation of areas threatened by natural hazards through prohibition of construction and usage involving high damage potential; Ensuring proactive hazard prevention.	ÖROK, state governments, municipalities, planners, water protection management, Torrent and Avalanche Control
3.12.4.4	Regulations for the management of existing zoning and buildings in hazard zones	Lowering the damage potential of natural hazard events; Ensuring proactive hazard prevention.	State governments, municipalities, Torrent and Avalanche Control (in an expert and advisory role in individual approvals)
3.12.4.5	Promotion of inter-municipal cooperation	Protection of large-scale "solidarity" areas for flood retention and hazard prevention; Introduction of compensation mechanisms and risk transfer models of between municipalities or bodies under public law according to the Water Rights Act WRG (e.g., water cooperatives/water boards) for the compensation of mutual land use between upstream and downstream communities.	Federal and state governments, municipalities, planners
3.12.4.6	Protection of fresh/cold air production areas, ventilation paths, and "green" and "blue" infrastructure within residential areas	Improvement in microclimates in densely built areas, prevention of overheating and heat-island effects, and compensation for increased bioclimatic stress on human health; Ensuring fresh/cold air supply in densely built areas; Overarching goal is the prevention of heat-related health risks.	State governments, municipalities, planners, nature conservation (at the state level), research (especially meteorology/microclimatology)
3.12.4.7	Review and (if necessary) adjustment of bioclimatic measures in development plans	Improvement of microclimates in densely populated areas, prevention of overheating and heat-island effects, and compensation for increased bioclimatic stress on human health; Prevention of heat-related health risks.	Municipalities, planners, urban planning, research (especially meteorology/microclimatology)
3.12.4.8	Increased protection of water resources and improved integration of spatial planning, water management planning, and usage with water demand	Protection of groundwater and drinking-water resources and support for groundwater recharge; Guarantee of quantitative and qualitative water supply security.	State governments, municipalities, planners, water management, agriculture, industry, energy industry, tourism

Nr.	Title	Objective	Key Actors
3.12.4.9	Increased protection of ecologically important open spaces (non-fragmented natural areas, habitat corridors, biotope networks) and minimization of further habitat fragmentation	Maintenance and improvement of a functional (even under changing natural conditions) network of protected areas and habitats for animal and plant species; Establishment and maintenance of non-fragmented areas of retreat for animal and plant species and prevention of further habitat fragmentation.	ÖROK, state governments, municipalities, planners, nature conservation (at the state level), transportation and infrastructure planning
3.12.4.10	Increased cooperation between spatial planning and tourism to promote a climate change-adapted, sustainable tourist infrastructure	Securing and supporting sustainable and climate change-adapted spatial development in tourism.	ÖROK, state governments, municipalities, planners (tourism planning, regional development: BMWFJ, state governments, tourism associations, regions, municipalities, Torrent and Avalanche Control)
3.12.4.11	Promotion of energy-efficient spatial structures	Strengthening the spatial dimension of the energy system; Reducing energy consumption and improving energy efficiency; Improved achievement of climate change mitigation objectives through reduction in greenhouse gas emissions; Increasing the contribution of renewable energy sources in the regional fulfilment of energy demand.	Federal government, ÖROK, state governments, municipalities, planners, energy suppliers, energy agencies, energy institutes, regional associations, regional management
3.12.4.12	"Climate-proofing" of spatial plans and instruments	Ensuring the resilience and adaptive capacity of plans, programmes, and development concepts to the current and future effects of climate change; Systematic consideration of potential consequences of climate change in future spatial development strategies, spatial plans, and planning processes.	BMLFUW, ÖROK, state governments, municipalities, planners
3.12.4.13	Promotion of quantitative soil protection	Consideration of soil functions in spatial planning procedures to ensure the ecosystem services of the soil.	Federal and state governments, municipalities, ÖROK, b4 Corporate Soil Competence (AGES, Environment Agency Austria, BFW, BAW), academic and non-academic research institutions, spatial planners

BMLFUW (2012b, p.118-119)

Table 13: Description of measures in the activity field Business/Industry

Nr.	Title	Objective	Key Actors
3.13.4.1	Protection of supply, transportation networks, and production through differentiated supply networks, regional clusters, and production close to the market	Ensuring security of supply, e.g., with agricultural products through regionally and seasonally differentiated supply networks; reducing the risk of failure in the supply chain; Reducing the risk of failure and/or fluctuations in price/amount (availability) in the supply chain through the regionalization of sub-supplier relationships; Securing the transportation routes in the supply and distribution networks, reducing the risk of interruptions along the transportation network, ensuring the quality, e.g., of agricultural products or food.	Companies, federal and state governments (food safety authorities), AGES, municipalities
3.13.4.2	Protection of delivery and production through long-term contracts and expansion of inventory	Maintenance of processes of freight flow along the value chain through long-term contracts and the extension of existing contracts, reducing the risk of losses, e.g., of agricultural delivery products, ensuring the quality of agricultural advance services; Reducing the risk of failure and/or fluctuations in price/amount (availability) in the supply chain by expanding inventory and avoiding supply shortages.	Companies, federal government
3.13.4.3	Measures to increase the resilience of production, sales, and operational infrastructure	Maintenance of the production process, ensuring adequate conditions of storage, preventing quality deterioration due to impaired storage, functional logistics in conditions of higher outdoor temperatures and during periods of drought, and protection of operational infrastructure during floods and other extreme weather events (storms, hail, snow load).	Companies, federal and state governments, municipalities
3.13.4.4	Increasing the security of energy supply through the promotion of alternative/ energy-efficient technologies	Increasing the security of energy supply through the increased use of renewable energy, diversification of energy sources, further development of heat and power cogeneration, network expansion, operational energy production, and measures to increase efficiency.	Companies, federal and state governments, energy industry
3.13.4.5	Development of climate-friendly and adaptation-fostering products	Increasing adaptive capacity with the help of innovative products.	Companies (supply- and demand-side), public sector (demand-side)
3.13.4.6	Adequate future scenario-based risk assessment, cooperation with R&D, monitoring of scientific results	Development of new risk assessment methods for the insurance industry taking climate scenarios into account; improved basis for risk assessment for companies.	Insurance companies, academic and non-academic research institutions
3.13.4.7	Public awareness-raising to prevent damages and reinforce the individual responsibility of the insured	Awareness-raising regarding potential damages as a contributing factor in their reduction.	Insurance companies, public institutions
3.13.4.8	Better risk diversification for insurers, thereby increasing the insurability of climate- and weather-induced damages	Introduction of a combined fire and natural hazard insurance for extended risk diversification.	Insurance companies, federal government
3.13.4.9	Provision of services to clients after damage claims	Assistance in managing and repairing damages as a contributing factor in limiting consequential damages.	Insurance companies, other service providers

Table 14: Description of measures in the activity field Cities – Urban Green and Open Spaces

Nr.	Title	Objective	Key Actors
3.14.4.1	Adaptation of the water management strategy for green and open spaces	Ensuring the water supply and retention functions of green and open spaces under changing climatic conditions.	Municipal departments, parks departments, water suppliers
3.14.4.2	Adaptation of soil management in urban green and open spaces	Maintenance of soil functions, especially their water storage and water filtration functions.	State governments, municipal departments, parks departments, planners, individuals
3.14.4.3	Conservation and promotion of biodiversity in urban green and open spaces	Maintenance of ecosystem services and species diversity in urban green and open spaces.	BMLFUW, state governments, municipal departments, parks departments, planners, urban planning, spatial planning, garden centres, horticulture
3.14.4.4	Adaptation of planning strategies for urban green and open spaces	Consideration of climate change in urban planning instruments.	State governments, municipal departments, urban development and planning, parks departments, spatial planning, planners, micrometeorologists
3.14.4.5	Adaptation of open space planning and maintenance	Consideration of climate change in the design, implementation, and maintenance of urban green and open spaces.	Municipal departments, parks departments, planners, micrometeorologists
3.14.4.6	Promotion and adaptation of green and open spaces for recreation and leisure uses under changing climatic conditions	Preservation and creation of green and open spaces as recreational and leisure area to promote human well-being under changing climatic conditions (especially during heat waves).	Municipal departments, parks departments, planners, micrometeorologists
3.14.4.7	Awareness-raising, improved networking, and adaptation of the training and further education of actors (public and private)	Advancement of knowledge and improvement of networking among affected actors.	City administrations, Association of Austrian Cities and Towns
3.14.4.8	Improvement of the knowledge base through inter- and transdisciplinary research on urban green and open spaces	For the purpose of adapting urban green and open spaces to climate change, issues must be explored at various levels and prepared in an interdisciplinary fashion for implementation.	Federal government (research programmes), academic and non-academic research institutions, city administrations, planners, micrometeorologists

BMLFUW (2012b, p.121)

3. Methodology

This section explains the various methods that have been applied in this paper to qualitatively and quantitatively analyse the National Adaptation Strategy, which is basically a list of measures (see Tab. 1-14). With the intention to summarize this list in multiple ways, we performed a categorization method that is based on the actors involved in the whole sequence cascade of the measures, starting from initiating the implementation of a measure through to the arisen benefits (see section 3.1.). Adger et al. (2005) point out the complexity of interrelationships between different actors by stating that adaptation to climate change involves decision-making by individuals, firms and civil society, as well as by public institutions and governments at local, regional and national scales, and international agencies. The challenge arises when coordinating the behaviour of the various agents to move the society towards a desirable goal (Adger et al., 2005). The necessary sequence cascade makes organization even more difficult since a measure must run through multiple steps before actually providing benefits, and disagreements between actors can occur in each step. Additionally, we performed weighting methods to adequately present public and private shares across measures (see section 3.2.) and across activity fields to cluster the activity fields in continua for predominantly public to predominantly private adaptation (see section 3.3.).

3.1. Categorization method

The aim of the categorization procedure is to efficiently separate the 132 measures into public and private measures in a transparent manner for further analyses. In addition to the distinction between public and private, we want to find out which governance level (federal, provincial etc.) is involved in providing the measures. For this purpose, we determine four roles that have to be specified for each measure. The differentiation is based on the function that is performed by the actor in the sequence cascade of adaptation decision-making and implementation (Fig. 2). A similar, but less detailed categorization can be found in Tompkins and Eakin (2012), where the authors basically distinguish between the public/private characteristics of providers and beneficiaries of adaptation measures. It is not closer specified, whether providers initiate the measures or only undertake expenditures to finance the measure or whether they also act as implementer as in our categorization.

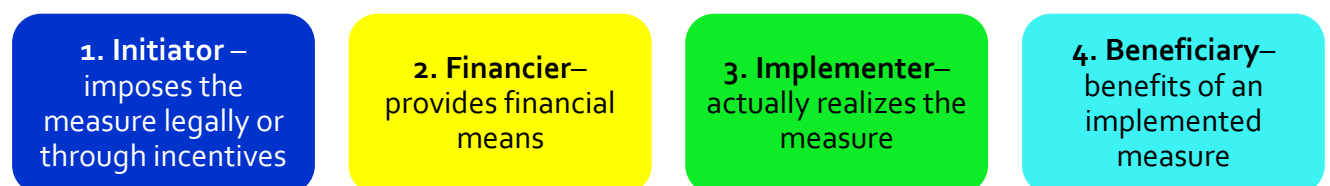


Figure 2: Different actor levels in the sequence cascade of adaptation decision-making and implementation

Initiator

The initiator of a measure is the one that imposes the measure through legal regulations or by setting incentives for its implementation. In some cases, the European Union decides on a regulation and member states must put it into practice. One example in the activity field of spatial planning is measure 3.12.4.2 that concentrates on the EU floods directive: *establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restriction* (BMLFUW, 2012b). More often, though, it is the federal government that is required to initiate a measure, by either providing financial incentives or preparing the legislative framework for regulative changes. This is for example the case for measure 3.6.4.6 in construction and housing: *revision of building standards and norms considering climate change* (BMLFUW, 2012b). The initiator must not be involved in later steps of the sequence cascade.

Financier

The second role is the person or institution that provides the financial means for the realization. This can be the federal government charging construction companies with the building of flood protection systems. As demonstrated by this example, the financier is also not necessarily included in the implementation step.

Implementer

The implementer, however, actually realizes the measure. In the above example these are the construction companies; other measures also include private households as implementers, such as measure 3.6.4.4: *implementation of structural measures in buildings as protection from extreme weather events* (BMLFUW, 2012b).

Beneficiary

The role of the beneficiaries is distinguished on the basis of the created good. Measures that lead to a good that is financially excludable, result in specific beneficiary groups, such as private companies or private households. These measures are then considered to create private goods. If, in contrast, the measure creates a good or an environmental state that no-one can be excluded from, then everybody benefits from the measure and hence a public good is produced. Public goods can be further divided into national or regional public goods. Whereas the former refers to beneficial situations that cannot be attributed to specific groups of people or to specific regions of Austria, the latter describes a situation from which only people living in a specific area benefit. An example for such a good are flood protection systems: only people living near the protection system benefit directly from their implementation.

For every measure, the specific actors, shown in Tab. 15, have to be identified for all four actor levels of the sequence cascade of adaptation decision-making and implementation. For each actor level, the first step is to identify whether the role is performed by a public or a private actor; then the actor is further classified into aggregates, such as “state” or “companies” for example, and the third step is the denomination of the subcategory (e.g. federal government, provinces etc.). The fourth level describes the particular actor. The choice of actors are defined according to the characterization of the general government sector (European Communities, 2002). In many cases a combination of actors can be involved in each actor level.

Table 15: Characterization of public and private sectors

Sector	Aggregate	Subcategory	Description	
Public Sector	Rest of World	EU and similar	Institutions of the European Union and other international institutions	
		Federal government	Ministries, public institutions of the federal government	
	State	Provinces	Departments of the provincial government, public institutions of the provinces	
		Municipalities	Public institutions of the municipalities	
		Social insurances	Legally mandatory unemployment, health, pension and accident insurance	
	Non-profit organizations	Non-profit organizations (private)	Non-profit institutions serving households (=non-market producers with a focus on societal goals) Even if non-profit organizations are mostly private, in statistical calculations, they are included in the public sector.	
		Companies	Public companies	Market-oriented companies fully or partially managed by the public hand
			Private companies	Private financial and non-financial companies, especially private banks, insurances, pension schemes
	Private Sector	Households	Private households	All private households or specific groups of households

The categorization for the analyses in this paper was done by sector experts of the two projects PATCH:ES (2015) & PACINAS (2015). For each activity field either several experts discussed on the

assignment of actors, or there was a cross-validation with other experts. Partners from the University of Natural Resources and Life Sciences in Vienna (BOKU Wien) for example were responsible for the assignment in the two activity fields agriculture and forestry. Other partners from the International Institute for Applied System Analysis in Laxenburg (IIASA) provided the assignment for disaster risk management and protection from natural hazards. The classification for all adaptation measures was provided in an excel-sheet (WEGC, 2015) with the possibility to comment and specify the choices made by the experts (e.g. in which way the public society may benefit from a measure or how a specific institution contributes to financing or implementing a measure).

For the following presentation of results, Tab. 16 summarizes which actors are referred to when we use the two aggregates “public” and “private”. Tab. 15 considers sectors, while now the focus is on actors. So, we cluster all possible actors of the two sectors private and public into private and public actors.

Table 16: Differentiation between public and private actors

Public actors	Private actors
EU	Private companies
Federal government	Private households
Provinces	
Municipalities	
Social insurances	
Public companies	
Non-profit organization	

3.2. Weighting method of nominations

To understand the graphs in the results section, which present the number of measures undertaken by specific actors, we must clarify how we counted the nomination of actors in case that more than one actor is contributing to the fulfilment of the one stage. For the three roles of initiator, financier and implementer we used a weighting method accounting for the total number of actors involved in one measure, ensuring that each actor is only responsible for the adequate share of the measure. This procedure allows us to maintain the total number of 132 measures for each of these three roles. In case of the beneficiaries, we applied a different method. According to the public good literature the utility of a good increases, the higher the number of users benefitting from it (Holler & Illing, 2009). The created good was therefore weighted only when it would benefit both Austria as a whole and a specific region of Austria in particular, since this does not increase the number of users of a measure. Otherwise, for each nomination of possible beneficiaries (public or private household or private company) we counted one created good.

For better comprehensibility, imagine measure 3.7.3.5 of the NAS *promotion of risk management with inclusion of appropriate risk transfer mechanisms*: the implementation would benefit private companies, such as insurance companies, private households, such as consumers of insurance companies, and the society in total through the restructuring of public risk transfer mechanisms, such as reserve funds, sovereign insurances, and catastrophe bonds (WEGC, 2015).

3.3. Method to distinguish between public and private activity fields

Adaptation measures are undertaken both by **public** and **private** actors through policies, investments in infrastructure and technologies and behavioural change (Agrawala and Fankhauser, 2008). In the literature, the line between public and private adaptation is typically drawn on the basis of responsibilities (Eakin & Patt, 2011; Tompkins & Adger, 2005; Klein et al., 2008). So is public action required for example when the government acts as the landowner (roads, bridges etc.), or if significant social organization is needed (flood control barriers or irrigation channels), or because adaptation undertaken by private actors need to be facilitated by the provision of public goods (e.g. adjustment to regulatory framework, information provision) (Eakin & Patt, 2011). When talking about public adaptation, Klein et al. (2008) refer to early-warning systems, new buildings codes, design standards and incentives for relocation (see Tab. 17). Adaptation is considered rather private, however, if private individuals act individually to minimize losses from climate change (Eakin & Patt, 2011). This includes the purchase of insurances, changes in farm practices or the purchase of air-conditioning (Klein et al., 2008). Hence, the distinction is determined by public policy and by underlying institutions and regulatory frameworks (Tompkins & Adger, 2005). Consequently, adaptation could not only exclusively fall into the public or the private sphere, but additionally there are overlaps and that this could also change over time (Tompkins & Adger, 2005).

Table 17: Dimensions of adaptation: public/private crossing anticipatory/reactive

		Anticipatory	Reactive
Natural system			Changes in length of growing Changes in ecosystem composition Wetland migration
	Public	Early-warning systems New buildings codes, design standards Incentives for relocation	Compensatory payments, subsidies Enforcement of building codes Reparation of protective structures
Human system	Private	Purchase of insurances Adaptation of houses to extreme weather events	Changes in farm practices Changes in farm insurance premiums Purchase of air-conditioning (maladaptation) Production of artificial snow (maladaptation)

Source: adapted from Klein (2003), p.4

According to this literature review, the differentiation of public and private adaptation primarily focusses on who pays and who acts in the provision of adaptation measures. We therefore decide that neither initiator nor beneficiary should be included to base the allocation of activity fields on. For the visualisation of the significance of public actors across the different activity fields we present two tables, allocating the activity fields in private-public adaptation continua for the financing as well as for the implementation step.

The weighting method as described in section 3.2. would lead to an underrepresentation of the private sector, because often the federal government, provinces and municipalities are announced jointly and therefore the additional announcement of private actors receives the weight of $\frac{1}{4}$ only. Yet, we are interested whether private or public actors are involved in the financing and implementing of a measure at all and how often this is the case in each activity field. We consequently accounted only for the two aggregates "public" and "private" and assigned either one or both of these attributes to every measure. For each field of activity we then checked if more than the average of measures in this activity field is private or public or both (for financier and implementer). In case the outcome is that more than the average of measures is public (private), we allocate the activity field to the predominantly public (private) adaptation corner, and to the intersection if both public and private actors were nominated in more than half of all measures in each activity field.

4. Results

This section is dedicated to the evaluation of the National Adaptation Strategy using the above described methods and categories. On the one hand, we want to find out which activity fields require high commitment of the public sector, and on the other hand, we are interested in the shares of public and private actors among the different roles. The distinction between the different governance levels allows further conclusions about the competence allocation of the measures.

4.1. Assessment for the National Adaptation Strategy in total

We start with an analysis of the NAS in total. Fig. 3 therefore shows the shares of public and private actors for each of the four actor roles for all 132 adaptation activities. Purely private or purely public means that all actors involved in one step (in case there are multiple) are private or public, respectively. A measure is mixed in one step of the sequence cascade if public and private actors contribute jointly to satisfying one of the four roles.

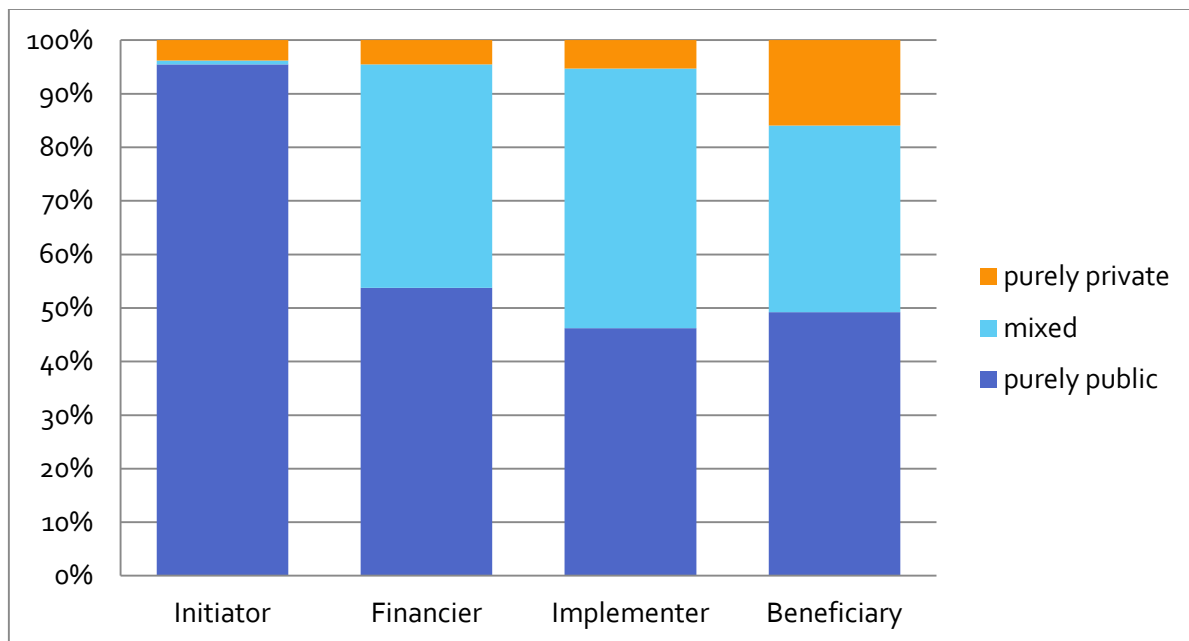


Figure 3: Categorization of adaptation measures according to public, private and mixed share (n=132)

95% of all measures are initiated by public authorities solely, whereas they act as single financier in 54% of the measures and collaborate in additional 42% ($\Sigma=96\%$). Similarly, public actors are involved in the implementation step of almost all measures (95%), but as exclusive implementer only in 46%. Private actors, thus households and companies, as the only financier and implementer are responsible for a small share of measures, that is 5% each, but collaborate in additional 42% and 48% of measures, respectively.

Considering the beneficiaries of a taken action, almost half of all measures benefit society in total either on a regional or national scale. Another third of measures create a good that is both beneficial for specific groups of households or companies and has positive effects for larger groups of the

society. Consequently, only 16% of all adaptation actions provide a pure private good that can be clearly attributed to specific subsections of the population.

Summing up, almost all measures are initiated publicly. Moreover, public authorities contribute in financing and implementing in a large share of the measures. It follows that the public sector is challenged to organize the required structures for the measures as well as to contribute in the later steps of the sequence cascade. Besides, the large share of mixed measures in the financing and implementation stage show that a good collaboration between public and private actors will be required to ensure the best outcome.

We now take a closer look on the four different roles and analyse them with respect to the specific actor that is in charge. Fig. 4 presents the weighted number of nominations of the subcategories according to the method described in section 3.2. Private and public actors sum up to 132 for initiator, financier and implementer and exceed this limit in case of the beneficiaries. To avoid a loss of information by presenting the weighted numbers, we also add the absolute values of measures in which actors are involved as single actor or jointly with other actors.

The initiator is predominantly public, as it was derived already from the previous analysis, but here we can see the composition of the public sector. The federal government is responsible for the initiation of 78.7 measures. These 78.7 measures in weighted terms split up into 66 measures in absolute terms for which the federal government acts as single initiator and 34 measures in absolute terms, where the federal government is one of two or more actors in charge of the initiation. This is followed by the provincial level with the initiation of 31.7 measures, 20 of which as single initiator and 32 jointly with other actors. Municipalities, impose 8.1 measures, consisting of 6 measures in which they are supposed to act individually and jointly in 7 measures. The EU, however, is involved in the initiation step of 23 measures (8.3 in weighted terms): as single initiator in one measure (3.12.4.2 of the NAS) and co-initiator in 22 measures. On a private basis only 5.25 measures are initiated: 5 solely and 1 jointly (find a closer description of these measures in section 4.2.).

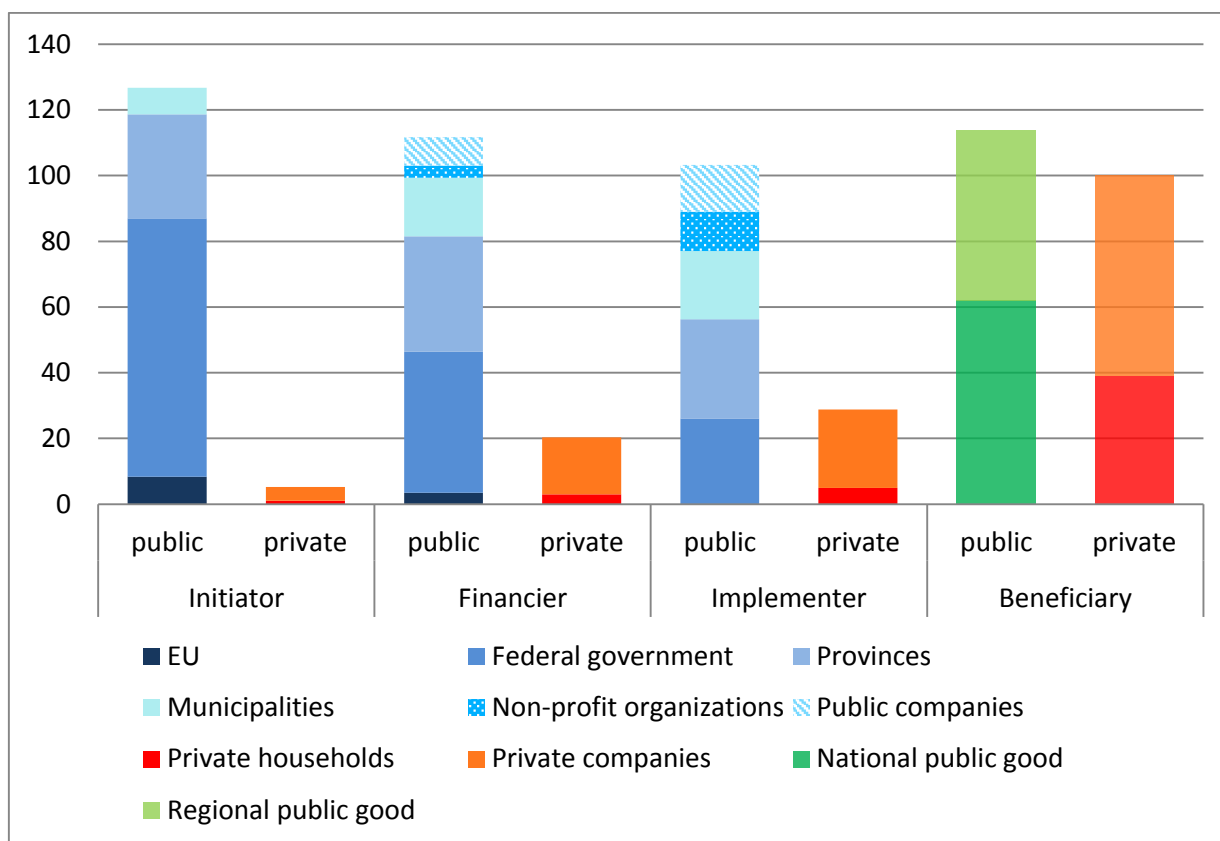


Figure 4: Initiator, financier, implementer and beneficiary: weighted number of nominations of the different subcategories

If we take the first stacked bar of the financier column, we can see that the federal government and the provinces are more deeply involved in financing the measures compared to other public authorities, such as the EU. The federal government is involved in 110 measures (43.05 in weighted terms): 18 times as single financier and 92 times as co-financier. The provinces are involved in 104 measures (35.05 in weighted terms): one time as single financier and 103 times as co-financier. If the EU is considered to provide financial means, this is mostly accomplished through subsidies and only occurring in the activity fields of agriculture, protection from natural hazards and transportation infrastructure. The private sector, on the contrary, finances 20 measures in weighted terms.

The picture is similar for the implementation step. In contrast to the initiator and financier role, the EU is not mentioned at all, and furthermore, the shares shift marginally from the upper governance levels to the lower levels (e.g. from federal to provincial and municipal level). Hence, the federal government is involved in the implementation of 81 measures compared to the financing of 110, in weighted terms this difference corresponds to 16.94 measures (26.11 and 43.05 respectively). The evaluation shows that if the federal government is still in the role of the implementer, it is jointly with other actors in more cases than in the financing step. Provinces and municipalities contribute in implementing 92 (30.2 in weighted terms) and 60 (20.7 in weighted terms) measures, respectively. Also non-profit organizations and public companies take a more prominent role in implementing

measures compared to their financing and even more compared to the role of the initiator. With regard to the private sector, the results show that especially private companies are far more strongly involved in the implementation than in the financing step: in weighted terms they implement 23.87 measures and finance 17.3 measures, which corresponds to a difference of 16 measures in absolute values. Private households are also, but only marginally more deeply involved in the implementation step (2.98 compared to 4.9 measures in weighted terms). This is the case, because some measures require households to take adaptation actions on an independent basis, but public authorities are still needed to provide information etc.

To conclude, these results combined with the results from Fig. 3 show that the further we advance in the sequence cascade, the more it is up to the lower governance levels to act. Hence, the EU has an important part in starting things, but not in actually doing it. The federal government is required to provide the legal basis as well as the financial means, but has a less prominent role in implementing measures. Provinces and municipalities are strongly needed in the implementation step and have to be prepared to collaborate with private and public companies. This will be taken up in the evaluation of the activity fields, where it becomes even more visible.

4.2. Evaluation by activity field

In this section, we analyse the activity fields one by one. The results are then used to find out, where public action is needed at a greater or smaller scale. For each activity field, we check for the relationship between public and private actors among the four different roles: initiator, financier, implementer and beneficiary. Subsequent to the analysis we proceed with the clustering of all activity fields in private-public adaptation continua to show their private-public adaptation proportion.

Agriculture

With 14 adaptation measures, the field of agriculture has the highest number of adaptation options within the adaptation strategy. All but one measure are publicly initiated. The one initiated on a private basis foresees the *breeding and targeted use of water-saving, heat-tolerant plants (species/varieties) within the meaning of a regionally adapted management* (3.1.4.3). Experts from the BOKU argue that public authorities are hardly interested in progressing research in breeding, but that it is up to private actors to initiate such a measure (WEGC, 2015). For both the financing and the implementation step there comes a different picture though: almost all measures must be financed and implemented in coordination between public and private actors. The large share of non-profit organizations mainly includes academic and non-academic research institutions, such as the BOKU,

AGES² and UBA³. With respect to the beneficiary, all measures benefit specific societal groups, such as farmers, and additionally provide co-benefits for society: measure 3.1.4.1 *sustainable soil composition and protection of soil fertility, structure, and stability* for example also increases the soil's functionality in filtering, saving and transformation (e.g. groundwater protection), as well as the biodiversity and regulatory function (e.g. material cycles – water) (WEGC, 2015).

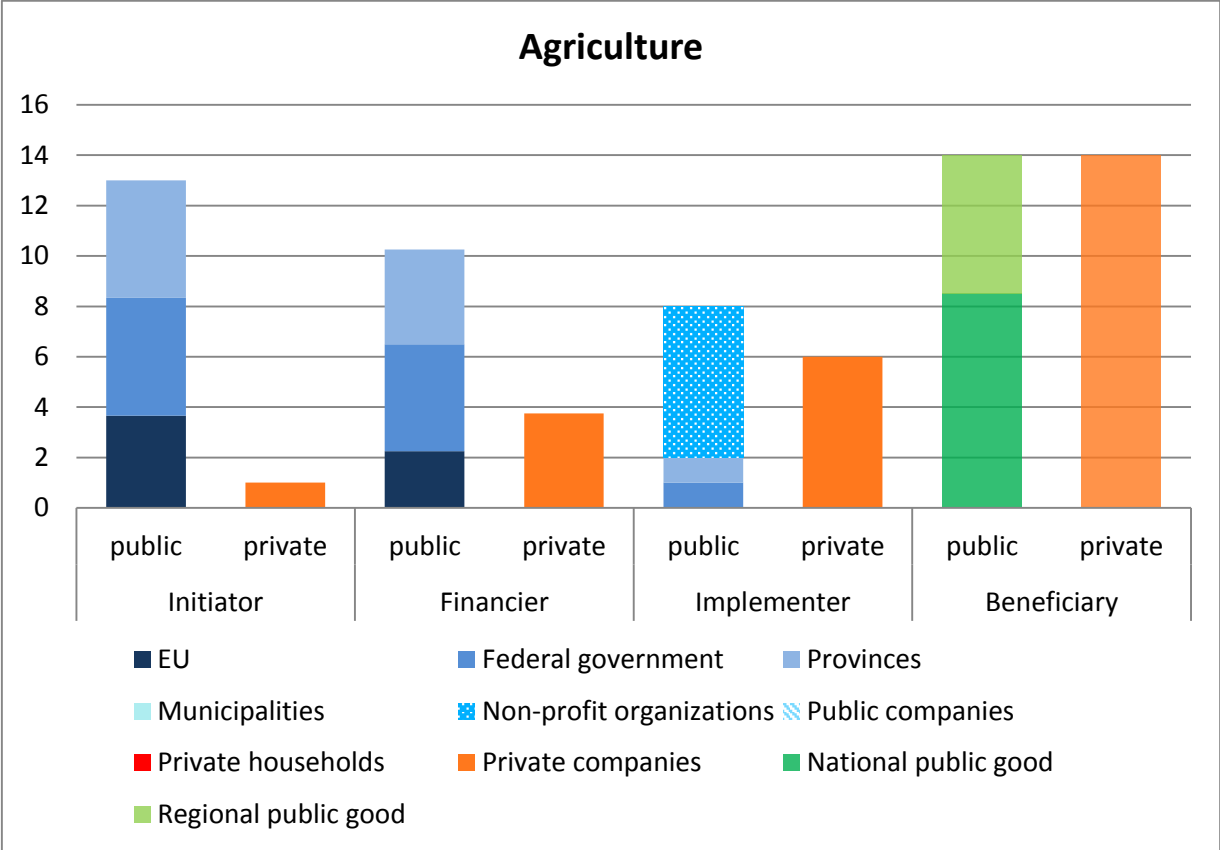


Figure 5: Public and private shares in the sequence cascade for activity field agriculture (in weighted terms)

² Agentur für Gesundheit und Ernährungssicherheit GmbH is a company managed by the Ministry of Health (BMG) and the Ministry of Agriculture, Forestry and Water Management (BMLFUW).

³ Umweltbundesamt (Environmental Protection Agency Austria)

Forestry

Similar to the previous activity field, one of 8 measures is initiated privately: the *development of modified and innovative techniques for wood processing taking into account potential changes in wood quality and tree species* (3.2.4.8) is rather in the scope of the wood-working and -processing industry than of public authorities (WEGC, 2015). The publicly initiated measures are initiated by the federal government (6 measures) and the provinces (1 measure). When comparing financiers and implementer, Figure 6 illustrates that lower governance levels, such as provinces and municipalities, are more deeply involved in implementing than financing a measure, whereas the federal government is always less involved when advancing in the sequence cascade. The one measure that is initiated privately (see above) is also the only measure that benefits only private companies. The remaining 7 measures provide benefits to the whole society, for example through the reinforcement of the protective, welfare and recuperative effect of the forest habitats.

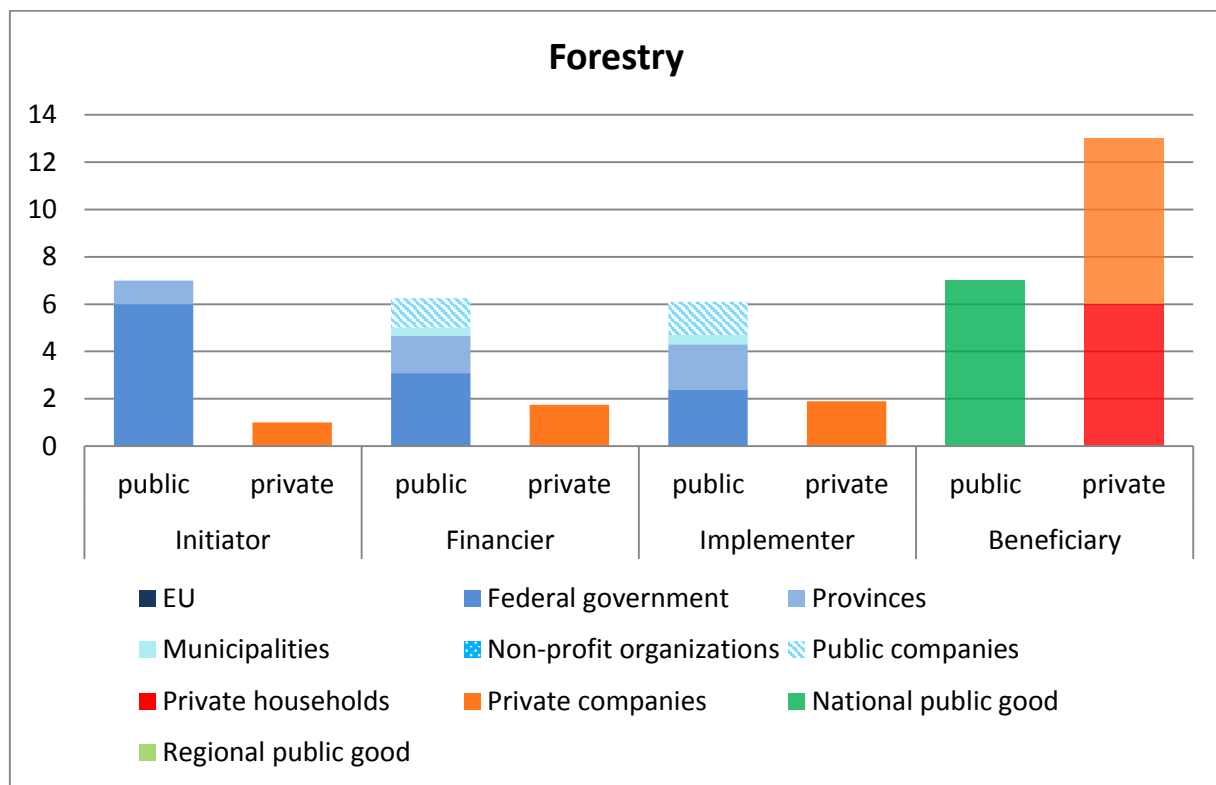


Figure 6: Public and private shares in the sequence cascade for activity field forestry (in weighted terms)

Water Resources and Water Management

The field of water resources and water management contains 10 measures. Out of these measures, 4 are content-related to the national water management plan and therefore initiated by the federal government (3.3.4.3, 3.3.4.5, 3.3.4.6 and 3.3.4.7). Also another 4 measures are initiated by the federal government, but the remaining 2 measures are supposed to be initiated by the provinces (3.3.4.3 and 3.3.4.4). In the financing step, often three or more actors are involved, including private households in measure 3.3.4.4 (*mindful use of water resources*) and 3.3.4.10 (*installation of industrial*

water management instruments). When it comes to implementation, public companies, such as energy and water suppliers, come into play in more than half of the measures. Again, the federal government, provinces and municipalities are often announced jointly in the implementation step, which requires good collaboration between the various administrative levels. In general, the society benefits from a responsible interaction with water resources and, in particular, supply companies as well as specific users are favourably affected.

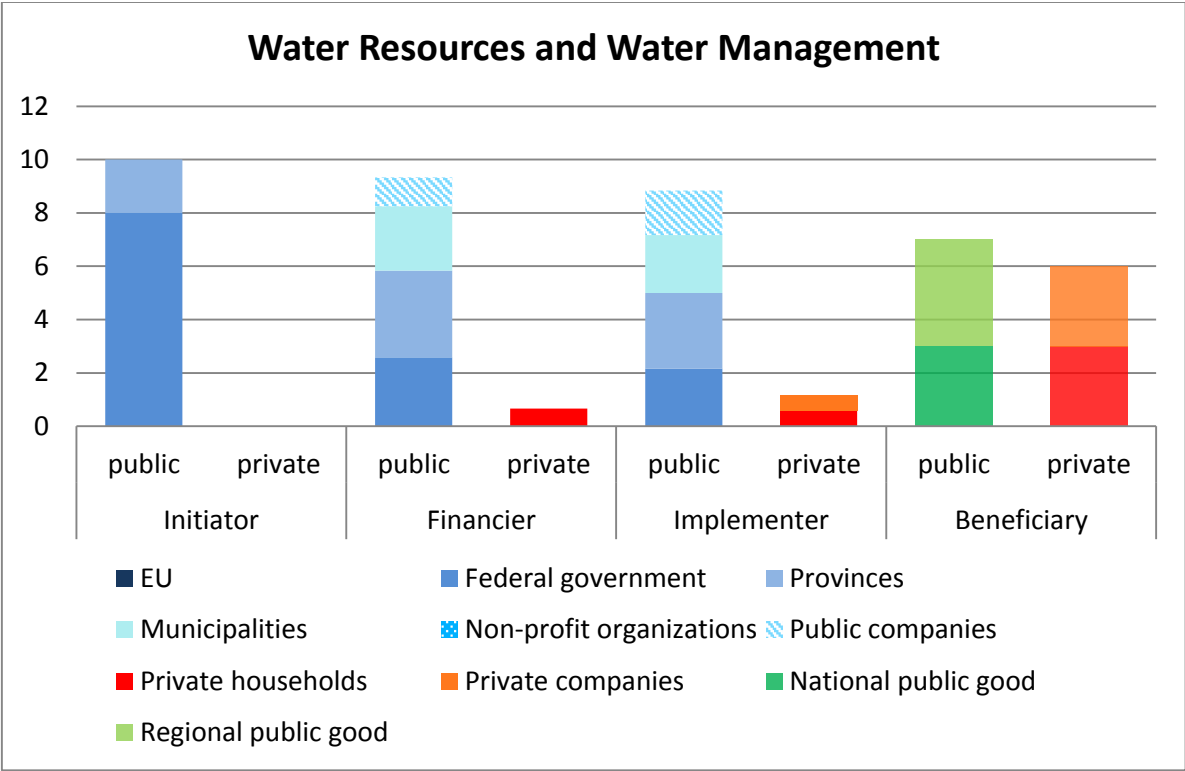


Figure 7: Public and private shares in the sequence cascade for activity field water resources and water management (in weighted terms)

Tourism

With only 3 measures to adapt to climate change, the field of tourism provides the smallest number of measures. All measures must be initiated by the federal government. Measure 3.4.4.1 is additionally financed and implemented by the federal government and the provinces jointly: *consideration of climate change in tourism strategies*, which is part of the national tourism strategy. This measure also creates a national public good. The other two measures, however, include private companies in financing and implementing the measure and benefit private companies only.

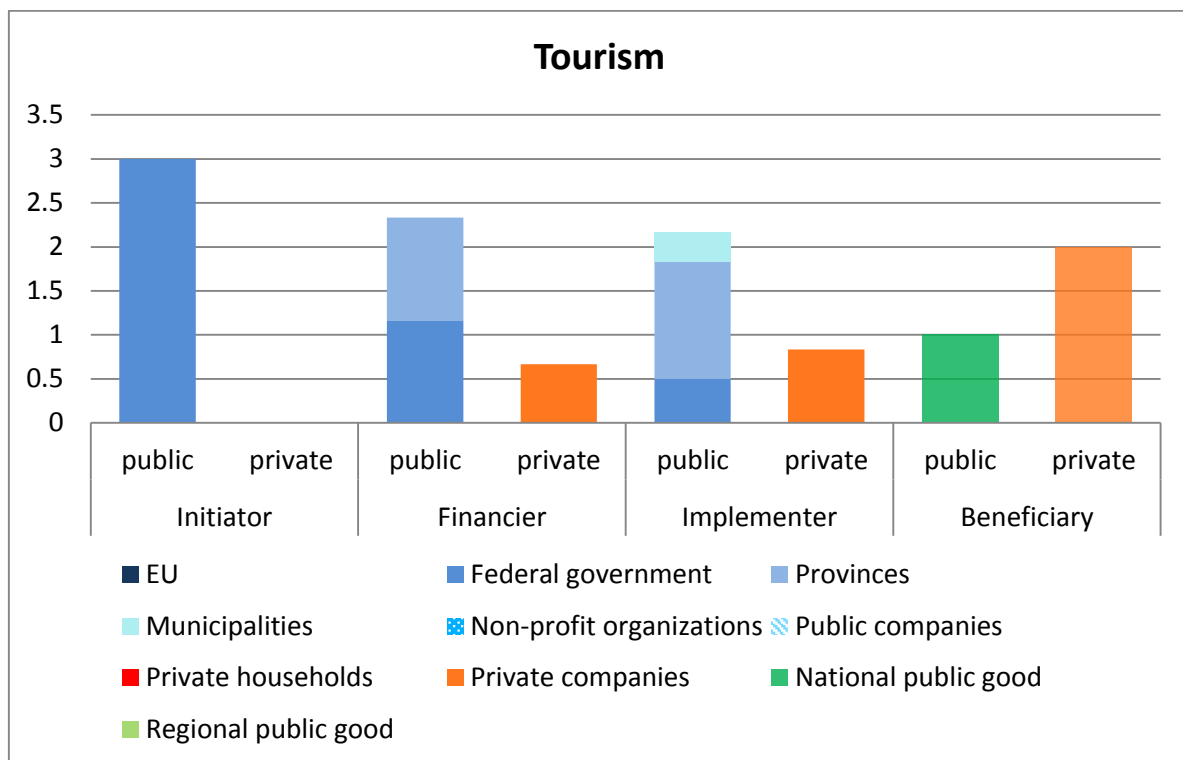


Figure 8: Public and private shares in the sequence cascade for activity field tourism (in weighted terms)

Energy – Focus on the Electrical Industry

The activity field energy contains 8 measures that are mainly processed by public actors, such as the federal government in the initiation step and a mix of federal government, provinces and public companies in the financing and implementation step. Private companies are considered to finance measure 3.5.4.7 *reduction of demand by means of increasing end energy efficiency and reducing internal loads* and to contribute in implementing measure 3.5.4.5 *optimization of the interaction between generation (from various sources) and consumption in the power supply system under varying supply and demand*. All measures benefit both private households and companies, and provide additional benefits for society through increased supply reliability for example.

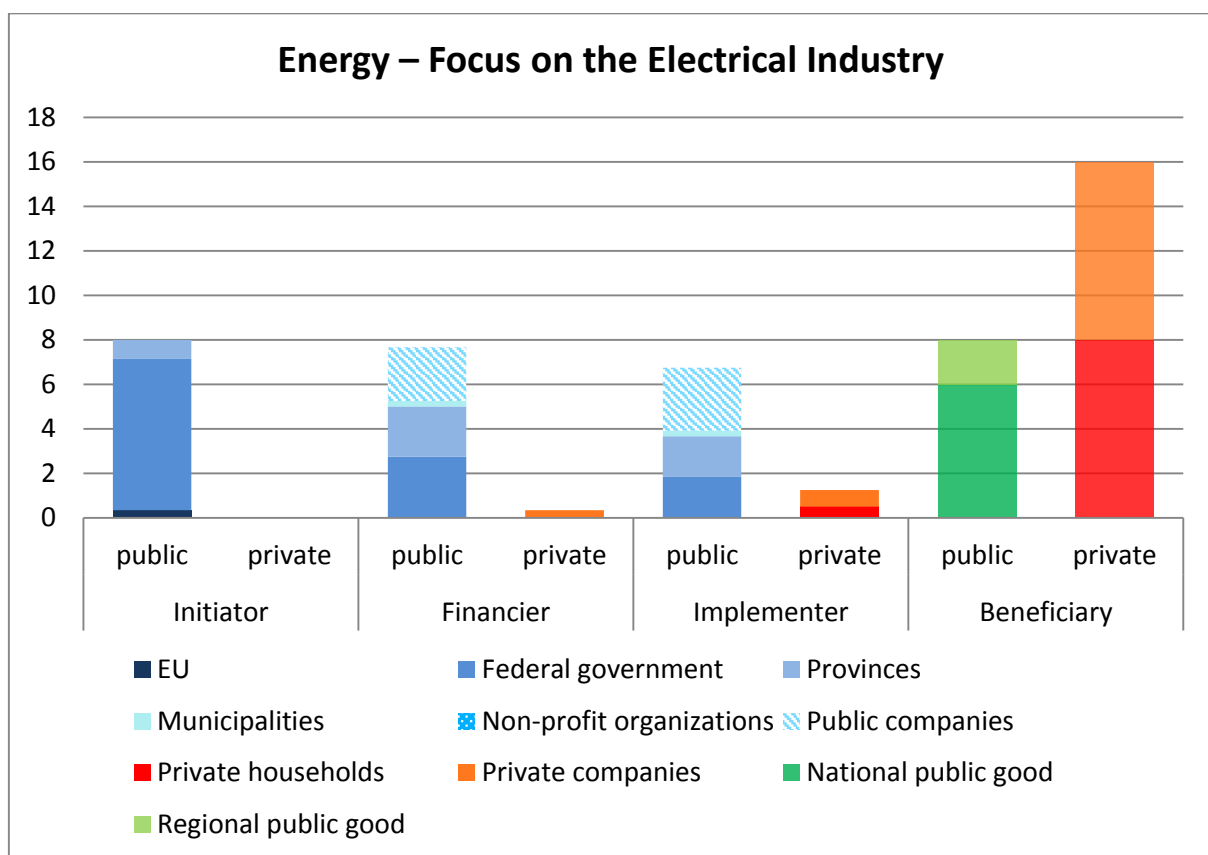


Figure 9: Public and private shares in the sequence cascade for activity field energy- focus on the electrical industry (in weighted terms)

Construction and Housing

In construction and housing (11 measures), 10 measures are initiated by public authorities, such as the federal government (5), provinces (4), and municipalities (1) and one measure is initiated by private households (3.6.4.4 *implementation of structural measures in buildings as protection from extreme weather events*). In the financing step, public actors are clearly outweighing private actors, however, private households co-implement 6 measures and private companies, such as construction companies, are single implementer of measure 3.6.4.11 *training and further education on issues of*

adaptation to the consequences of climate change in the area of construction and housing in order to secure competitive advantages. Regarding the beneficiaries, most adaptation measures within this activity field benefit those private households and companies that are staying (either for living or working) in a climate-improved building. In contrast, for example measure 3.6.4.5 *increase of water retention* typically provides benefits to one specific area creating a regional public good.

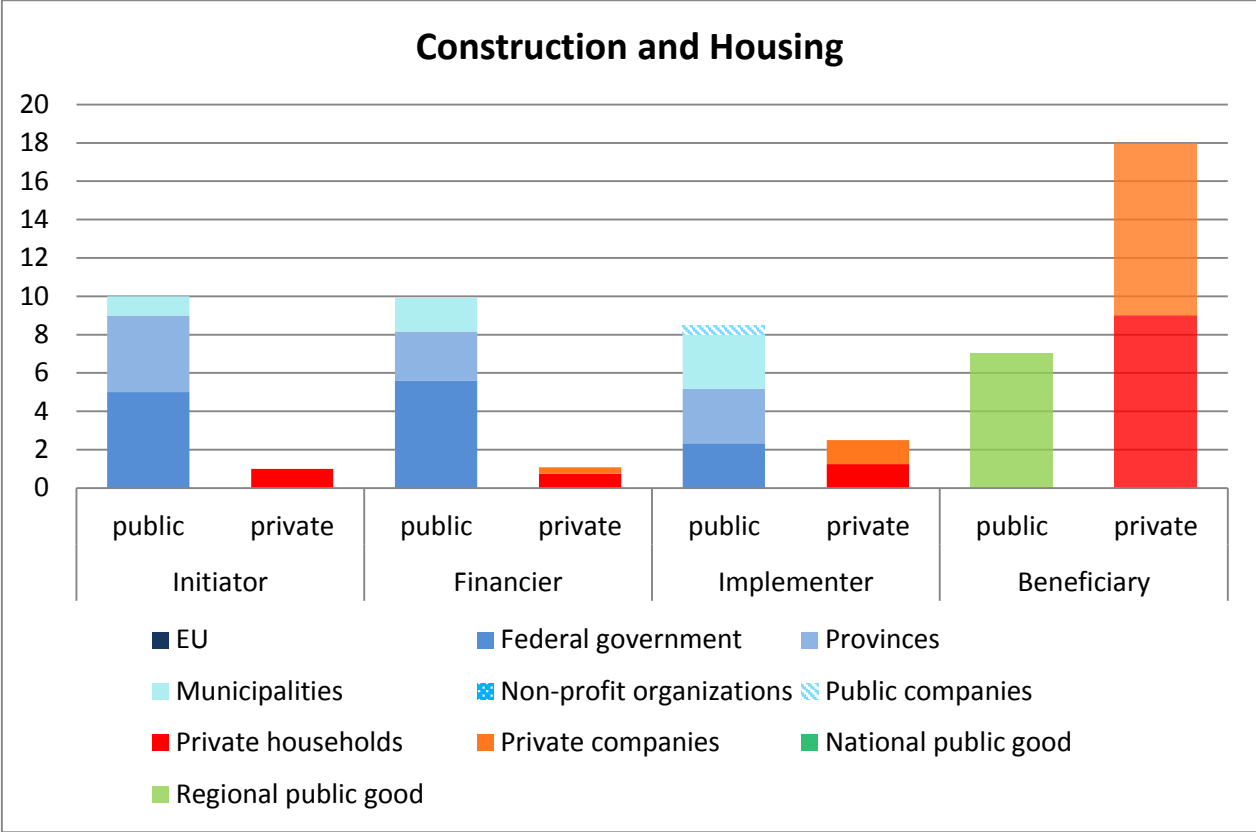


Figure 10: Public and private shares in the sequence cascade for activity field construction and housing (in weighted terms)

Protection from Natural Hazards

Containing 7 measures, the competences in the initiation step are spread among public actors: the federal government is mentioned twice as single and 5 times as co-initiator, whereas the EU is involved in initiating and financing measure 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*. Due to the local component of measures 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*) and 3.7.3.6 (*promotion of technological property protection measures (permanent and temporary) as a contributing factor to self-sufficiency*), municipalities are involved in the sequence cascade. However, especially in the financing and implementation step, this activity field strongly relies on the contribution of private actors, such as private households and companies. Additionally, non-profit organizations (in

measure 3.7.3.4, see above) and public companies, such as the National Crisis and Disaster Protection Management (SKKM)⁴, the ZAMG⁵ and the Geological Survey of Austria (in measure 3.7.3.1 *promotion of hazard and risk awareness, self-sufficiency of the population, and the development of consulting models*) and jointly in measure 3.7.3.7 *promotion of forecasting, (early) warning, and measuring systems* contribute to implement the measures. The beneficiaries are private for two measures (3.7.3.5 and 3.7.3.6) and public for all other measures.

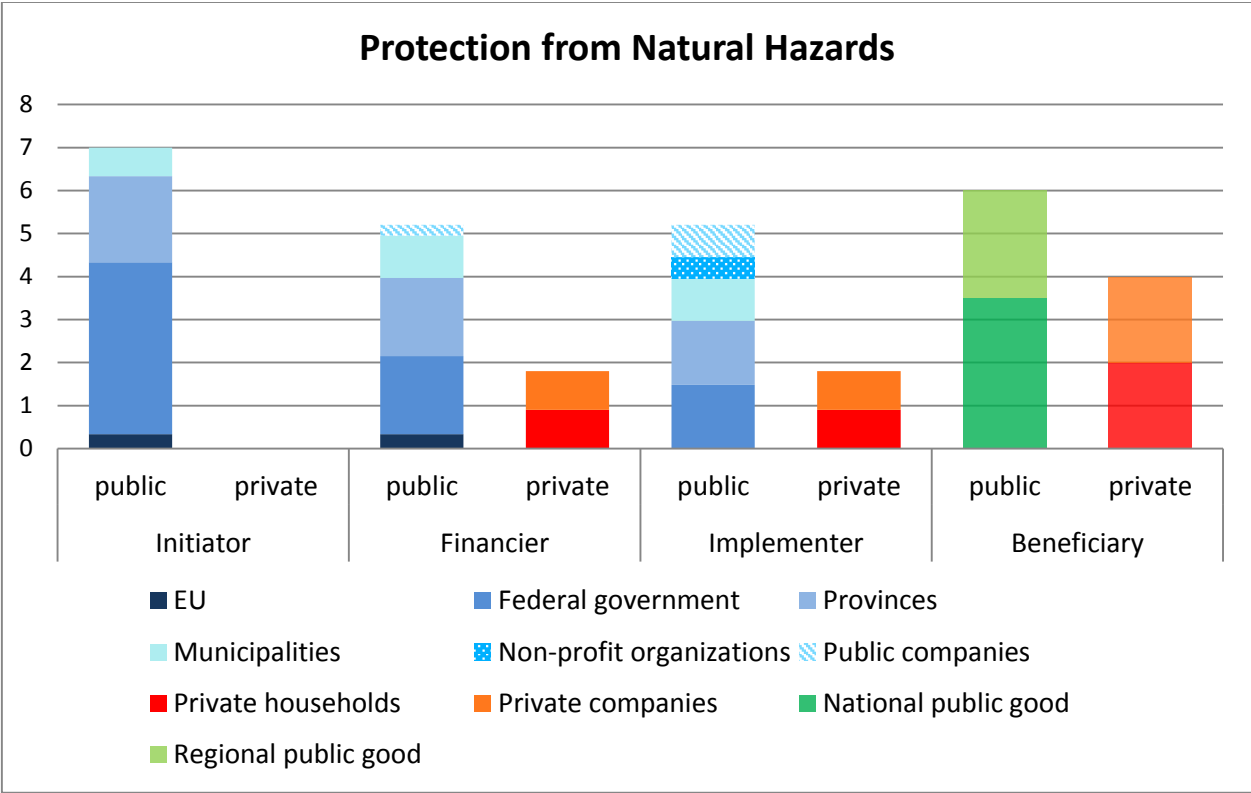


Figure 11: Public and private shares in the sequence cascade for activity field protection from natural hazards (in weighted terms)

Disaster Risk Management

The activity field disaster risk management contains 9 adaptation measures. The federal government is involved in the initiation and financing of every measure, and in the implementation of 7 measures (excluding measures 3.8.3.5 and 3.8.3.7). Fig. 12 illustrates the shift from higher to lower administrative levels when advancing in the sequence cascade. Provinces co-initiate 3 measures, co-finance 5 measures and co-implement 6 measures. Municipalities co-initiate 1 measure, co-finance 3 measures and co-implement 5 measures. Non-profit organizations, such as humanitarian organizations, are involved in the financing of measure 3.8.3.3 *creation and maintenance of appropriate frame conditions for volunteer engagement in the field of disaster risk*

⁴ Staatliches Krisen- und Katastrophenschutzmanagement
⁵ Zentralanstalt für Meteorologie und Geodynamik is under the management of the ministry of science, research and economics (BMWFW).

management and in the implementation of further 7 measures. When private companies contribute, it is mostly emergency organizations (WEGC, 2015). All measures benefit society in total through reduced exposure and vulnerability.

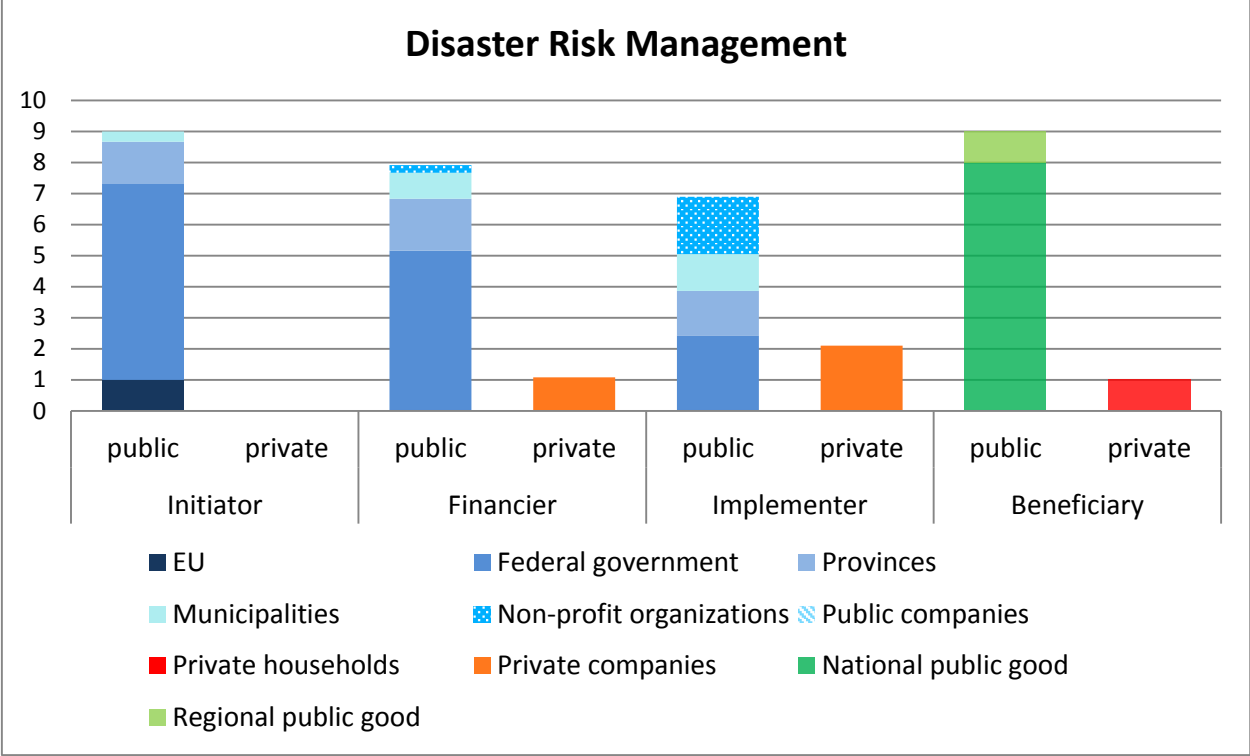


Figure 12: Public and private shares in the sequence cascade for activity field disaster risk management (in weighted terms)

Health

The activity field health contains 8 measures, all of which have a purely public sequence cascade from initiation through to benefits. The federal government initiates all but one measure, which is initiated by the provinces: 3.9.4.3 *dealing with floods, mudslides, landslides, avalanches, and rockfalls*. In the financing step provinces play a prominent role, whereas public companies, such as the AGES, Gesundheit Österreich GmbH or the ÖÄK (Austrian Medical Chamber) are involved in the implementation step of every measure. Measures aiming at events that occur in specific regions (3.9.4.2 *dealing with heat and drought*, 3.9.4.3 see above and 3.9.4.6 *dealing with pollutants and ultraviolet radiation*) create regional public goods, and national public goods otherwise.

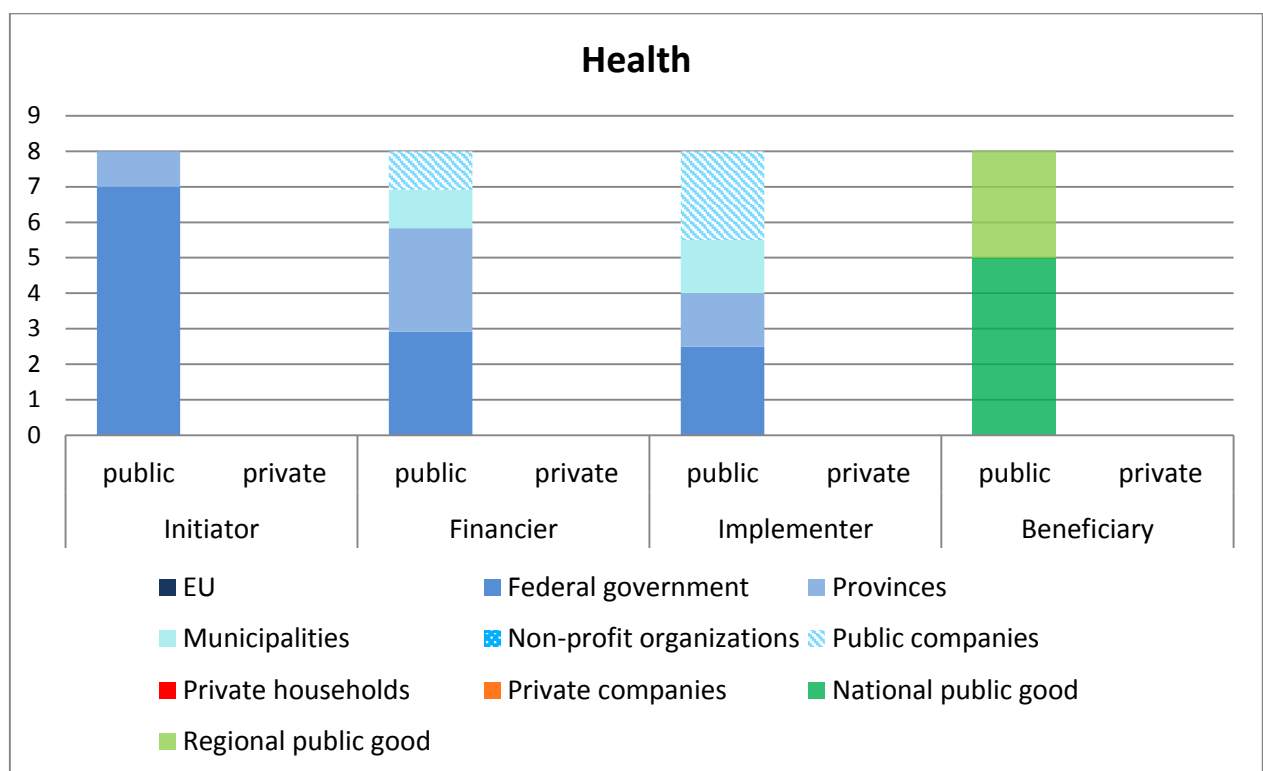


Figure 13: Public and private shares in the sequence cascade for activity field health (in weighted terms)

Ecosystems/ Biodiversity

The activity field ecosystems/biodiversity consists of 13 measures to adapt to climate change. Except for measure 3.10.4.6 *adjustments of offers for leisure and vacation activities* that is initiated by private companies, all measures are initiated by public authorities: the EU has a role in co-initiating 7 measures, but does not provide financial means. These are mainly provided by the federal government, the provinces and non-profit organizations. In general, however, it is hard to categorize expenditures in this activity field since all measures are soft or green measures, which means that they concentrate on planning instruments and the provision of knowledge and information (WEGC, 2015). It is true, however, that public authorities are responsible for (co-

Implementing all measures: 9 measures are implemented in collaboration between federal government, provinces and public companies. Private companies contribute in 4 measures, whereas private households and municipalities are jointly implementing measure 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*. This is also the only measure that creates a private good accruing to those living in the considered residential areas. In general, however, each measure creates either a regional or national public good.

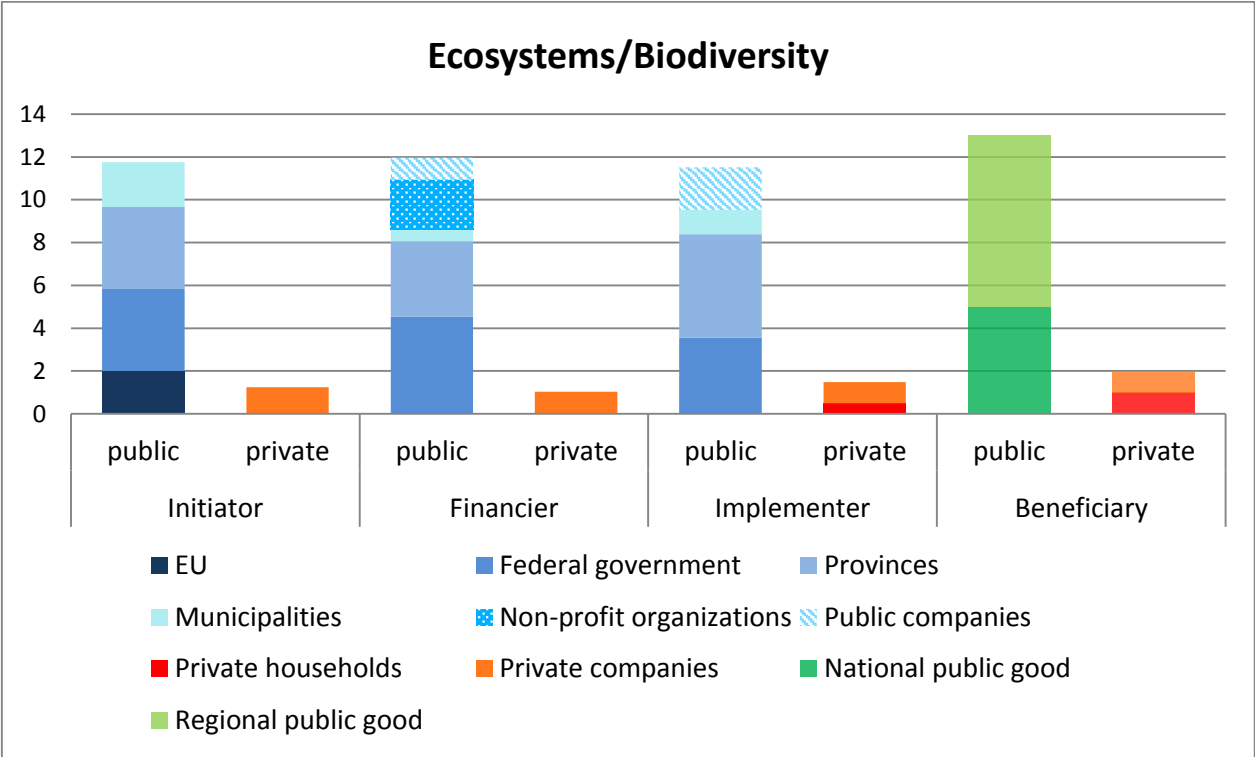


Figure 14: Public and private shares in the sequence cascade for activity field ecosystems/ biodiversity (in weighted terms)

Transportation Infrastructure

All 11 measures in the field of transportation infrastructure are initiated by the federal government. It is further the single financier of 4 measures and co-financing the other 7 measures in collaboration with primarily public actors. Private companies are co-financing 3 measures (3.11.4.2-3.11.4.4). The 3 measures including research activities (3.11.4.6, 3.11.4.8 and 3.11.4.9) are financed jointly by the EU, the federal government and provinces. When it comes to the implementation of the measures, private and public companies, such as the ASFINAG⁶ or ÖBB⁷, and non-profit organizations, such as research institutions, are largely involved. The benefits of 10 measures accrue to the whole society,

⁶ Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft (Autobahn and high way financing stock corporation). The ASFINAG is an Austrian publicly owned corporation which plans, finances, builds, maintains and collects tolls for the Austrian autobahns.

⁷ Österreichische Bundesbahn

either on a regional or national scale. Measure 3.11.4.4 *reduction of potential heat stress for passengers and personnel in public transportation through appropriate air conditioning* clearly only benefits the passengers and personnel in public transportation and is thus classified as a private good.

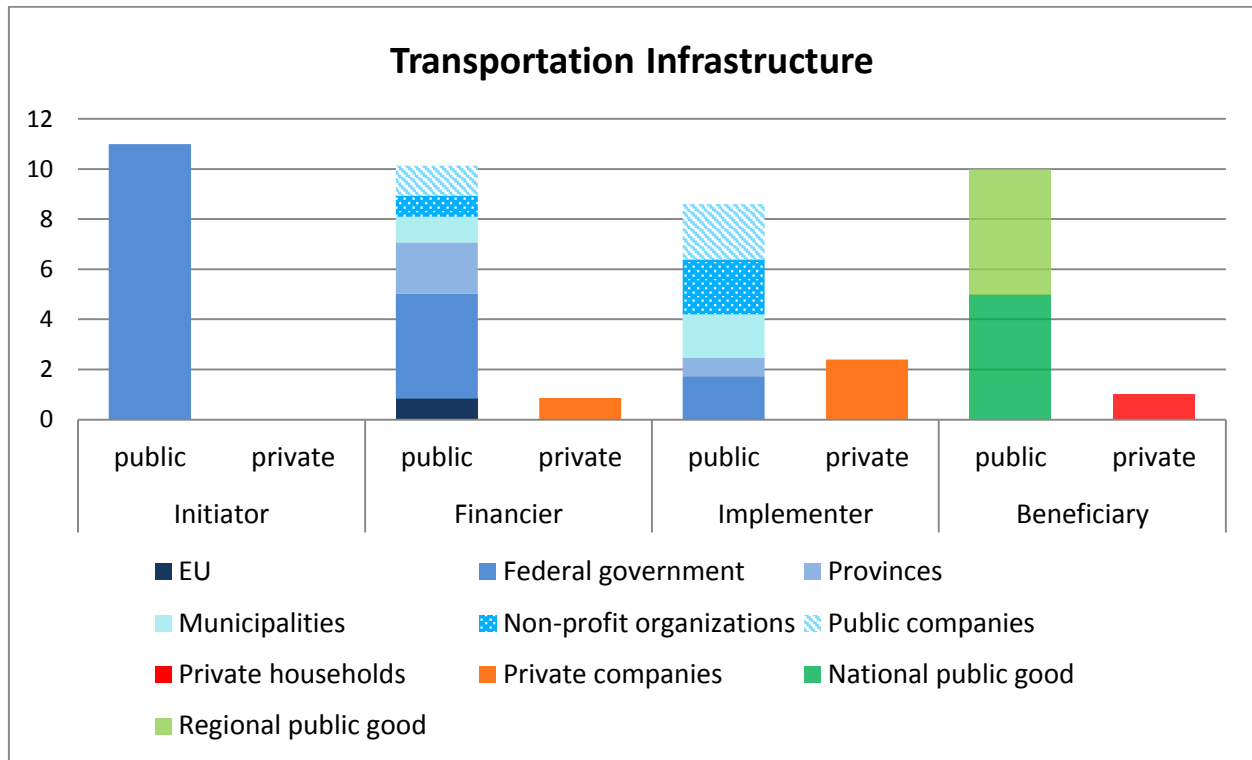


Figure 15: Public and private shares in the sequence cascade for activity field transportation infrastructure (in weighted terms)

Spatial planning

This field of activity contains 13 measures in total. Even though the Austrian Conference on Spatial Planning (ÖROK⁸) is formally managed by the federal government, spatial planning lies rather in the competence of the provinces. It follows that the provinces appear as important actors within this activity field, which is illustrated by Figure 16. In general, all measures are at least partially initiated, financed and implemented publicly. The EU imposes measure 3.12.4.2 *establishment and protection of flood retention and drainage zones and clear regulation of zoning prohibitions and restrictions*, but the largest share of measures is initiated by provinces. Measure 3.12.4.4 *regulations for the management of existing zoning and buildings in hazard zones* requires private households to co-finance with respect to property-related insurance expenditures; and measure 3.12.4.12 *"climate-proofing" of spatial plans and instruments* increases inspection and procedural efforts for private companies. Private companies are also asked to co-implement measures 3.12.4.10 *increased cooperation between spatial planning and tourism to promote a climate change-adapted, sustainable*

⁸ Österreichische Raumordnungskonferenz

tourist infrastructure and 3.12.4.10 promotion of energy-efficient spatial structures. However, in the adaptation strategy for spatial planning, private actors play a minor role compared to public actors. Except for measure 3.12.4.4 (see above), which benefits owners of real-estate property through increased security, all measures create public goods (WEGC, 2015).

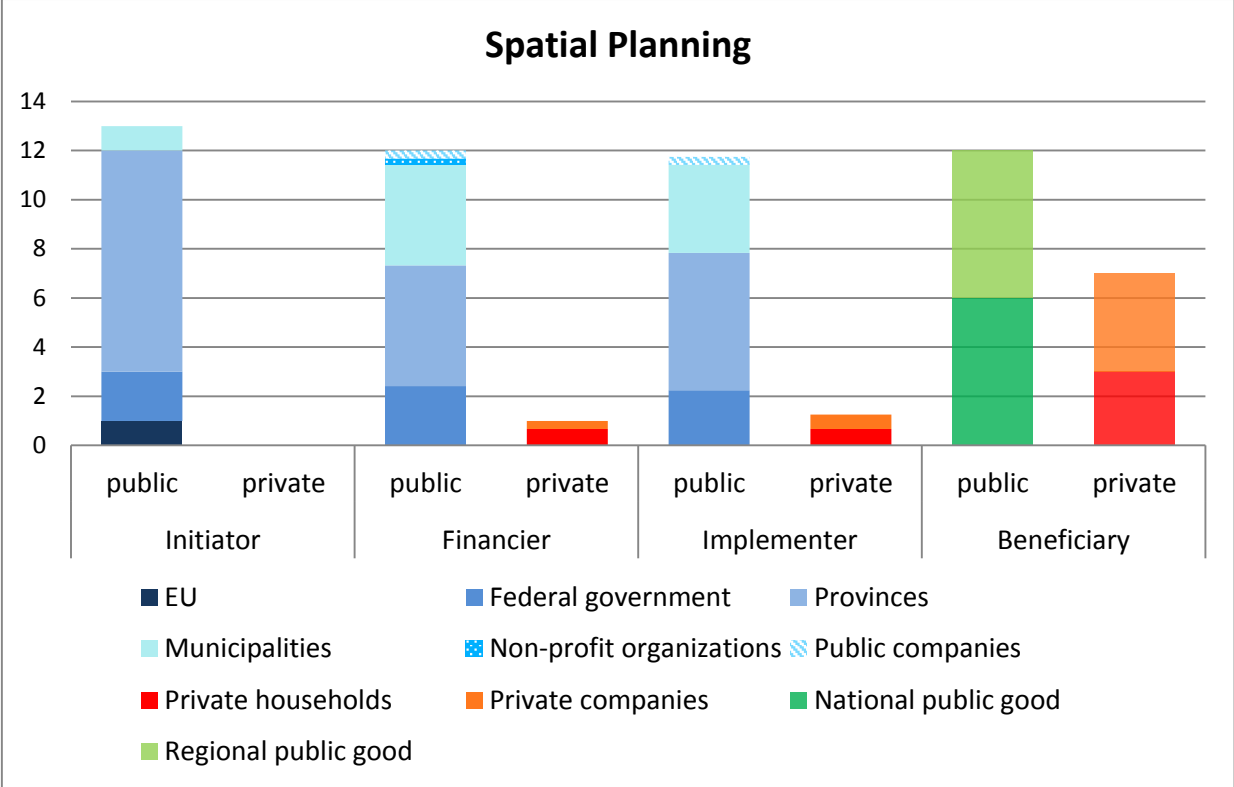


Figure 16: Public and private shares in the sequence cascade for activity field spatial planning (in weighted terms)

Business/Industry

The activity field of business/industry contains 9 adaptation measures. There is one measure that is purely private (3.13.4.9 provision of services to clients after damage claims), which means that there are only private actors involved in every step of the sequence cascade. Apart from that, all other measures are initiated by the federal government, but governmental contribution in financing and implementing is less prominent than in other activity fields. Private actors are required to contribute in the financing and implementation of every single measure. As a consequence, the created goods are also primarily private. An interesting fact is that one measures of the business/industry field is financed and implemented by private actors only, but creates a public good through easing the burden for the public disaster fund: 3.13.4.8 better risk diversification for insurers, thereby increasing the insurability of climate- and weather-induced damages. We conclude that the public sector is mainly needed as the formal initiator, through legislation in measures 3.13.4.3 (measures to increase the resilience of production, sales, and operational infrastructure) and 3.13.4.8 (see above), or through providing incentives as in measure 3.13.4.4 (increasing the security of energy supply through the

promotion of alternative/ energy-efficient technologies). More specifically, note that 4 out of the 9 measures are related to the insurance sector where private companies (insurance companies) adapt their models to climate change out of self-interest.

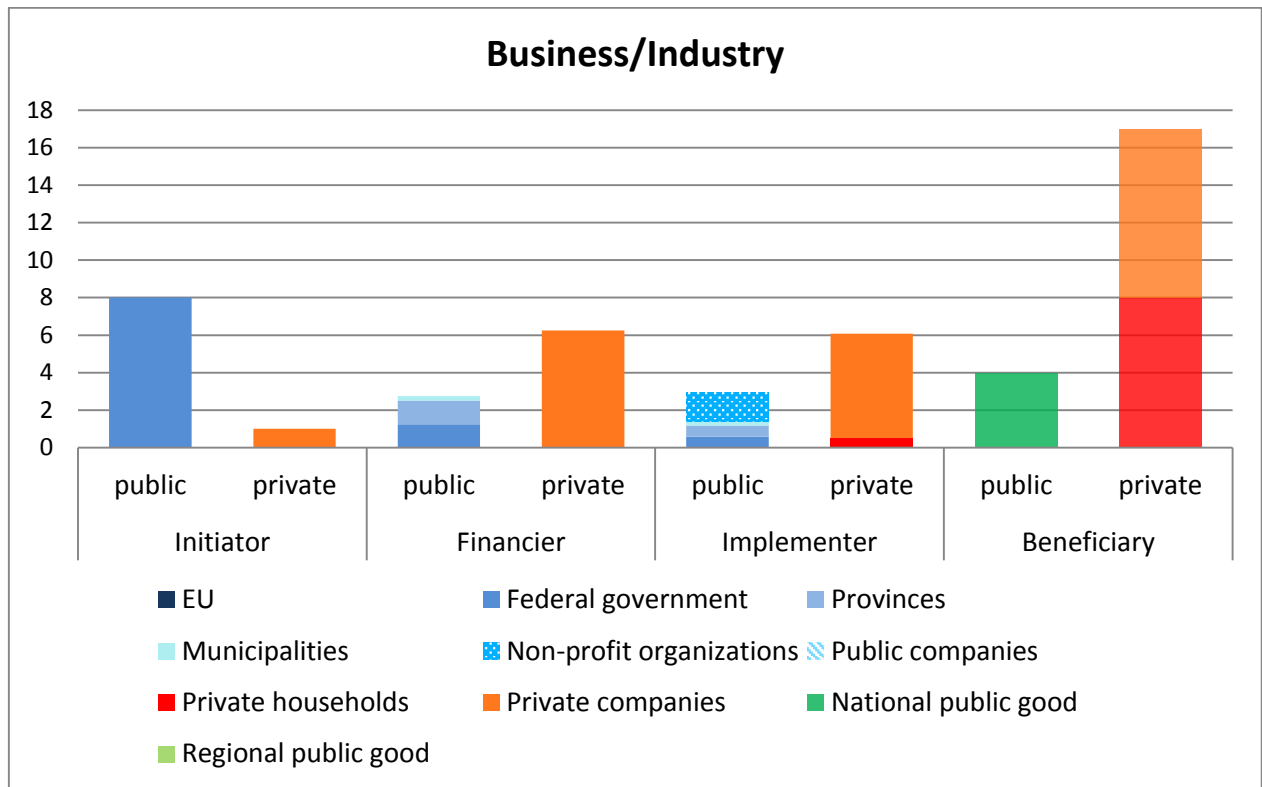


Figure 17: Public and private shares in the sequence cascade for activity field business/industry (in weighted terms)

Cities – Urban Green and Open Spaces

The field of urban green and open spaces includes 8 measures to adapt to climate change. All measures are exclusively initiated, financed and implemented by public authorities, namely federal government, provinces and municipalities. Since all measures are rather local and regional at most, municipalities are the key actors as is shown by Fig. 18. A further consequence is that all measures provide a regional public good that benefits all individuals living near the green and open spaces that are aimed to be improved with regard to different aspects (see Tab. 14 for full list of measures).

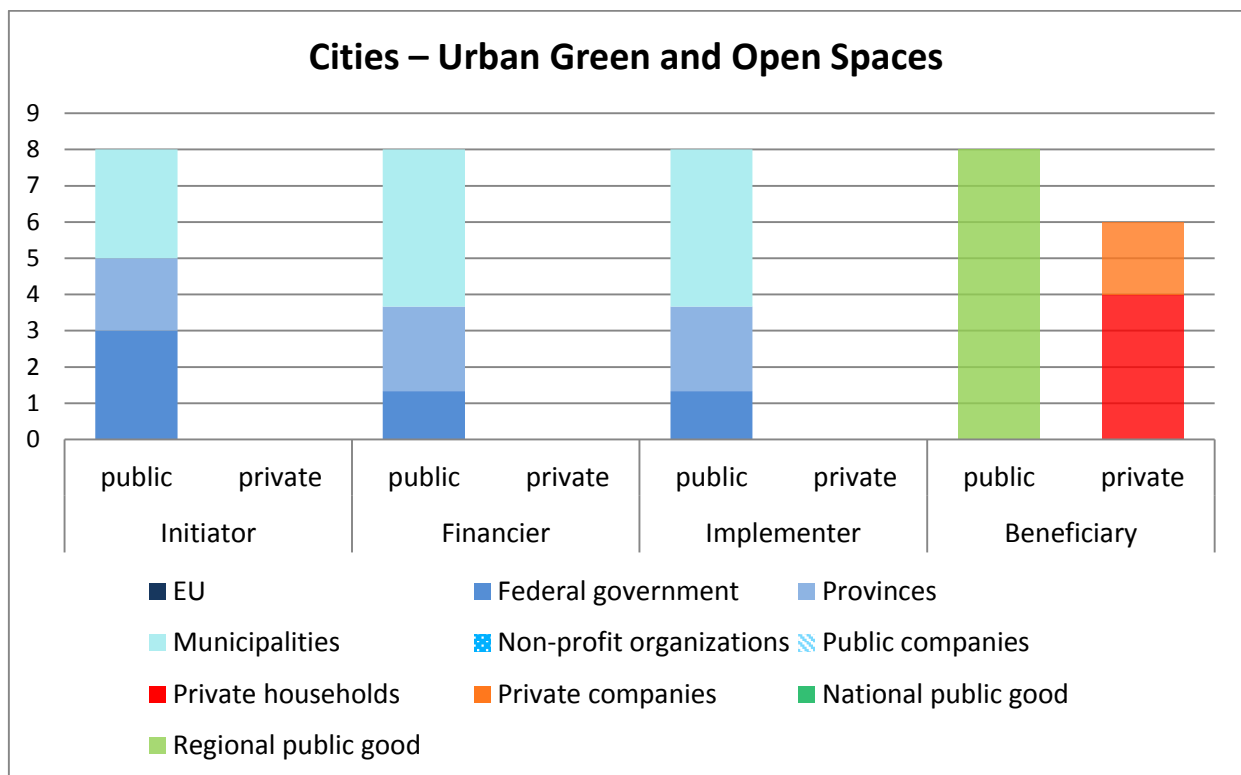


Figure 18: Public and private shares in the sequence cascade for activity field cities- urban green and open spaces (in weighted terms)

4.3. Allocation of activity fields in private-public adaptation continua

The private-public adaptation continua are presented in tables 18 and 19 for the role of the financier and the implementer, respectively. For the assignment of the activity fields, we use the method described in section 3.3.

We find significant responsibility placed to public authorities in the financing of measures in public infrastructure fields like energy, water, transport as well as health, spatial planning, construction and housing, cities and urban green, ecosystems and biodiversity, protection from natural hazards and disaster risk management. However, there is one activity field that is clearly private in the financing step: business/industry. Both the public and the private sector are required to contribute in agriculture, forestry and tourism.

When it comes to implementing the measures, private companies and households become more relevant. Activity fields like water, energy, protection from natural hazards, health, ecosystems and biodiversity, spatial planning and cities and urban green are still considered primarily public, but agriculture, forestry, tourism, construction and housing, disaster risk management, transport and business/industry lie in the intersection of public and private adaptation.

Table 18: The significance of the public sector in the role of the financier by activity fields

Predominantly public adaptation	Public and private adaptation	Predominantly private adaptation
Water Resources and Water Management Energy – Focus on the Electrical Industry Construction and Housing Protection from Natural Hazards Disaster Risk Management Health Ecosystems and Biodiversity Transportation- Infrastructure Spatial Planning Cities – Urban Green and Open Spaces	Agriculture Forestry Tourism	Business/Industry

Table 19: The significance of the public sector in the role of the implementer by activity fields

Predominantly public adaptation	Public and private adaptation	Predominantly private adaptation
Water Resources and Water Management Energy – Focus on the Electrical Industry Protection from Natural Hazards Health Ecosystems and Biodiversity Spatial Planning Cities – Urban Green and Open Spaces	Agriculture Forestry Tourism Construction and Housing Disaster Risk Management Transportation- Infrastructure Business/Industry	

What can be clearly seen by these two tables is that providing financial means for the measures is predominantly public, whereas private actors come in more prominently at the implementation step: 8 out of 14 activity fields require both public and private actors to help implementing measures. This is the case, because the implementation step of a measure typically includes several action levels and these are filled by different actors.

5. Conclusion

We conclude that Austria's public sector in general, and the federal government in particular, will be one of the main actors when proceeding with the National Adaptation Strategy. This is in contrast to the common understanding that adaptation –unlike mitigation– is mostly privately undertaken, because benefits are supposed to accrue on a rather local scale compared to the benefits of mitigation that arise globally (Agrawala & Fankhauser, 2008). It is true that the NAS includes fields that are generally attributed to the public sector, such as health or water supply, but we cannot confirm that throughout the development process of the NAS only public issues have been considered. It seems reasonable to us that some aspects of private adaptation, that is autonomous adaptation action for example, have no part in an adaptation strategy. However, it might be the case that there is more private adaptation needed than captured by the NAS. Therein though we do not see a point of criticism that less adaptation than presented in this paper is public (measured in absolute terms), but argue that there might be additional private adaptation. Contrarily, the shares of what is public and private might shift towards private adaptation.

Overall, the analyses show that there is one field of activity that needs little to no public regulations (business/industry) and others that require public intervention primarily at the initiation step (e.g. agriculture, protection from natural hazards). However, the majority of activity fields lies in the predominantly public adaptation category for financier and, thus, necessitates public authorities to not only initiate the measures, but also to finance them. As a consequence, adaptation expenditures must be considered in future public budget to prevent internal shifting of financial means in the ongoing period for achieving sufficient means. Yet, private actors have a role to play within the predominantly public adaptation measures as well, and especially in the implementation step. In almost all activity fields, private companies are co-implementing measures, such as technical measures in the construction and housing area. Moreover, a well-organized cooperation between public and private authorities and companies is required in activity fields such as agriculture and forestry, where adaptation is executed on a common level, and also between the different administrative levels in fields where primarily a mix of public actors is required to act, such as health or energy. Private households, in turn, are asked to contribute in activity fields such as disaster risk management or protection from natural hazards, where expenditures are clearly public but the implementation happens on a hierarchical lower level. Our findings are thus in line with Adger et al. (2005) who argue that the issue of adaptation might intensify existing troubles about objectives between private and public actors, and that institutional interactions at different scales need planned management to enhance cooperation.

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