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A) Projektdaten

Allgemeines zum Projekt	
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Allgemeines zum Projekt	
	Universität Innsbruck, Institut für Geographie (Tirol)
Schlagwörter:	Climate Risk Management; participatory methods; flood risk; drought risk, stochastic debt modeling
Projektgesamtkosten:	250.000 €
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B) Projektübersicht / Project overview

1 Kurzfassung

Schäden durch Klima- und Wetterextreme, wie Überschwemmungen und Dürren, haben in den letzten Jahrzehnten zugenommen und werden sich mit dem Fortschreiten des Klimawandels und der sozioökonomischen Entwicklung noch ausweiten. Österreich ist dabei überwiegend Hochwasser- und Dürreereignissen ausgesetzt, die oft gravierende soziale und wirtschaftliche Folgen nach sich ziehen. Solche klimarelevanten Risiken werden bereits heute im Rahmen des Naturgefahrenmanagements sowie der Klimawandelanpassung aufgegriffen und bewältigt. Um jedoch diese Klimarisiken noch effektiver zu managen, sollten diese beiden Bereiche unter dem Dach des Klimarisikomanagements (KRM) verknüpft werden (Jones et al., 2014). Ein pro-aktives KRM ist essenziell, um den Herausforderungen an dieser Schnittstelle wirkungsvoll zu begegnen.

Übergeordnetes Ziel von RESPECT war es, die Einführung eines umfassenden KRM in Österreich wissenschaftlich zu unterstützen. In enger Zusammenarbeit mit relevanten Stakeholdern verfolgte das RESPECT-Projekt folgende Ziele: (1) Zusammenstellung von Klimarisikoinformationen für Österreich, einschließlich Risiko Governance Aspekte; (2) Verwendung dieser Informationen zusammen mit einer räumlichen und zeitlichen Risikobewertung, zur Ermittlung des aktuellen Klimarisikos, sowie möglicher zukünftiger Szenarien und Interventions-maßnahmen; (3) Identifizierung von Rollen und Verantwortlichkeiten im KRM durch den Einsatz partizipativer Forschungsmethoden auf lokaler Ebene; (4) Ermittlung der potenziellen fiskalischen Risiken für Österreich, wenn implizite und/oder explizite klimabedingte Risiken im öffentlichen Haushalt schlagend werden; (5) Schließung der Lücke zwischen Forschung, Praxis und Politik in Bezug auf ein umfassendes KRM in Österreich.

Der erste Schritt des RESPECT-Projekts bestand darin, die aktuellen Entscheidungs- und Politikgestaltungsprozesse im KRM auf lokaler und nationaler Ebene zu analysieren. Aufbauend auf dieser Analyse, wurden digitale Karten für das Hochwasser- und Dürrerisiko in Österreich entwickelt, welche auf umfassenden Klima- und sozioökonomischen Daten beruhen. Diese Karten und Daten wurden in Fallstudien auf nationaler und lokaler Ebene eingesetzt. Auf lokaler Ebene wurde eine Rollenspielsimulationen entwickelt, um Rollen und Verantwortlichkeiten im KRM partizipativ zu identifizieren und zuzuordnen. Auf nationaler Ebene wurde ein Modell zur stochastischen Schuldensimulation entwickelt, um potenzielle Eventualverbindlichkeiten des öffentlichen Sektors aufgrund des aktuellen und zukünftigen Hochwasserrisikos zu bewerten.

Die Stakeholder-Analyse ergab, dass KRM (noch) nicht explizit in die österreichische Risikomanagementlandschaft eingebettet ist. Unsere Ergebnisse zeigen, dass es an dieser Schnittstelle in Österreich auf verschiedenen Ebenen erheblichen Verbesserungsbedarf gibt. Gemeinsam mit österreichischen Stakeholdern wurden verschiedene Maßnahmen entwickelt um das KRM Konzept in die politische und institutionelle Risiko-Governance-Landschaft Österreichs zu integrieren. Zum Beispiel wurde die Einrichtung eines nationalen Klimarisikorates, der für die zentrale Koordinierung der großen Anzahl von AkteurInnen im KRM zuständig ist, vorgeschlagen.

Aufbauend auf einer umfassenden Indikator- und Literaturdatenbank wurden insgesamt 87 Indikatoren für die sozioökonomische und physische Vulnerabilität hinsichtlich Überschwemmungen sowie für die sozioökonomische Vulnerabilität hinsichtlich landwirtschaftlicher Dürren entwickelt. Danach wurden die Vulnerabilitätsindizes in Klimarisikobewertungen, mit besonderem Schwerpunkt auf Hochwasser, integriert. Im Mittelpunkt dieser Bewertung stand die Integration verschiedener Indikatoren durch den „Geon-Ansatz", der darauf abzielt, homogene Einheiten von Vulnerabilität / Risiko zu modellieren, die von administrativen Grenzen unabhängig sind.

Die in der lokalen Fallstudie verwendete Rollenspielmethode erwies sich als vielversprechendes partizipatives Format für die Förderung von KRM in der Praxis. In einer ersten Bewertung der Methode stellten die TeilnehmerInnen fest, dass die verschiedenen Stakeholder auf diese Weise die wichtige Möglichkeit zum Austausch erhalten und dass das Konzept, die Rolle eines anderen Stakeholders zu übernehmen, ein hohes Potenzial hat, das Verständnis und die Akzeptanz der verschiedenen Interessen zu fördern. Die Rollenspielmethode wurde in einem Handbuch dokumentiert, welches zur Unterstützung der Anwendung des Rollenspiels in der Praxis allen AnwenderInnen frei zur Verfügung steht.

Ein stochastisches Schulden-Simulationsmodell wurde entwickelt um mögliche Eventualverbindlichkeiten des öffentlichen Sektors aufgrund des gegenwärtigen und zukünftigen Hochwasserrisikos zu bewerten. Die Ergebnisse deuten darauf hin, dass Klimaextreme an sich auch in Zukunft keinen kritischen fiskalischen Druck auf Österreich ausüben werden. Gleichzeitig muss die bestehende Ex-ante-Regelung des österreichischen Katastrophenfonds im Hinblick auf einen längerfristig ökonomisch nachhaltigen Umgang mit extremen Hochwasserrisiken kritisch überprüft werden. Die Methodik kann auch in anderen EU-Mitgliedstaaten angewandt werden, potenzielle fiskalische Auswirkungen eines breiteren Spektrums von Naturgefahren, z. B. Hitzewellen und Dürren, berücksichtigen und auf öffentliche Kosten für den Klimaschutz und die Anpassung an den Klimawandel ausgedehnt werden.

2 Executive Summary

Damages caused by climate and weather extremes have increased over the last decades and will likely only broaden with the progression of climate change and socioeconomic development. Austria is largely exposed to floods and droughts, which often bring grave social and economic consequences with them. Such climate-related risks are already being tackled within the framework of natural disaster risk management (DRM), as well as climate change adaptation (CCA). However, to manage these climate-related risks more effectively it is necessary to link DRM and CCA to develop approaches more comprehensively, leading to what has been broadly referred to as climate risk management (CRM) (Jones et al., 2014).

The overarching aim of RESPECT was to support the implementation of comprehensive CRM in Austria. Working closely with relevant stakeholders, the RESPECT project pursued the following objectives: (1) Compilation of climate risk information for Austria, including risk governance aspects; (2) Application of this information, together with a spatial and temporal risk assessment, to identify current risk levels, possible future scenarios, and potential intervention measures; (3) Identification and allocation of roles and responsibilities in CRM via participatory research methods at the local level; (4) Identification of the potential fiscal risks for Austria, if implicit or explicit climate-related risks become striking in public budgets; (5) Closing the gap between research, practice, and policy regarding comprehensive CRM.

The first step of the RESPECT Project was to analyze the current processes of CRM decision and policy-making at the local and national levels. RESPECT then built upon this analysis and developed digital maps for flood and drought risks in Austria, comprising complete and accessible climate and socioeconomic data. The data was integrated in case studies at the national and local level and was used to develop appropriate methods and instruments that can be implemented at both levels in the scope of CRM. At the local level, we developed and applied role-play simulations for identifying and allocating roles and responsibilities in CRM, at the national level a stochastic debt simulation was developed and employed to assess potential contingent public sector liabilities arising from current and future flood risk.

The stakeholder analysis revealed that CRM is not (yet) explicitly embedded in Austria's risk management landscape. Instead, the consideration of climate risks in decision-making depends mostly on the initiative of individual actors acknowledging the importance of a more holistic approach. Our results show that there is considerable room for improvement and better cooperation at the interface between DRM and CCA at different scales in Austria. Several measures were co-developed with Austrian stakeholders to help embed CRM in Austria's political and institutional risk governance landscape. For example, establishing a national climate risk counsel with the responsibility to centrally coordinate the substantial number of actors at the interface of DRM and CCA.

Building on a comprehensive indicator and literature database, a set of overall 87 risk indicators for the socio-economic and physical vulnerability dimension for floods, and for the socio-economic vulnerability dimension for agricultural droughts was developed. In a later stage, the vulnerability indices were integrated into risk assessments, with a special focus on floods. At the center of the climate risk and vulnerability assessment, was the integration of various indicators through the 'geon approach', which aims to model homogenous units of vulnerability/risk that are independent from administrative boundaries. The choice and identification of vulnerability and risk indicators was done with utmost scientific rigor. In the future it should be reflected with end-users if such a science-based indicator framework is expected and/or if the focus should rather be on selected key indicators only.

The role-play method utilized in the local level case study turned out to be a promising participatory format for fostering CRM in practice. In a first evaluation of the method, participants appreciated that the different stakeholders in CRM get the opportunity for exchange and that the concept of taking on the role of another stakeholder has a high potential to raise the understanding and acceptance of the different interests and resources amongst them. The RESPECT role-play concept can be a great asset to support real CRM decision processes, and can be an integral part of a comprehensive participatory process. The role-play method is documented in a guidebook to aid scientists, experts and municipalities and regions facing concrete climate-related risks, who are interested in further developing and/or applying participatory tools for operationalizing CRM in practice.

A stochastic debt simulation model was developed and employed to assess potential contingent public sector liabilities arising from current and future flood risk. The results indicate that climate extremes per se are unlikely to put significant fiscal pressure on Austria. At the same time, the existing ex-ante arrangement of the national disaster fund has to be critically reviewed in terms of dealing with extreme flood risks in a fiscally sustainable way over the longer term. The stochastic debt modeling approach can be replicated in other EU member states, incorporate potential fiscal impacts of a broader range of natural hazards, e.g., heatwaves and droughts, and be expanded to include public cost for climate change mitigation and adaptation.

3 Hintergrund und Zielsetzung / Background and goals

Damages caused by climate and weather extremes have increased over the last few decades and will likely only broaden with the progression of climate change and socioeconomic development. Austria is largely exposed to floods and droughts, which often bring grave social and economic consequences with them. Such climate-related risks are already being tackled and overcome within the framework of natural disaster risk management (DRM), as well as climate change adaptation (CCA). However, to manage these climate-related risks more effectively it is necessary to link DRM and CCA to develop approaches more comprehensively, leading to what has been broadly referred to as climate risk management (CRM; Figure 1) (Jones et al. 2014).

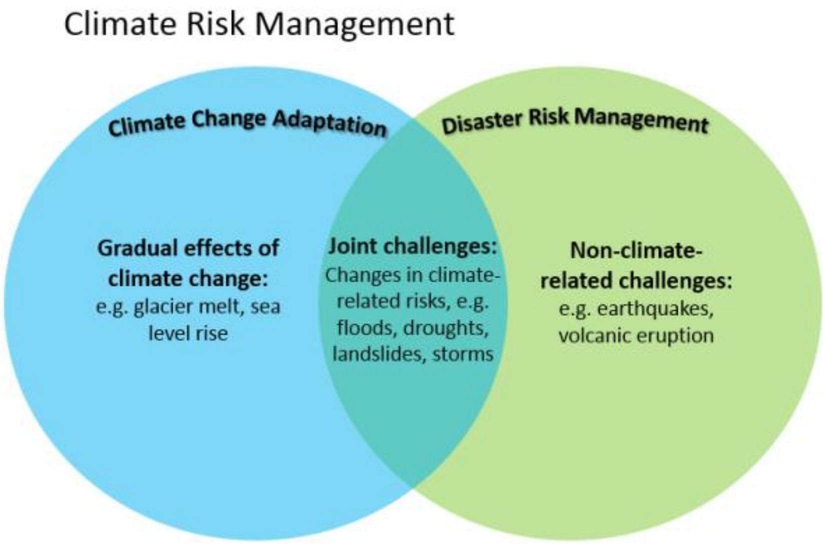

***Figure 1**: CRM - Tackling joint challenges of DRM and CCA*

CRM aims to include private actors (citizens, companies, insurance providers, NGOs) as well as public actors (public administration on the municipal, provincial, and national level), as both their efforts are considered crucial to manage potential future climate-related risks. In addition to the relevance of insurance, to date it has been public sector risk management that has played a significant role in the application of proactive risk management approaches. Governments' central position in disaster risk management (DRM) is due to its fundamental role in providing public goods and services and redistributing income (Mechler 2004). While losses due to extreme hazard phenomena can be high, governments usually treat disaster risk as a contingent liability, i.e., costs that accrue only in the case of an event. As a result, governments have often ignored catastrophic risks in their budget planning, and implicitly or explicitly exhibit risk-neutrality (Mechler 2004; Gurenko 2004). Given that climate change is expected to increase extreme event risk in the foreseeable future, embedded in a complex fiscal and economic context in the EU with many other stress factors (e.g. the increasing costs of demographic change in an ageing society), the challenge of achieving a sustainable fiscal pathway is at the top of the public policy agenda.

In general, there is good and increasing understanding that joint action in terms of building multi-stakeholder partnerships between private and public actors is essential, yet their respective and collective roles and responsibilities are blurry and subject to negotiation (based on insights gained in former ACRP projects like PATCH:ES, PACINAS, ARISE, and the EU FP7 project ENHANCE): Many risks affect private as well as public goods; legislation and policy practice (e.g. in Austria) has evolved over the years towards a partly explicit, partly implicit understanding of each actors' roles in preventing, financing, responding to or recovering from risks and events linked to natural hazards; actions undertaken by one actor may limit or widen the room to maneuver of, or the actions expected from other actors, and may encourage inaction or free-riding behavior. These roles are being discussed and renegotiated continuously: i.e. the role insurance in a changing climate is a constant topic of contested debate in Austria and other EU countries (see ACRP InsAdapt project). Applied policy-relevant research is called upon to generate appropriate methods and tools to disentangle the complex distribution of competencies and responsibilities in order to take CRM to more effective levels.

As part of a CRM approach, the concept of risk layering has seen increasing attention (Schinko et al. 2016; Mechler et al. 2014). Risk layering involves identifying efficient and acceptable interventions based on the recurrence of hazards and allocating roles and responsibilities to reduce, finance or accept risks. Disaster risk is complex, as it lumps together frequent events with minor impacts, and infrequent but devastating catastrophes. Not all disaster risk can be eliminated, and it is imperative to know which risks should be reduced, which insured against and which will require governmental or international aid efforts. To this effect, segregating risk according to risk preference via risk layering has raised general interest in several areas of risk policy and management (e.g., agriculture, finance and insurance). Yet, risk layering has been operationalized exclusively for instrumental debate in the insurance sector (Cummins and Mahul 2008; Mechler et al. 2016). Some methodological development has occurred with regard to empirical and modelling analysis of climate-related fiscal risk and finance implications (see e.g., Schinko et al. 2016; Hochrainer et al. 2014), yet this has not been linked to innovative stakeholder engagement, such as policy exercises or role-play, particularly at lower governance levels, such as municipality level.

Against this background, the overarching goal of RESPECT was to support the implementation of comprehensive CRM in Austria. More specifically, the RESPECT project pursued the following objectives: (1) A compilation of climate risk information for Austria; (2) Application of this information, in combination with a spatial and temporal risk assessment, to identify current risk levels, possible future scenarios, as well as potential intervention measures; (3) Identification and allocation of roles and responsibilities in CRM through participatory implementation of the risk portfolio methods at the local level; (4) Identification of the potential fiscal risks for Austria if implicit or explicit climate risks are undertaken by public and private actors and become striking in the public budget balancing; (5) Closing the gap between research, practice, and politics regarding comprehensive CRM; (6) Integration of information at different administrative levels to reconcile local and national needs, as well as courses of action.

4 Projektinhalt und Ergebnis(se) / Content and results

To meet the objectives and to answer the associated key research question RESPECT was structured around six work packages, which were strongly interlinked and arranged in an order that ensures a smooth and logical workflow. RESPECT first set out to assess the current CRM decision and policy making context in Austria in order to understand at which point scientific and civil society input is needed, in which form it is most effective, and what kind of information is needed (WP1). Then the project conducted –building on the IPCC’s framing of risk as the nexus of hazard, exposure and vulnerability – a mapping of flood and drought risk in Austria, synthesizing multiple and available climate- and socio-economic data for the national and local level case studies (WP2). Appropriate methods and tools for operationalizing CRM and risk layering in Austria at the national level (fiscal risk assessment with a stochastic longer-term budget analysis) and the local level for the city of Lienz (role-play simulation addressing local risks as jointly identified via the 'Local Reasons for Concern'- approach developed in the ARISE project) were developed and each employed in a specific case study to proof the effectiveness of the respective concept and eventually support its operationalization (WP3). Throughout the project we linked the Austrian case to the broader international CRM decision context. Building on the lessons learnt from the Austrian case, we synthesized information towards a more generic approach informing CRM practice also in other decision contexts (WP4). WP5 dealt with project management, while WP6 focused on internal and external communication and outreach, to ensure that the knowledge produced in the project is made publicly available.

WP1: Revisiting the Austrian climate risk governance- and decision context

The first objective of WP1 was to identify and map CRM stakeholders in the areas of flood risk and drought risk management, with a particular focus on national level actors. These two climate-related risks were chosen as the focus throughout RESPECT, as they are particularly relevant for Austria. To assure maximum comprehensiveness, we adopted an inclusive definition of stakeholders, following Grimble and Wellard (1997:3-4) suggesting that stakeholders are „ […] any group of people organized, who share a common interest or stake in a particular issue or system“. Consequently, in WP1 a large inventory of CRM actors was developed, ranging from the national level (e.g. ministries) to the local level (e.g. local council, private households).

The key method applied in WP1 was a systematic stakeholder analysis (Freeman 1984), which appeared the most suitable instrument to capture information about relevant actors, allowing to draw conclusions about their interests, motivations, behaviors and decision processes (Reed et al. 2009; Brugha and Varvasovsky 2000). The multi-level perspective of stakeholder analysis (Varvasovszky and Brugha 2000) was essential because issues evolving around climate risk governance concern all political and institutional levels. A stakeholder analysis was applied to purse two distinct objectives: (1) to identify relevant CRM stakeholders at different levels, and (2) to assess the existing risk governance landscape, including decision structures, cooperation, and existing and future challenges.

To conduct the stakeholder analysis, we adopted a systematic approach, building on Reed et al. (2009). After a screening of the existing literature on Austria's risk governance landscape a tentative list of stakeholders was compiled. In a next step, personal (face-to-face) interviews were conducted with 14 selected stakeholders (despite only 5–7 telephone interviews were suggested in the RESPECT project proposal) to identify the responsibilities and activities of the stakeholders and to generate detailed insights into the governance structure, challenges and actor relations. Prior to the interviews, an interview guideline was developed to ensure that all interviewers address a consistent set of topics.

Finally, two separate CRM stakeholder maps were compiled with one focusing on flood risk (see Figure 2) and the other one on drought risk. In order to understand at which point scientific and civil society input is required (another target of WP1), CRM activities were mapped against each stage of the CRM cycle in two separate stakeholder activity matrices (see Figure 3 for drought risk).

To the best of our knowledge, this project is the first attempt to identify and systematically map the actors that play a relevant role in CRM in Austria. The two stakeholder maps, one for flood risk and one for drought risk, were developed with close consultation of stakeholders in WP1 (personal fact-to-face interviews, two stakeholder workshops) and provide a comprehensive overview of the CRM landscape in Austria. The stakeholder maps reveal that CRM stakeholders operate across all four levels assessed in WP1: international, national, regional and local. While the scope of some actors is limited to a distinct level (e.g. local council), the activities of other stakeholders can span several levels, such as the chamber of agriculture which is a country-level institution but also has provincial branches. Universities and research institutions for instance, may be involved in international research projects, but also provide information and data on a local level (e.g. down-scaled climate change projections, numbers of heat days, precipitation forecasts etc.).

A close inspection of the stakeholder activity matrices, developed based on the stakeholder and institutional mapping, revealed that almost all stakeholders consider scientific input essential; however, the inherent uncertainty of climate models is regarded as a severe limitation and therefore makes the consideration of climate risks in decision-making a major challenge. In combination with the insights gained in the two stakeholder workshops, our results show that CRM is not (yet) established in Austria's institutions. Instead, the consideration of climate risks in decision-making depends on the initiative of individual actors acknowledging the importance of a more holistic approach (e.g., taking into account consequences of climate change when natural hazard maps or flood risk management plans are being revised or new flood defense schemes are developed). In addition, there is a clear agreement on the importance of CRM to effectively manage present and future climate risks. Two of the common themes that emerged from our analysis are related to the difficulties that arise with the high degree of uncertainty in climate models and the importance to raise awareness for climate related risks among the general population.

Two subsequent stakeholder workshops (one in project year 2, another one in project year 3) were conducted to engage stakeholders with the concept of CRM and to elicit insights into how the existing risk governance landscape shapes their decisions (another target of WP1). Moreover, the stakeholder workshops were used to develop potential measures in close cooperation with stakeholders that help overcome the lack of integration of present and future climate risks (projected climate change impacts) into disaster risk management.

Two innovative approaches to systematically establish CRM in Austria are the institutionalization of a national climate risk counsel and the publication of a periodical climate risk report. These measures would allow to centrally manage several climate risk related issues, bring together actors, create networks around climate risk management, and to make information on climate risks readily available for all interested parties.

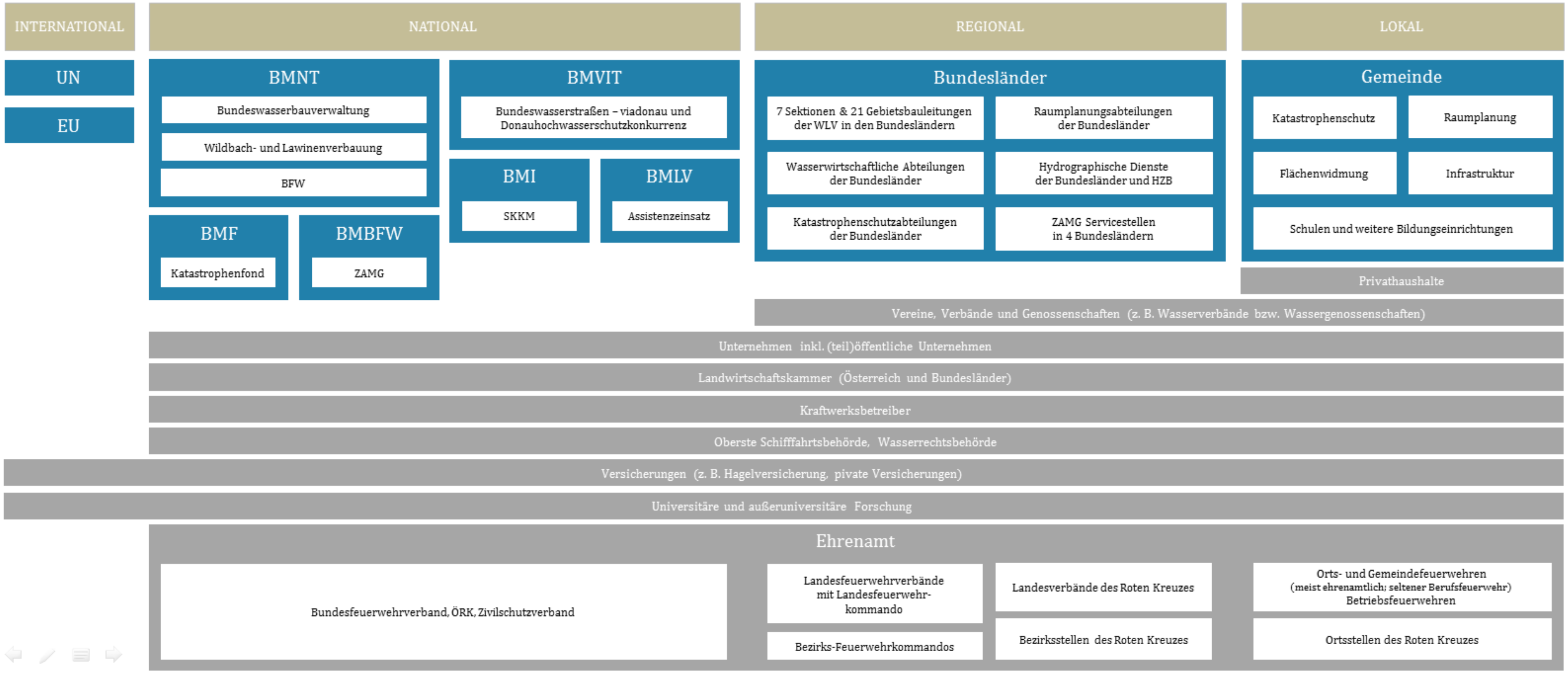

***Figure 2**: Climate Risk Management stakeholder map: Flood risk*

Stakeholder	1. KRM-Bestandsaufnahme	2. Klimarisiko-Analyse	3. KRM-Maßnahmen	4. KRM-Umsetzung					Monitoring und Evaluierung 1	Monitoring und Evaluierung 2
				4.1 Prävention	4.2 Vorbereitung	4.3 Bewältigung	4.4 Regeneration			
Hagelversicherung		- Eigene Abteilung "Meteorologie" - Aufbereitung und Nutzung von Satelliten- und Wetterdaten		- Aktivitäten im Bereich der Bewusstseinsbildung	- Eigenes Warnsystem (HV-Warncockpit) für Landwirte - Aufbereitung und Nutzung der Daten von der ZAMG		- Versicherung von Landwirten, Gärtnern, Wein- und Obstbauern gegen die Folgen außergewöhnlicher Wetterereignisse - Dürreversicherung inkl. Indexversicherung, Frostdeckung, Überschwemmungsdeckung - Schadensmeldungen und Schadenserhebung größtenteils am Schadensort		- Identifizierung von "Hotspots" durch die Analyse von Schadensdaten	
Landwirtschaftskammer				- Aktivitäten im Bereich der Bewusstseinsbildung - Beratende Tätigkeiten (z. B. wassersparender Anbau und Sortenwahl für Dürregebiete, Fruchtfolgeanpassung etc.)	- Frühwarnsystem im Form einer Online-Applikation					- Programm der ländliche Entwicklung, wird alle 6 Jahre evaluiert - Klimaanpassung und Erosion sind Teilbereiche
ZAMG									- Im Bereich der Hitzeschutzpläne wird Häufigkeit der Warnungen dokumentiert und welche Maßnahmen gesetzt wurden - Evaluierung allerdings schwierig - Erstellung von Karten für die Abschätzung der Waldbrandgefahr	
BMNT Forstwirtschaft		- Kontakt mit Bundesländer hinsichtlich erwarteter Schäden durch den Borkenkäfer	- Forstliche Raumplanung, Schutzwald und nachhaltige Entwicklung der Waldressourcen - Waldstrategie 2020+ (inhaltlich auch Klimawandelanpassung und Naturgefahren behandelt) - Koordinative Rolle - Möglichkeit von Verordnungen und Erlässen - Weitere Aktivitäten: Förderungen und Empfehlungen							
BFW	- Trockenheit und Hitze neuere Felder in denen Expertise aufgebaut werden muss									
BMNT Landwirtschaft	- Osttirol als Hotspot für Trockenheit, insbesonders kleinräumige Gebiete - Problematik im pannonischen Raum stärker ausgeprägt	- Analyse-Fokus liegt auf witterungsbedingten Ereignissen (z. B. Dürre, Sturmschäden, Hochwasser, Frost (Obstkulturen) und Wetterunbilden (Einfluss auf Ertragsleistung der Landwirtschaft)) - Hauptsächlich Einsatz von Drittanbieter-Tools für Risikoanalysen, insbesondere Gefährdungskarten					- Einzelstaatliche Maßnahmen, z. B. im Rahmen der Co-Finanzierung der Hagelversicherung (Finanzierung über Katastrophenfonds, Abwicklung über das BLFUW)			
Hydrographischer Dienst Salzburg			- Thema in der allgemeinen Wasserwirtschaft - Schwerpunkt auf Strategien für die Wasserversorgung (z. B. bei Trockenheit)							

Figure 3: *Stakeholder activity matrix: Drought risk*

WP2: Synthesizing climate risk information for Austria

In the scope of WP2, indicators are defined with respect to a certain purpose or goal, in this case the assessment of climate change related flood and agricultural drought risk. Moldan and Dahl (2007) define indicators as "symbolic representations […] designed to communicate a property or trend in a complex system or trend in a complex system or entity". They are different from raw data and statistics in that they incorporate reference values, as for example benchmarks, thresholds and targets (Moldan and Dahl 2007, Kienberger et al. 2009). It is important that the indicator selection process is driven by the validity of indicators rather than starting from the search for available data. This ensures that indicators are context-specific. However, indicators are usually data-driven to some extent, meaning that the availability of data also determines the choice of indicators (Birkmann 2007).

We collected indicators as a baseline repository or database for the national level assessment. The structure of this indicator database was derived from a combination of the MOVE framework (Birkmann et al 2013) and a template for indicator aggregation and an indicator and data fact sheet, both supporting documents of the Vulnerability Sourcebook by Fritzsche et al. (2014).

The mental frame guiding the indicator selection process was the relevance of indicators for the national assessment for Austria as well as to the flood and drought hazards and the vulnerability domain (and dimension) it is associated with. Additionally, suitable and appropriate data to feed an indicator had to be available in general and – except for the census data, which is provided by Statistik Austria for a fee – had to be accessible open access/without costs. An additional criterion for the choice of appropriate indicators was that data to populate an indicator needs to be available nationwide and on the basis of a 1 km² grid or can be aggregated to a 1 km² grid. Furthermore, we aimed to avoid indicators holding redundant information. By aggregating the existing, partly redundant indicators and thus revealing the most meaningful ones, the indicator database could be condensed to the most important and prominent indicators. The result was a list of indicators to use for the risk assessment, distinguished by the three different components of risk – hazard, exposure and vulnerability – and, in the case of vulnerability, by its subordinate dimensions. In most cases, sub-indices needed to be developed, providing the opportunity to weight specific sub-indicators (Kienberger et al. 2014).

For the exposure component, different data was selected depending on the two vulnerability dimensions, physical and socio-economic. Jones and Andrey (2007) used the total population and population density to reflect potential exposure in their social vulnerability index. The latter additionally provides an indirect measure of time necessary for evacuation (Jones and Andrey 2007). As not only the place of residence of people can be relevant to risk since damaged assets, infrastructure or workplaces can show various impacts on people's lives as well, we used an extended version of such a population (density) indicator.

Consequently, for the exposure component to combine with socio-economic vulnerability, data on the permanent settlement area was used. This data was provided in the shapefile format and as open access by Statistik Austria (Statistik Austria 2017), which indicates a (potential) possibility for people to settle or to already be settled in that area. This was considered the critical criterion to be relevant for socio-economic vulnerability. For the risk index construction in combination with physical vulnerability (for floods), we decided on a different exposure indicator. However, too much area containing physical assets, such as infrastructure, had been excluded in this dataset, presumably because of the population threshold mentioned before. Consequently, we decided to use a land cover classification excluding the CLC class water bodies for obtaining the exposure component indicator data for the risk assessment in combination with physical vulnerability, assuming a potential exposure for physical assets and infrastructures at any other location within the study area. For the exposure component, there is neither future scenario data available, nor data the future developments could be approximated with. For this reason, exposure was held constant on basis of the present-day conditions in order to assess the risk for the years 2050 and 2100.

A holistic approach towards vulnerability is complex to assess and is not yet covered by any existing dynamic or numerical modelling approaches. Consequently, the identification of a set of indicators reflecting the physical and socio-economic dimensions of vulnerability to floods and agricultural droughts was given special emphasis. For each of the three assessment dimensions a set of indicators was developed, comprising 40 indicators for the socio-economic flood vulnerability, 30 indicators for the physical flood vulnerability and 15 indicators for the socio-economic drought vulnerability. Data was populated from various public and open-source database, ranging from statistical data, road networks, and climate change data (ÖKS15).

In a next step, a correlation analysis of the indicators was carried out, to identify highly correlated indicators following the recommendation of (Saisana 2012). A few indicators were required to be excluded. Before weighting and aggregating the sub-indicators to sub-indices (composite indicators), the input variables needed to be normalized as they had different units of measurement and value ranges. Consequently, in order to make data comparable, the different datasets were normalized through a linear min-max normalization (de Lange and Nipper 2018). The min-max normalization is a special case of the normalization via a lower and an upper threshold, which transforms the initial values to a value range between a certain lower and upper threshold. The weighting of the indicators was done on a normative basis through expert choice by the authors. Where required, an aggregation to sub-indicators was carried out through a weighted mean approach.

The vulnerability units were derived from the composite vulnerability indicators. For this purpose, a regionalization approach applied to multidimensional data, as the one object-oriented image analysis is offering, was appropriate (Kienberger et al. 2009). Through the assignment of weights to each input layer as well as the choice of shape values (compactness versus smoothness) and a scale parameter, the size and shape of the final homogeneous units and the final index value itself can be influenced (Hagenlocher et al. 2013). In the absence of justifiable weights, we chose to apply equal weighting to combine the composite indicators. Subsequently, a vulnerability index (V) was determined, calculating the weighted vector magnitude – the length of the vector for each region – considering the different layers (v1, v2, …, vn) in the multidimensional indicator space. The final index values were normalized again within a zero to 100 scale range. Finally, to derive a risk index value, the vulnerability units were combined through a geometric mean approach with the hazard layer. The vulnerability units included already the exposure layer.

The very final step was to visualize the results as digital maps. In general, the flood risk and vulnerability maps (see Figure 4) reflect the topography, as risk and vulnerability decrease or disappear towards the mountainous terrain of the Alps. Furthermore, flood risk and vulnerability tend to concentrate around settlement and transport axes across the country. Urban centres were shown to be at higher risk as rural and agriculturally characterized areas. For drought, the pattern is more diverse, with hotspots throughout the country. Those hotspots also represent a localised concentration of high drought socio-economic vulnerability values.

The presented approach to a CRVA for floods and droughts can be transferred to assess risk in other countries or regions. However, the respective indicators and methodologies should always be checked and (slightly) modified depending on the use-case. This ensures a proper assessment of the concept being measured.

In general, it should be kept in mind that there is a scale gap between vulnerability, exposure and hazard data. As a national-scaled assessment of flood and drought risk and vulnerability was the aim, an abstraction to a 1 km² spatial resolution can already be considered fine-scale. However, the hazard component was included on the basis of continuous data to prevent a loss of information for the fine spatial structures of the flood zones.

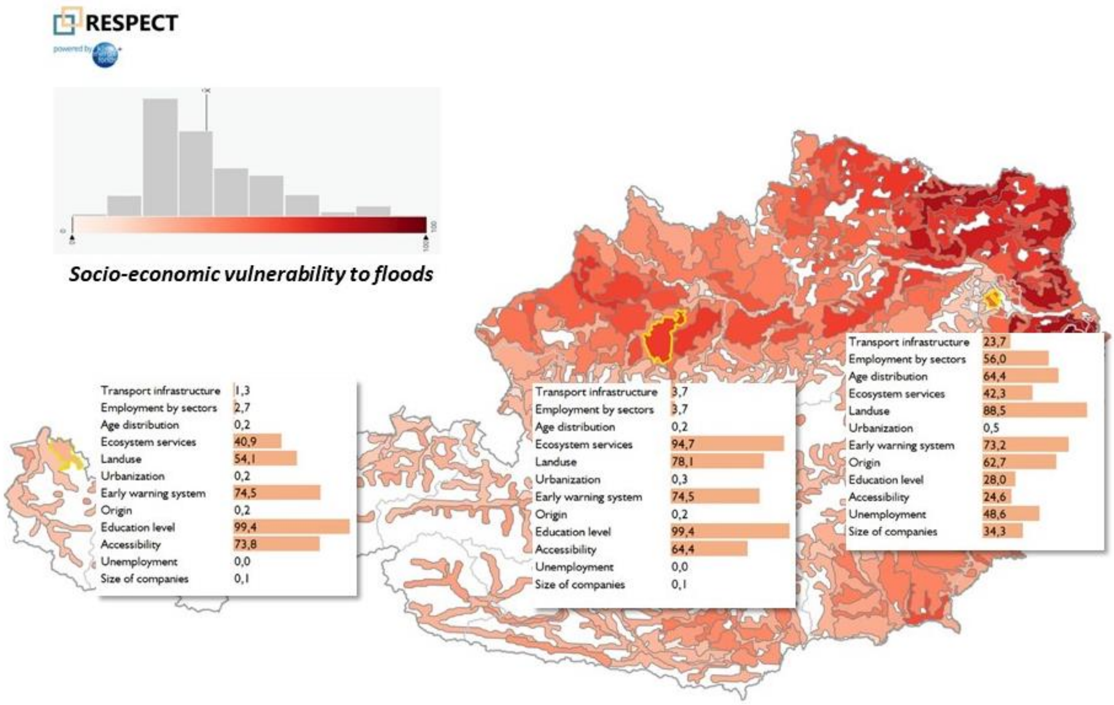

Figure 4*: Regions of socio-economic flood vulnerability in Austria. For selected regions the contribution of the different indicator is shown in the bar charts*

The absence of a risk index value equating 100 or even getting close might serve as proof for the diversity of indicators. This can be seen as a positive characteristic of the conducted CRVA: It is natural that one region does not reach the highest values for the entire set of different indicators. Furthermore, it should be kept in mind that the use of the vector magnitude makes changes among the larger indicator values impact the index more intensely than changes of smaller values (Kienberger et al. 2017, p. 728).

The spatial structures and distributions of different risk levels seem to be in fair agreement with the underlying indicator value distributions. The resulting patterns appear plausible and respond to topographic characteristics, population patterns, socio-economic as well as physical factors and hazard zonings. Thus, the risk maps provide a possibility in visualizing spatially explicit information and integrating several factors (Kienberger et al. 2017, p. 733) related to floods. Thus, an overview on various risk factors is given in an integrated manner. This not only enables exploration of the different factors, but also the quality of risk can be examined by evaluating the risk units and the respective factors contributing and characterizing these regions (Kienberger et al. 2017, p. 733).

In addition, the conducted CRVA proves the operationalization of the geon concept for successfully regionalizing spatially explicit data into risk and vulnerability units. Thus, innovative techniques from the field of remote sensing analysis, combined with index construction approaches for the assessment of complex phenomena such as risk and vulnerability succeed in mapping risk and vulnerability on a national level, independently from administrative boundaries. Therefore, unit-related biases, such as the MAUP, as well as the related effect of ecological fallacy, are reduced (Kienberger et al. 2014, p. 69 et seq.).

Apart from identifying hot spot areas, as a core objective, the derived regions of equal risk and vulnerability can serve as a basis to develop place-specific mitigation and intervention measures to combat the impacts of floods in the future. For instance, such measures might be river basin management and flood and drought risk management plans, the empowerment of community actions, the development of different adapted prevention, protection and preparedness actions or generally more informed technical, financial and political decisions. A region can be examined and visualized in regard to the underlying indicators. This enables the choice of the appropriate measures for each region as adequate intervention measures may differ from one region to another. Finally, a number of challenges and difficulties are constituted in the assessment of risk and vulnerability in combination with the geon approach, for instance related to data availability (Kienberger et al. 2014, p. 70) or scale gaps between different data.

WP3: Co-designing and allocating risk layers in CRM

The overarching objective of WP3 was to develop and test methods and tools for co-designing and allocating roles and responsibilities across risk layers in CRM in Austria. This is done in two real-world settings at the local (Task 3.2) and national level (Task 3.3), building on joint framework development (Task 3.1).

<u>Task 3.1</u>: A draft guidance document for the joint methodological framework in RESPECT, integrating risk layering with a scenario approach in a participatory set-up, was developed in the first half of the project. This draft guidance document was based on an extensive literature review and has been used as a living document to incorporate any lessons learned throughout the remaining project horizon, with the eventual goal in mind to develop a guidebook for the application of a participatory stakeholder engagement process in local level CRM (see following paragraphs on Task 3.2). In order to make the role-play simulation directly useful and applicable for Austrian local-level stakeholders, we developed an open-source handbook, describing in detail how to plan and implement the role-play simulation in practice (Lintschnig et al, 2019b). The working paper is written in German in order to make it most useful for Austrian policy and decision makers. The handbook has been shared with selected stakeholders (e.g., KLAR! region managers) who provided feedback and showed interest in applying the RESPECT role-play simulation also in their own local contexts.

Task 3.2: In the local level case study we utilized the role-play simulation method in a participatory environment including private and public actors at community level, as there is good and increasing understanding that a joint action between them is essential to manage potential future climate-related risks. Nevertheless, their respective and collective roles and responsibilities are blurry and subject to negotiations. This circumstance is part of the barrier that prevents communities from implementing concrete adaptation measures against future climate-related risks they are likely to be concerned with. The RESPECT role-play concept addresses this issue by employing the risk layering approach in combination with possible future risk scenarios for the climate-related risks flood and drought.

The future risk scenarios are integrated in the RESPECT role-play concept in the form of storylines that were jointly developed together with WP2 based on the most recent data for the study region "Zukunftsraum Lienzer Talboden" from ÖKS15 and socio-economic scenarios from the former ACRP project ARISE (Adaptation and Decision Support via Risk Management through Local Burning Embers). The methodological framework ensures that results from the spatial risk assessment conducted in WP2 can be used to compile storylines for all municipalities and regions in Austria. Storylines provide narrative descriptions of plausible pathways that lead to the development of future climate-related risks. Possible futures are mainly described by words and not by numbers, tables or graphs that can be dry and confusing, especially for lay people (Alcamo, 2008) and they have been recognized as valuable tool for communicating climate-related risks (Shepherd et al., 2018). Nevertheless, quantitative results substantiate the developed storylines.

The RESPECT role-play concept includes that players have to work out responsibilities related to adaptation measures for public and private sector actors and to elaborate the effectiveness of the measures for two contrasting hazard categories that differ in their return period and level of stress imposed by risk. Thus, the risk layering approach is integrated as well as the identification of roles and responsibilities.

Role-plays operate in a "no-penalty zone" (O'Sullivan, 2011) which "looks like, seems like, but is not actuality" (Heathcote, 1991). Therefore, participants are permitted to test attitudes and decisions without risk and worries about real consequences. Furthermore, they experience the decision process that is incorporated in the RESPECT role-play concept not from their personal point of view, but from the perspective of another stakeholder involved in CRM. Given these opportunities, role-playing is widely accepted as a powerful method for changing perspectives and behaviors.

To ensure a successful implementation of the RESPECT role-play concept in the study region, a pre-test was conducted with nine participants at the Wegener Center of Climate and Global Change at the University of Graz on April 6th 2018. Due to the experiences and feedbacks, the concept was further improved. The first role-play workshop on flood risk (Figure 5) took place in the premises of the engineering office REVITAL in Nussdorf-Debant near Lienz on June 7, 2018 (eight recruited stakeholders from different fields of action in CRM, seven attended finally) and the second role-play workshop on drought risk was conducted at the University of Innsbruck on December 10, 2018 (nine recruited stakeholders from different fields of action in CRM, eight attended finally).

Figure 5*: Impressions of the first role-play in Lienz in the seminar room of REVITAL on June 7th 2018. Copyright: M.Lintschnig*

The goal of the enactment phase of the role-play workshops (see Figure 6) was to reach a joint decision for a strategy in form of a prioritization of adaptation measures and the responsible players for their implementation. The decisions of the groups have a generally good conformance with the results of the preceding individual assessments of the effectiveness of the measures, but do not conform in all points. In the role-play workshop on flood risk, the measure "Spatial Planning" had the second highest priority for the group for both hazard categories (high frequency/low impact, low frequency/high impact), although its individually assessed effectiveness was amongst the lowest. In the role-play workshop on drought risk, the measure "Water saving irrigation systems" was prioritized on first place for the drought category with high frequency and low impacts although it was not amongst the highest rated in the individual assessment on effectiveness. In both cases, it were possible negative effects of the measures on specific players that influenced the individual assessments of the effectiveness negatively. Due to the possibility to talk about all the different perceptions in the discussion, the players set up mandatory conditions to prevent the possible negative effects. This outcome points out that fostering the operationalization of CRM must combine the agreement upon sometimes blurry and continuously renegotiated responsibilities with the identification and discussion about possible negative effects of adaptation measures, especially when it comes to the question of financing.

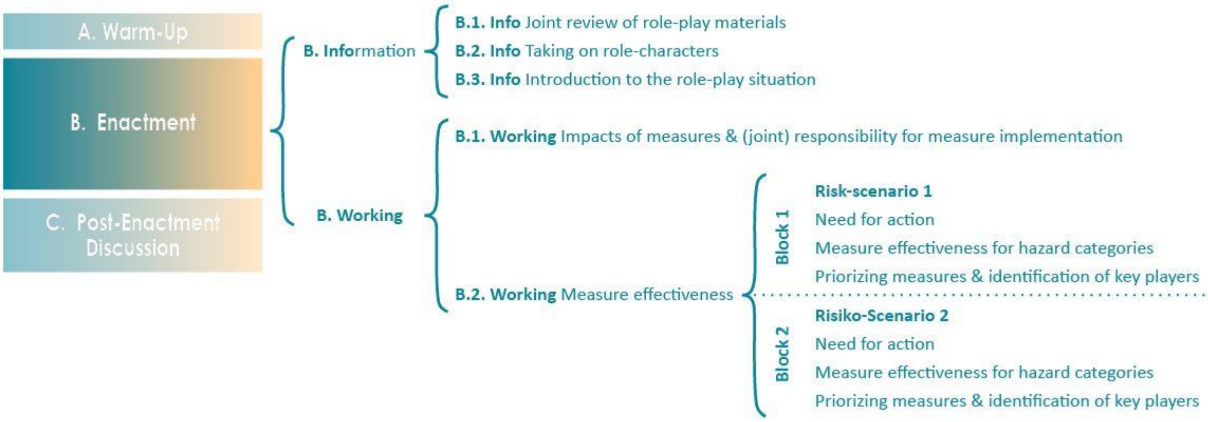

Figure 6: *Overview of the role-play workshop concept and procedure in the enactment phase*

Both role-play workshops were systematically assessed, using five different evaluation instruments (see methods section below). Overall, 14 (out of 17) participants returned the feedback form. The results (see Figure 7) indicate that the role-play materials and tasks were mostly assessed between "understandable" and "rather understandable" (5-graded rating scale: 1 = "understandable", 2 = "rather understandable", 3 = "neither nor", 4 = "rather not understandable", 5 = "not understandable"). The applicability of the role-play concept to work out aspects of CRM in specific points was also mostly assessed between "appropriate" and "rather appropriate" (5-graded rating scale from 1 = "appropriate" to 5 = "not appropriate") and the rate of recommendation is presented in Chapter 2.2.4. The most diverse assessment was on the prior aspect of role-playing, namely taking on the perspective of another stakeholder. 4 chose "I found it easy", 4 "I found it rather easy", 2 "neither nor", 4 "I found it rather hard" and no one "I found it hard". Different reasons were given by participants who had difficulties, e.g., the role was a controversial one or there was too little background information provided on the role.

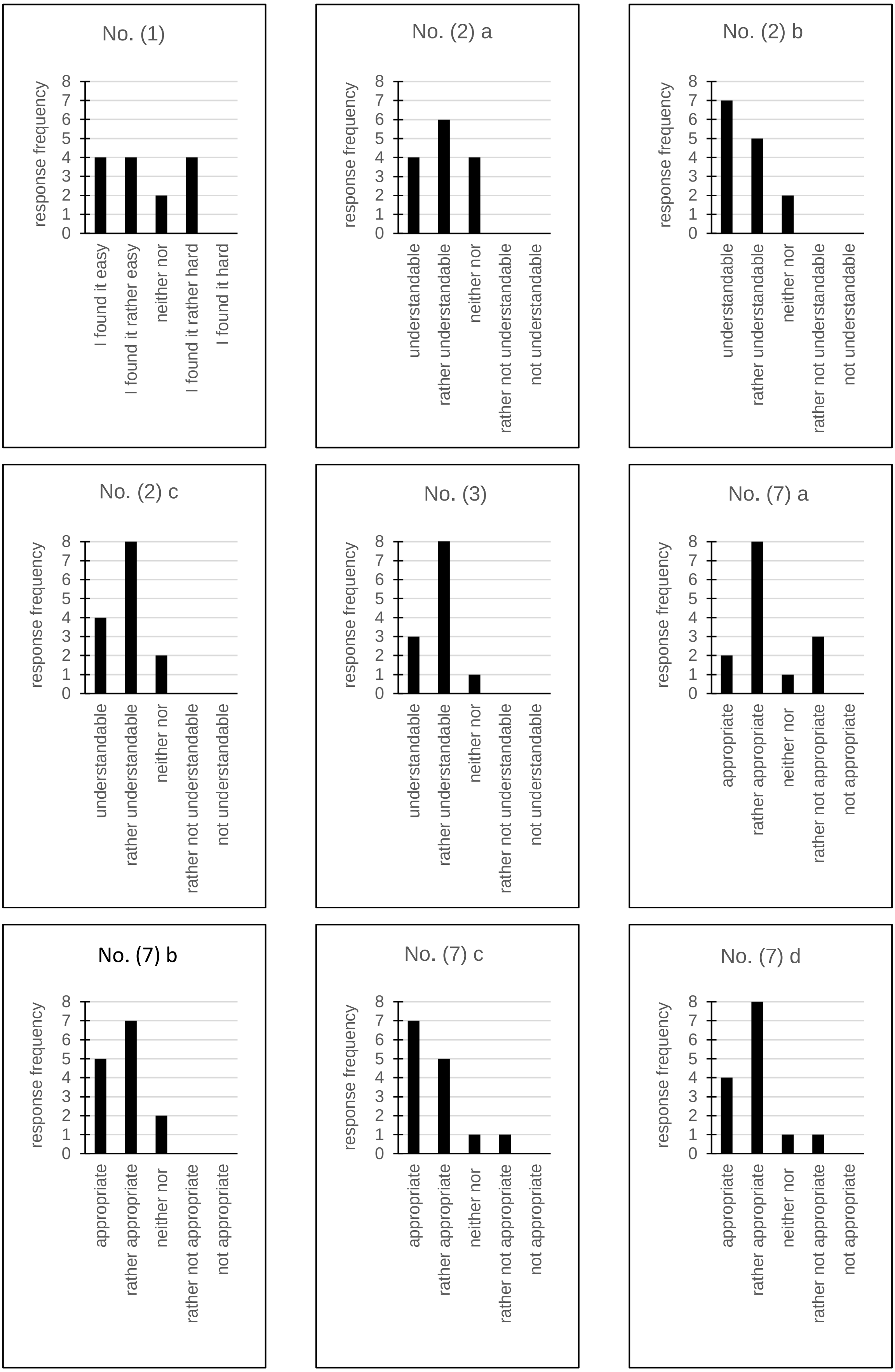

***Figure 7**: Results of rating scale questions*

10 participants filled out the standardized pre- and post-questionnaire with 5-graded rating scale questions (from 1 = "does not apply at all" to 5 = "does apply completely") on risk attitudes and risk behavior. Ratings that differ at least two scales between pre- and post-inquiry are taken as indicators of change as this means that there must be a considerable difference. 19 indicators of change were recognized and two are described exemplarily. After the workshops, two participants changed their opinion concerning their ability to cope with problems regarding their protection against flood/drought on their own. Both were sure to be definitely able to do so before the workshops and changed to a rating of 2 ("does rather not apply") afterwards. Two participants changed their opinion about their concerns about flood/drought. Being asked whether the participants have higher personal concerns than their protection against flood/drought, two participants changed their pre-rating by two scales, showing an increase of concern after the role-play workshops.

Task 3.3: While ageing-related costs are perceived as the major drivers of fiscal pressure in the EU, concerns over climate-related public expenditures have received comparatively little attention in securing the EU's long-term fiscal sustainability. A generic methodological approach for integrating climate-related costs into mainstream fiscal planning tools has been developed in RESPECT and published in the international peer-reviewed journal Regional Environmental Change (Mochizuki et al., 2018). We incorporated a climate-related cost calculation based on the combined use of the shared socioeconomic pathways (SSPs) and representative concentration pathways (RCPs), as the area outside of red-dotted lines in Figure 8 demonstrates. We make use of demographic assumptions as a means to link ageing cost and climate concern, which has multiple benefits since demographic and climate projections typically share similar forecast spans that are far beyond the usual myopic public policy framing of a few years. Furthermore, demographic variables, such as population ageing, are closely linked to social vulnerability to natural hazards such as heatwaves.

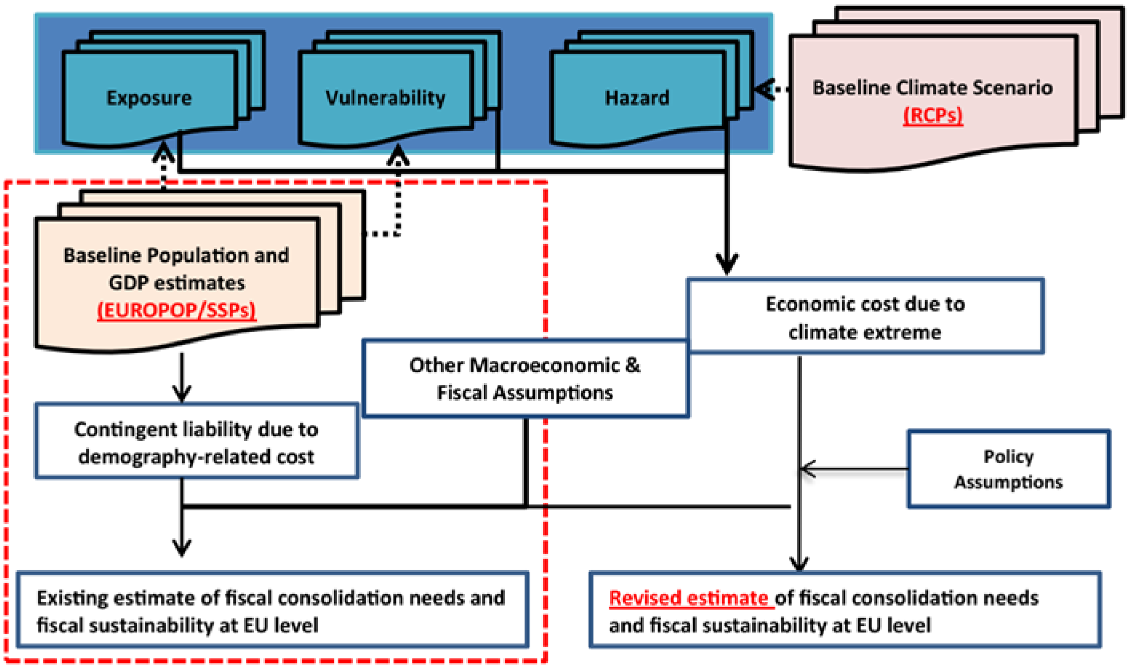

Figure 8*: Conceptual flow of fiscal mainstreaming model (applied to climate risk cost calculations) using IPCC scenarios. Source: Mochizuki et al. (2017)*

The generic mainstreaming methodology (Figure 8) was operationalized by means of a stochastic debt assessment and a national disaster fund analysis in a case study for flood risk in Austria (Mochizuki et al., 2018). A stochastic debt assessment is a common fiscal sustainability analysis tool used in various countries and contexts. Debt dynamics equations are built based on baseline projections of macroeconomic variables, and confidence bounds of debt trajectories are evaluated through stochastic simulations (IMF 2006; Medeiro 2012; Eller and Urvova 2012; IMF 2012). Stochastic assessment, which draws on a wide range of possible future scenarios, gives a more complete depiction of debt sustainability risks than the traditional deterministic approach (Celasun et al. 2007). Our modeling approach is unique in that we evaluated stochasticity arising from public contingency of climate extreme events in addition to conventional macroeconomic variables.

The stochastic simulation (Figure 9) shows how the Austrian fiscal position may deviate from the baseline debt projections due both to macroeconomic variability of GDP, short and long-term interest rates and climate-related extreme events. The 95th percentile value at risk of debt-level in 2030 is estimated to be as high as 249% with macroeconomic and climate extreme risks combined and 97.0% with climate extreme risks only. Macroeconomic variability has a much higher impact than the direct risk of climate extremes, suggesting that climate extremes per se are unlikely to put significant fiscal pressure on Austria. At the same time, the existing ex-ante arrangement of the national disaster fund has to be critically reviewed in terms of dealing with extreme flood risks in a fiscally sustainable way over the longer term. We find that while the probability of a disaster fund depletion will be reduced as a result of ex-ante DRR investments, the magnitude of the shortfall will increase over the same period because of the expected rise in extreme flood risks.

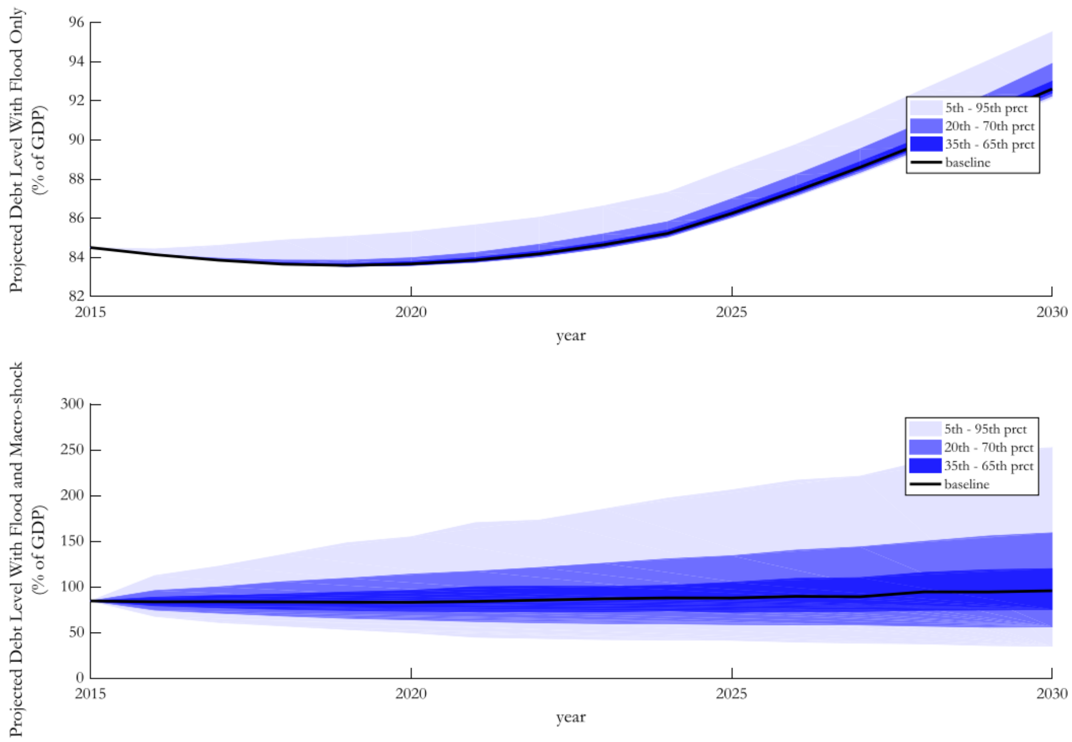

***Figure 9**: Stochastic debt trajectories for Austria under SSP2 scenario up to 2030. Showing 5th to 95th percentiles. Source: Mochizuki et al. (2017)*

WP4: Synthesis and international dimension

WP4's objective was to synthesize insights from national and local-level case studies, and also to reflect on this with selected international experts working on CRM issues. The exchange with international researchers from the EU and representatives from policy- and decision-making was organized via two focused expert workshop at the beginning (October 2017) and towards the end of the project (September 2019). This moderated sharing of insights and experience across different contexts and governance structures led to consolidated insights on how to operationalize comprehensive CRM in practice.

Based on discussions with our international colleagues, we extended our original set of climate-related risks (flood risk, drought risk) with a focus on heat waves, because this particular risk is not exclusive to a specific population segment (e.g. flood risk is only relevant for residents in flood-prone areas) but affects almost all members of the general population. Existing data from the pre-project PATCHES allowed us to zoom into the individual level and assess how risks from heat waves are perceived and which factors influence intentions and behaviors to protect against heat waves. Multiple regression analysis based on data from 700 respondents from two cities in Austria showed that the perceived severity of heat waves primarily depends on how people had experienced heat waves in the past. The results also indicate that the probability of a future heat wave is expected to be high, although the denial of heat waves mitigate these effects. The most striking finding is that risk perception was not found to be a significant driver of intentions and behaviors that could minimize the negative impact of extreme temperatures (e.g. drink plenty, purchase an air conditioner, go to a public pool/park to cool down). Perceived response efficacy, costs and self-efficacy were identified as the most significant determinants of heat protection intentions and behaviors. Overall, the results indicate that raising awareness about heat wave risks may not be sufficient to increase heat wave resilience of individuals. Instead, interventions and campaigns are required to communicate the effectiveness and costs of protective behaviors and help build trust in peoples' own abilities to ultimately adopt these behaviors (self-efficacy). Further details on the methods, key results of the analysis and policy-recommendations are summarized in Babcicky (2019, under review).

WP5: Project Management

The objective of this WP was to ensure a timely, target-oriented project management and coordination of activities, information management, subcontracting to partners, communication with the funding agency, coordination of interim and final reports and accounting. Concurrent project management and controlling with respect to objectives, costs and timeline was implemented as of the start of the project; four project team meetings were held throughout the project; and the interim and final reports were developed and submitted.

WP6: Dissemination and communication strategy

WP6's objective was to ensure that the knowledge produced in the project is made publicly available. The project and its results were propagated via tailored dissemination channels and information was translated for various audiences. In particular, a project website, a CI manual and document templates were created, project results were disseminated at national and international scientific and expert meetings, and peer-reviewed publications and targeted working papers and guiding documents were developed. A particular highlight was the coverage of a third implementation of the RESPECT role-play simulation by the Austrian Television Channel 2 (ORF 2) within their well-known TV format 'Thema' (broadcasted on May 28, 2019).

5 Schlussfolgerungen und Empfehlungen / Conclusions and recommendations

RESPECT brought to the fore that climate risk management (CRM) is not (yet) explicitly embedded in Austria's risk management landscape. Instead, the consideration of climate risks in decision-making depends on the initiative of individual actors acknowledging the importance of a more holistic approach. Our results show that there is considerable room for improvement and better cooperation at the interface between (disaster risk management) DRM and climate change adaptation (CCA) at different scales in Austria. Also, there is a clear agreement on the importance of CRM to effectively manage present and future climate risks.

One possible way to stimulate CRM in Austria would be the implementation of a national climate risk counsel to centrally manage all issues related to climate risks, bring together actors, create networks around climate risk management, and to make information on climate risks readily available for all interested parties. Further, our findings show that it may be advisable to improve existing risk management tools, such as the national disaster fund. Public-private partnerships (e.g. private insurances combined with the national disaster fund) were discussed as one way to advance CRM in Austria. Moreover, the resources of the disaster fund may also be increasingly used to support preventive measures (instead of solely focusing on damage compensation and financing reconstruction). It is concluded that policy decisions in climate risk management also require broad public support. Therefore, interventions are recommended that increase the awareness of the general public about climate risks and possible adaptation strategies.

From the climate risk and vulnerability assessment it can be concluded that data and methods to populate such an assessment are rich in Austria, compared to many other countries. The devil however is often in the details, and challenges arise especially in the selection of the risk and vulnerability indicators. To select the most appropriate and useful ones for policy and decision making in practice, multiple feedback rounds with experts and stakeholders are considered beneficial. This was by purpose not foreseen in the context of RESPECT, which started to build potentially applicable indicators on a much more basic level, but provides opportunities for future research. Furthermore, it can be concluded that the spatially explicit approach employed in RESPECT provides much more detailed insights than methods being based on gridded-data or based on administrative levels. First feedback from users also strongly underline this observation. Additionally, it can be concluded that the risk landscape for floods and agricultural drought is very heterogonous in Austria, given changing characteristics in the underlying socio-economic and physical indicators.

The role-play method utilized in the local level case study turned out to be a promising participation format. The participants highly appreciated that different stakeholders in CRM get the opportunity for exchange and that the concept of taking on the role of another stakeholder has a high potential to raise the understanding and acceptance of the different interests and resources amongst them. As the role-play provides a "no-penalty zone", it has the ability to break down sometimes hardened positions on the condition that the participants engage themselves in the role-play process and simultaneously do not misuse it as opportunity to push their own interests. The developed role-play concept can be a great asset to support real CRM decision processes but should not be used to derive concrete decisions as this is in conflict with its aim to provide a "no-penalty zone". We therefore suggest to integrate the role-play in a comprehensive participatory CRM-process, e.g. in combination with the concept developed in ARISE. The results of the local level case study give interesting insights on the utilization of the role-play method in the context of CRM. Scientists and experts interested in participative tools, as well as municipalities and regions that want to deal with possible future climate-related risks they are likely to be concerned with, are provided with a guidebook that gives substantial information on how to conduct the RESPECT role-play workshop. The two implementations of the developed RESPECT role-play simulation in the local level case study (WP3) show promising first results. However, to gain deeper significant insights on its ability to change attitudes and raise awareness concerning climate-related risks, further implementations including an evaluation are required. We furthermore suggest that there is a need to build long-lasting participatory partnerships that go beyond separate series of workshops of different but consecutive projects to gain sustainable results.

The stochastic debt modelling insights inform ongoing discussions regarding mainstreaming climate risk into fiscal planning in Austria and beyond in a number of ways. Generally, we found the magnitude of public contingent liability due to flood risk on annual average basis to be small relative to ageing related public cost liability, and flood risk alone will unlikely impact Austria's budgetary stance in the future. However, a further in depth analysis of the Austrian disaster fund indicated that though the DRR earmarking will reduce risk of a disaster fund depletion, the magnitude of the shortfall will increase due to expected increase in extreme events. This may stress the country's disaster fund, prompting the need for re-evaluation of the current funding and reserve arrangements as well as for putting the disaster fund as one specific tool in a more comprehensive risk management perspective. The Austrian disaster fund in its current form only provides financial assistance for the replacement of capital, not for additional risk reduction (or building back better) after disaster events. Neither does the fund support any ex-ante risk-reduction measures by private sector entities nor public risk reduction measures broadly beyond physical protection. These facts, combined with the lack of protection against catastrophic events, make the Austrian disaster fund less than comprehensive. This prompts the need for further discussions regarding potential reforms in line with the EU floods directive 2007/60/EC, which would encourage a more comprehensive approach to flood risk management (European Parliament and Council 2007). Potential risk financing mechanisms such as natural catastrophe (NatCat) insurance systems already in place in other EU member states, such as Belgium and Germany, and the European Solidarity Fund may be applicable instruments for managing catastrophic flood risk in Austria.

The stochastic debt model runs conducted within the RESPECT national level case study (WP3) were only a first application of the proposed climate-related fiscal risk mainstreaming framework, and further studies are certainly needed to test the broader applicability of this approach beyond the case of flood risk in Austria. First, given that this model builds on the existing fiscal sustainability assessment conducted at the EU level, this approach can be replicated in other EU member states. Second, this modelling framework can also incorporate potential impacts of a broader range of natural hazards, such as heatwaves and drought risk that may also cause large fiscal consequences and that may benefit from proactive longer-term adjustment in policy incentives. Thirdly, it can also be expanded to include other public cost of additional climate change related expenditures, such as mitigation and adaptation costs, including potential public liability due to stranded carbon-intensive assets. Finally, economy-wide assessments of climate triggered damages and associated follow-on effects may be additionally performed.

C) Projektdetails / Project details

6 Methodik / Methodology

WP1: Revisiting the Austrian climate risk governance- and decision context

The first objective of WP1 was to identify and map CRM stakeholders with respect to two specific climate risks: flood and drought risk. These two risks were chosen, as they are particularly relevant for Austria. To assure maximum comprehensiveness, we adopted an inclusive definition of stakeholders, following Grimble and Wellard (1997:3-4) suggesting that stakeholders are „[…] any group of people organised, who share a common interest or stake in a particular issue or system". Consequently, a large inventory of CRM actors was compiled, ranging from the national level (e.g. ministries) to the local level (e.g. local council, private households).

A systematic stakeholder analysis (Freeman 1984) was applied, which appeared the most suitable instrument to capture information about relevant actors, allowing to draw conclusions about their interests, motivations, behaviours and decision processes (Reed et al. 2009; Brugha and Varvasovsky 2000). The multi-level perspective of stakeholder analysis (Varvasovszky and Brugha 2000) was essential because issues evolving around climate risk governance concern all political and institutional levels. A stakeholder analysis was applied to purse two distinct objectives: (1) to identify relevant CRM stakeholders at different levels, and (2) to assess the existing risk governance landscape, including decision structures, cooperation, and existing and future challenges.

To conduct the stakeholder analysis, we adopted a systematic approach (Figure 10), building on Reed's et al. (2009). After a screening of the existing literature on Austria's risk governance landscape a tentative list of stakeholders was compiled. In a next step, personal (face-to-face) interviews were conducted with 14 selected stakeholders (5–7 telephone interviews were suggested in the RESPECT project proposal) to identify the responsibilities and activities of the stakeholders and to generate detailed insights into the governance structure, challenges and actor relations. The final inventory of relevant stakeholders consisted of 33 stakeholders. Prior to the interviews, an interview guideline was developed to ensure that all interviewers address a consistent set of topics.

Finally, two separate CRM stakeholder maps were compiled with one focusing on flood risk and one on drought risk. In order to understand at which point scientific and civil society input is required, CRM activities were mapped against each stage of the CRM cycle following Schinko et al. (2016) in two separate stakeholder activity matrices (one for each climate risk).

Two subsequent stakeholder workshops were conducted to engage stakeholders with the concept of CRM and to elicit insights into how the existing risk governance landscape shapes their decisions. Moreover, the stakeholder workshops were used to develop potential measures in close cooperation with stakeholders that help overcome the lack of integration of present and future climate risks (projected climate change impacts) into disaster risk management.

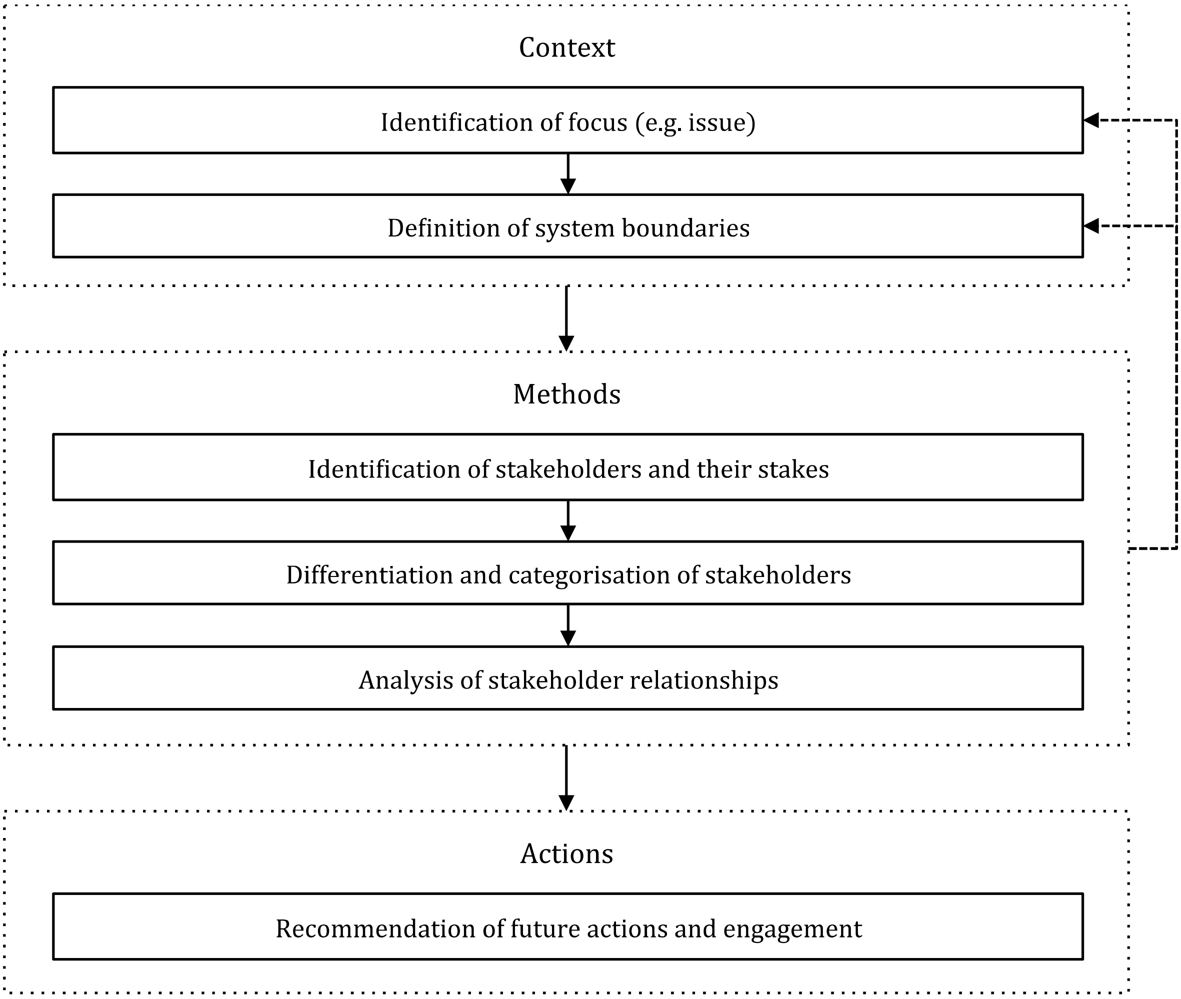

***Figure 10**: Schematic representation of key methodological steps applied in the stakeholder analysis (adapted from Reed et al. 2009)*

WP2: Synthesizing climate risk information for Austria

In the scope of WP2, indicators are defined with respect to a certain purpose or goal, in this case the assessment of climate change related flood and agricultural drought risk. Thus, the vision or goal behind the indicator-development process is the central issue, rather than the interest in an indicator itself. Along those lines, Moldan and Dahl (2007) define indicators as "symbolic representations […] designed to communicate a property or trend in a complex system or trend in a complex system or entity". They are differentiated from raw data and statistics in that they incorporate reference values, as for example benchmarks, thresholds and targets (Moldan and Dahl 2007). Within this definition, the goal of communicating a complex issue and the purpose of identifying and recognizing trends is related to the issue of regular monitoring (Kienberger et al. 2009).

In general, it is important that the indicator selection process is driven by the validity of indicators in the first place rather than starting from the search for available data. This ensures that indicators are context-specific. However, indicators are usually data-driven to some extent, meaning that the availability of data also determines the choice of indicators (Birkmann 2007). To respond to the recommendation of a context-driven indicator selection process, we took the results from the literature studies as a starting point. Based on the literature analysis conducted before, we started to collect indicators as a baseline repository or database for the national level assessment. The structure of this indicator database was derived from a combination of the MOVE framework (Birkmann et al 2013) and a template for indicator aggregation as well as an indicator and data fact sheet, both supporting documents of the Vulnerability Sourcebook by the Fritzsche et al. (2014). Next to the literature review, the MOVE indicator database was used as an additional information source.

The mental frame guiding the indicator selection process was the relevance of indicators for the national assessment for Austria as well as to the flood and drought hazards and the vulnerability domain (and dimension) it is associated with. Additionally, suitable and appropriate data to feed an indicator had to be available in general and – except for the census data, which is provided by Statistik Austria for a fee – had to be accessible open access/without costs. An additional criterion for the choice of appropriate indicators was that data to populate an indicator needs to be available nationwide and on the basis of a 1 km² grid or can be aggregated to a 1 km² grid. Furthermore, we aimed to avoid indicators holding redundant information. By aggregating the existing, partly redundant indicators and thus revealing the most meaningful ones, the indicator database could be condensed to the most important and prominent indicators. The result was a refined and final list of indicators to use for the risk assessment, distinguished by the three different components of risk – hazard, exposure and vulnerability – and, in the case of vulnerability, by its subordinate dimensions. In most cases, sub-indices needed to be developed, providing the opportunity to weight specific sub-indicators (Kienberger et al. 2014).

For the exposure component, different data was selected depending on the two vulnerability dimensions, physical and socio-economic. Jones and Andrey (2007) used the total population and population density to reflect potential exposure in their social vulnerability index. The latter additionally provides an indirect measure of time necessary for evacuation (Jones and Andrey 2007). As not only the place of residence of people can be relevant to risk since damaged assets, infrastructure or workplaces can show various impacts on people’s lives as well, we used an extended version of such a population (density) indicator.

Consequently, for the exposure component to combine with socio-economic vulnerability, data on the permanent settlement area was used. This data was provided in the shapefile format and as open access by Statistik Austria. The dataset we used is the generalized permanent settlement area. It sums up the classes settlement area and area amenable for settlements to a single class of permanent settlement area and generalizes this area. This step of generalization made the data more suitable for the delineation of geons (see Figure 11) as there are larger areas available for defining regions of vulnerability and risk, since little fragments and single grid cells have already been eliminated. The second class includes the area unamenable for settlements (Statistik Austria 2017). Within the area unamenable for settlements, the exposure of people or assets can be assumed to be unlikely. The other category indicates a (potential) possibility for people to settle or to already be settled in that area. This was considered the critical criterion to be relevant for socio-economic vulnerability. For the risk index construction in combination with physical vulnerability (for floods), we decided on a different exposure indicator. However, too much area containing physical assets, such as infrastructure, had been excluded in this dataset, presumably because of the population threshold mentioned before. Consequently, we decided to use a land cover classification excluding the CLC class water bodies for obtaining the exposure component indicator data for the risk assessment in combination with physical vulnerability, assuming a potential exposure for physical assets and infrastructures at any other location within the study area. For the exposure component, there is neither future scenario data available, nor data the future developments could be approximated with. For this reason, exposure was held constant on basis of the present-day conditions in order to assess the risk for the years 2050 and 2100.

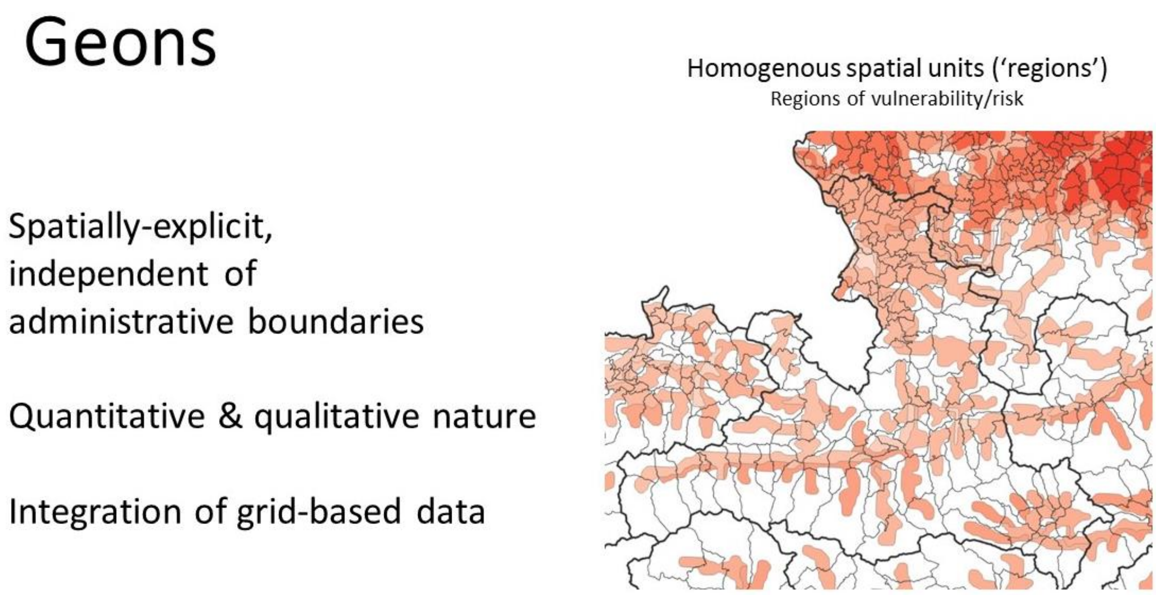

***Figure 11**: Key characteristics of the geon approach, in modelling homogenous, spatial regions for a multi-dimensional phenomenon (in this case socio-economic vulnerability to floods).*

A holistic approach towards vulnerability is complex to assess and is not yet covered by any existing dynamic or numerical modelling approaches. Consequently, the identification of a set of indicators reflecting the physical and socio-economic dimensions of vulnerability to floods and agricultural droughts was given special emphasis. For each of the three assessment dimensions a set of indicators was developed, comprising 40 indicators for the socio-economic flood vulnerability, 30 indicators for the physical flood vulnerability and 15 indicators for the socio-economic drought vulnerability. Data was populated from various public and open-source database, ranging from statistical data, road networks, data from different ministries, as well as climate change data (ÖKS15).

In a next step, a correlation analysis of the indicators was carried out, to identify highly correlated indicators following the recommendation of (Saisana 2012). A few indicators were required to be excluded.

Before weighting and aggregating the sub-indicators to sub-indices (composite indicators), the input variables needed to be normalized as they had different units of measurement and value ranges. Generally, a normalization needs to be conducted in such a way that a temporal, spatial and factual comparability is preserved or established (de Lange and Nipper 2018). Consequently, in order to make data comparable, the different datasets were normalized through a linear min-max normalization. The min-max normalization is a special case of the normalization via a lower and an upper threshold, which transforms the initial values to a value range between a certain lower and upper threshold. In the case of min-max normalization, the initial values are transformed to a value range between zero (minimum of the initial values xmin) and one (maximum of the initial values xmax). The weighting of the indicators was done on a normative basis through expert choice by the authors. Where required, an aggregation to sub-indicators was carried out through a weighted mean approach.

The vulnerability units were derived from the composite vulnerability indicators. For this purpose, a regionalization approach applied to multidimensional data, as the one object-oriented image analysis is offering, was appropriate (Kienberger et al. 2009). Through the assignment of weights to each input layer as well as the choice of shape values (compactness versus smoothness) and a scale parameter, the size and shape of the final homogeneous units as well as the final index value itself can be influenced (Hagenlocher et al. 2013). In the absence of justifiable weights, we chose to apply equal weighting to combine the composite indicators. Subsequently, a vulnerability index (V) was determined, calculating the weighted vector magnitude – the length of the vector for each region – considering the different layers (v1, v2, …, vn) in the multidimensional indicator space. The final index values were normalized again within a zero to 100 scale range. Finally, to derive a risk index value, the vulnerability units were combined through a geometric mean approach with the hazard layer. The vulnerability units included already the exposure layer. The very final step was to visualise the results as digital and paper maps.

WP3: Co-designing and allocating risk layers in CRM

Task 3.2:

In the local level case study we utilized the role-play method in a participatory environment including private and public actors at community level as there is good and increasing understanding that a joint action between them is essential to manage potential future climate-related risks. Nevertheless, their respective and collective roles and responsibilities are blurry and subject to negotiations. This circumstance is part of the barrier that prevents communities from implementing concrete adaptation measures against future climate-related risks they are likely to be concerned with. The developed RESPECT role-play concept addresses this issue by employing the risk layering approach in combination with possible future risk scenarios for the climate-related risks flood and drought.

The future risk scenarios are integrated in the RESPECT role-play concept in the form of storylines that were jointly developed together with WP2 based on the most recent data for the study region "Zukunftsraum Lienzer Talboden" from ÖKS15 and socio-economic scenarios from the former ACRP project ARISE (Adaptation and Decision Support via Risk Management through Local Burning Embers). The developed storyline framework ensures that the results from the spatial risk assessment conducted in WP2 can be used to compile storylines for all municipalities and regions in Austria. Storylines provide narrative descriptions of plausible pathways that lead to the development of future climate-related risks. The focus is on giving information in a qualitative rather than in a quantitative way. Possible futures are described by words and not by numbers, tables or graphs that can be dry and confusing, especially for lay people (Alcamo, 2008) and they have been recognized as valuable tool for communicating climate-related risks (Shepherd et al., 2018). Nevertheless, quantitative results substantiate the developed storylines.

The RESPECT role-play concept includes that players have to work out responsibilities related to adaptation measures for public and private sector actors and to elaborate the effectiveness of the measures for two contrasting hazard categories that differ in their return period and level of stress imposed by risk. Thus, the risk layering approach is integrated as well as the identification of roles and responsibilities.

Role-plays operate in a "no-penalty zone" (O'Sullivan, 2011) which "looks like, seems like, but is not actuality" (Heathcote, 1991). Therefore, participants are permitted to test attitudes and decisions without risk and worries about real consequences. Furthermore, they experience the decision process that is incorporated in the RESPECT role-play concept not from their personal point of view, but from the perspective of another stakeholder involved in CRM. Given these opportunities, role-playing is widely accepted as a powerful method for changing perspectives and behaviors.

As proposed by Wohlking & Gill (1980) and illustrated in Figure 6, the RESPECT role-play is basically structured in three functional phases. In the beginning (A), the participants are gently introduced before (B) the participants step into their roles and the major part of enactment takes place. Afterwards, (C) the players leave their roles and the role-play is completed by debriefing and discussion.

Both role-play workshops were systematically assessed with five different evaluation instruments:
(1) A documentation of the workshops by audio recording to assure that discussions and arguments can be reconstructed afterwards.
(2) A documentation of the results of all tasks worked out in the workshops by collection of handed out working sheets and flipcharts to be able to analyze the results afterwards.
(3) A feedback form with both open ended (n = 7) and closed (rating scale, n = 10) questions to figure out if there is a need to further modify the role-play concept. The questions were related to the following aspects:

- The role-play method itself (3 questions).

- The comprehensibility of the role-play materials and tasks (8 questions).
- The applicability of the role-play concept to work out aspects of CRM in specific points (4 questions).
- The personal experiences and findings due to the role-play workshop (1 question).
- The rate of recommendation for other municipalities (1 question).

(4) Oral reflection and discussion of the role-play concept and components with participants and role-play personnel for any necessary refinements.

(5) Pre- and post-role-play standardized questionnaires to assess the effect of the role-play on risk attitudes and risk behavior (15 questions).

Task 3.3:

Instead of (or in combination with) conventional demographic projections (such as EUROPOP used in the EU fiscal assessment), SSP-based projections can be used as a harmonized basis for age-related expenditure in fiscal sustainability assessment. As described in Cuaresma 2017, projections of age, gender and educational level disaggregated population up to 2100 can be used to estimate future projections of potential GDP. The use of demographic assumptions as a means to link ageing cost and climate concern has multiple benefits since demographic and climate projections typically share similar forecast spans that are far beyond the usual myopic public policy framing of a few years, such as those seen in public election or budgetary planning cycles. Furthermore, demographic variables, such as population ageing, are closely linked to social vulnerability to natural hazards such as heatwaves. The use of SSPs as a base for fiscal sustainability discussions, therefore, opens up the potential for broader discussions on environmental sustainability and wellbeing in the future. The major advantage of this mainstreaming approach is that one can harmonize socioeconomic assumptions. Calculation of public cost of mitigation and adaptation can therefore be made in a consistent manner both regionally and globally. The integrated assessment modelling community is increasingly taking this kind of harmonized approach to model climate policy costs globally, and the adoption of these scenarios provides a natural entry point to integrating available analysis from biophysical and socioeconomic modelling.

The generic mainstreaming methodology (Figure 1) was operationalized by means of a stochastic debt assessment and a national disaster fund analysis in a case study for flood risk in Austria (Mochizuki et al., 2018). A stochastic debt assessment is a common fiscal sustainability analysis tool used in various countries and contexts. Debt dynamics equations are built based on baseline projections of macroeconomic variables, and confidence bounds of debt trajectories are evaluated through stochastic simulations (IMF 2006; Medeiro

2012; Eller and Urvova 2012; IMF 2012). Stochastic assessment, which draws on a wide range of possible future scenarios, gives a more complete depiction of debt sustainability risks than the traditional deterministic approach (Celasun et al. 2007). Stochastic assessment, which draws on a wide range of possible future scenarios, gives a more complete depiction of debt sustainability risks than the traditional deterministic approach and thus is more appropriate for evaluating potential deviation of fiscal policy paths and macroeconomic developments that may trigger short-term liquidity crisis and other adverse consequences (Celasun et al. 2007).Our modeling approach is unique in that we evaluated stochasticity arising from public contingency of climate extreme events in addition to conventional macroeconomic variables.

Following Berti (2013), stochastic debt dynamics incorporating macroeconomic variability and longer-term, demography-related public cost may be extended to take the following form. We include a new stochastic variable of reconstruction needs due to climate extremes (j). The baseline potential output (g_t) refers to the future GDP projections calculated according to five alternative demographic projections (Moss 2008; Cuaresma 2017). Projected increase in the costs of demography-related public expenditure (c_t) can also be calculated based on SSP projections.

$$d_t = d_{t-1}\frac{1+i_t}{1+g_t} - b_t + c_t + j_t + f_t \qquad \ldots(1)$$

d_t = Debt to GDP ratio in year t

i_t = Real implicit interest rate at year t

g_t = Real GDP growth rate at year t

b_t = Structural primary balance over GDP in year t

c_t = Change in age-related costs over GDP in year t relative to base year

j_t = Residual public contingent liability due to climate extreme events over GDP in year t

f_t = Stock flow adjustment over GDP in year t

The variable j_t represents both explicit and implicit public contingent liability that exceed available ex-ante fiscal resources, expressed relative to GDP. Here, explicit liability refers to ‘government liabilities recognized by a law or contract’ and implicit liability refers to ‘a moral obligations of government’ (Palockova 1999).

Since some of climate extreme costs may be covered with available ex-ante policy instruments such as national disaster fund, budgetary reserve, or private insurance; the total public contingent liability relative to GDP (j_t) and in absolute term, expressed as J_t are calculated as residual of these ex-ante resource availabilities.

We extended our analysis to assess the Austrian national disaster fund, where a portion of public revenue is earmarked each year for risk reduction and disaster response expenditures. Expressed in absolute terms, flood damage at year *t* (FD_t) may be divided into public (PbD_t) and private (PrD_t) damages and assuming private insurance coverage (α) as follows:

$$FD_t = PbD_t + (1-\alpha)PrD_t + \alpha PrD_t$$

Where national disaster fund, budgetary reserve and additional resources may be used to finance the recovery of uninsured losses up to proportion β. Public indirect contingent liability (IC_t) is thus given by:

$$IC_t = \beta * (1-\alpha)PrD_t$$

Where $\beta=1$ refers to full compensation by government, $\beta=0$ refers to no government compensation.

Total public contingent liability due to climate extreme events at year t (TC_t) is therefore summed as:

$$TC_t = PbD_t + \beta * (1-\alpha)PrD_t$$

Further, the government is assumed to fulfill its public contingent liability using the following lexicographic order based on the existing disaster financing arrangement in Austria (Schinko et al. 2016): fiscal resource for national disaster fund earmarked for reconstruction ($\gamma * Df_t$) is drawn first, followed by budgetary reserve (DR_t). Once both resources are exhausted, it is assumed that budget diversion must take place, which affects the baseline debt-trajectory. Hence, residual public contingent liability that exceeds ex-ante fiscal sources (J_t) can be expressed as:

$$J_t = TC_t - (\gamma * Df_t + DR_t)$$

Where γ is an earmarked factor for disaster recovery usages, assumed to remain constant in the baseline.

The total resource availability for the national disaster fund (Df_t) increases proportional to the stochastic growth in output (G_t) using a baseline tax rate (τ).

$$Df_t = \tau * G_t$$

If the disaster fund earmarked for reconstruction is unspent in year t, the resource is carried over as a budgetary reserve, which is capped at 30 million Euro ($\overline{DR}$).

$$DR_t = min\{DR_{t-1} + CO_t;\ \overline{DR}\}$$

Where CO_t is the amount of carry-over calculated as the difference of $\gamma * Df_t$ and TC_t if $\gamma * Df_t > TC_t$.

Finally, a proportion of the national disaster fund is earmarked for disaster risk reduction investment with an earmark factor (δ) where $\gamma + \delta = 1$. Total risk reduction benefit from DRR investment expressed as (DRR) is calculated as an annual average benefit (μ) summed over its project lifespan (*sp*), which is assumed to be 20 years in the baseline.

$$DRR = \sum_{Sp=t}^{t+20} \mu * \delta * Df_t$$

Our model introduced two sources of stochastic shocks to our baseline SSP2 debt and national disaster fund projections, comprising macroeconomic variability and stochastic flood damages. To simulate potential macroeconomic shocks, we generated a historical variance-covariance matrix of GDP and long-run and short-run interest rates using quarterly observations between 2002 and 2015. We then sample sets of these variables using a Monte Carlo simulation assuming a joint normal distribution. Quarterly shocks were then aggregated to annual shocks in a manner similar to those explained in Berti (2013) taking into account an average maturing of debt for long-run interest rates. Stochastic output shocks are then translated as shocks to primary balance using the assumed semi-elasticity parameter. Further, direct economic risk due to flooding in Austria from 2015 to 2050 was estimated using a structured coupling of probability loss distributions on the basin scale (derived from LISFLOOD; see van der Knijff et al. 2010; Rojas et al. 2012) with the method discussed in Jongman et al. (2014) and more recently in Timonina et al. (2015). Dependencies between river basins were estimated based on maximum river discharges for the period 1990–2011, using copulas. The loss distributions from each basin were then coupled using the copulas and a minimax ordering approach in order to derive a loss distribution at the national level.

7 Arbeits- und Zeitplan / Work and time plan

Work package (WP) / Task	Start MM/YY	End MM/YY
WP1: Revisiting the Austrian climate risk governance- and decision context		
Task 1.1: Stakeholder Mapping and Interaction	06/2017	04/2019
Task 1.2: Climate risk governance context - shaping decisions	09/2017	05/2018
WP2: Synthesizing climate risk information for Austria		
Task 2.1: Develop an IPCC-based set of indicators for flood/drought	07/2017	11/2017
Task 2.2: Aggregate indicators towards an integrated risk measure	12/2017	10/2018
Task 2.3: Visualization of results through interactive tools and maps	02/2018	08/2019
Task 2.4: Validation of results and identification of potential intervention measures	09/2018	08/2019
WP3: Co-designing and allocating risk layers in CRM		
Task 3.1: Joint framework development for allocating risk and responsibility	09/2017	05/2019
Task 3.2.1: Role-play design	10/2017	04/2018
Task 3.2.2: Recruitment of participants	11/2017	12/2018
Task 3.2.3: Implementation of role-play runs	05/2018	12/2018
Task 3.2.4: Participant debriefing and evaluation	05/2018	01/2019
Task 3.3.1: Data collection	08/2017	03/2018
Task 3.3.2: Model development	01/2018	08/2018
Task 3.3.3: Model and scenario implementation	05/2018	12/2018
Task 3.3.4: Interpretation of quantitative model results	09/2018	12/2018
WP4: Synthesis and international dimension	08/2017	09/2019
WP5: Project Management	06/2017	09/2019
WP6: Dissemination and communication strategy	06/2017	09/2019

8 Publikationen und Disseminierungsaktivitäten / Publications and dissemination

Publications	Journal	Other
Mochizuki, J., Schinko, T., Hochrainer-Stigler, S. (2018). Mainstreaming of Climate Extreme Risk into Fiscal and Budgetary Planning: Application of Stochastic Debt and Disaster Fund Analysis in Austria. *Regional Environmental Change*. doi:10.1007/s10113-018-1300-3	X	
Babcicky, P. (2019): "Risk perception, intention and behaviour during heat waves: A 'hot role' for coping beliefs", submitted to *Risk Analysis* September 2019 [currently under review].	X	
Mechler, R., Huggel, C., Juhola, S., Bouwer, L., Wallimann-Helmer, I., Schinko, T. (close to final draft). State of the art of assessing climate risks, threats and transformation. Manuscript under preparation for *Global Environmental Change*	X	
Leis, L., Kienberger, S. (2017). Work Package 2: Synthesising climate risk information for Austria Milestone 2.1: Indicator database for floods and droughts for the national level assembled. RESPECT internal working paper.		X
Schinko, T., Babcicky, P., Kabas, T., Lintschnig, M., Mechler, R. (2018). A methodological framework for allocating risk and responsibility in Climate Risk Management in Austria. RESPECT internal WP3 working paper.		X
Lintschnig, M., Kabas, T., Schinko, T., Bednar-Friedl, B. (2019a). RESPECT Working Paper No. 2: Community level Climate Risk Management (CRM) case study – a role-playing simulation. Available at: https://respectprojectnet.files.wordpress.com/2019/10/respect_working-paper-2.pdf		X
Leitner M., Glas, N., Babcicky, P., Schinko, T. (2019). RESPECT Working Paper No. 1: Klimarisikomanagement (KRM) in Österreich: Bestandsaufnahme der Stakeholder-Landschaft und der Governance-Strukturen für die		X

Klimarisiken Hochwasser & Trockenheit/Dürre. Available at: https://respectprojectnet.files.wordpress.com/2019/05/respect_wp1-report_v01_20190507_final.pdf		
Leis, L., Kienberger, S. (2019). Work Package 2: Synthesising climate risk information for Austria. Milestone 2.2: Aggregated and synthesized risk results for flood and drought at the national level for Austria. Milestone 2.4: Documentation of the applied methodology and discussion/validation of results. RESPECT internal WP2 working paper.		X
Lintschnig, M., Schinko, T., Ortner, S., Kienberger, S., Leitner, M., Glas, N. (2019b): Rollen und Verantwortlichkeiten im lokalen Klimarisikomanagement. Handbuch zum Rollenspiel-Workshop Klimarisikomanagement. - Wegener Center Verlag, Wissenschaftlicher Bericht Nr. 81-2019, Graz, 26 S., ISBN: 978-3-9504501-9-4. Available at: https://respectprojectnet.files.wordpress.com/2019/06/handbuch_final.pdf		X

Dissemination activities (conferences, blogs and other media)	**Type of activity**
Schinko, T. (2018). Mainstreaming of Climate Extreme Risk into Fiscal and Budgetary Planning. 19. Österreichischer Klimatag, April 25, 2018, Universität Salzburg, Austria. Available at: https://respectprojectnet.files.wordpress.com/2018/05/schinko_klimatag_2018_v35.pdf	Conference presentation
Schinko, T. et al. (2018). Responsibility & Risk: Operationalizing comprehensive climate risk layering in Austria among multiple actors (RESPECT). ACRP poster presentation at the 19. Österreichischer Klimatag, April 25, 2018, Universität Salzburg, Austria. Available at: https://respectprojectnet.files.wordpress.com/2018/05/respect_poster_acrp-session_final_update.pdf	Conference presentation
Mechler, R. (2018). A perspective on risk layering to operationalise climate risk management. Session	Conference presentation

'Comprehensive Climate Risk Management – Dealing with Climate-related loss and damage.' Understanding Risk Forum, Mexico City, May 14th, 2018.	
Mechler, R. (2018). Understanding risk and limits to adaptation. Workshop Reducing Disaster Risks under Environmental Change. Knowledge-Action Network on Emergent Risks and Extreme Events. ICSU, Paris, June 28th 2018.	Conference presentation
Leitner, M. (2019). RESPECT - Rollen und Verantwortlichkeiten im Klimarisikomanagement. Presentation at one of the regular exchange meetings of the National Platform on Disaster Risk Reduction (ASDR), January 14, 2019, ZAMG, Vienna, Austria. Available at: https://respectprojectnet.files.wordpress.com/2019/06/respect-asdr_meeting_20190114_final.pdf	Conference presentation
Schinko, T., Lintschnig, M., Ortner, S. (2019). Identifying roles, responsibilities and options in climate risk management by employing role-play simulations: the case of flood risk in the "Zukunftsraum Lienzer Talboden. Poster presentation at the 20. Österreichischer Klimatag, 25. April 2019, TU Vienna, Vienna, Austria. Available at: https://respectprojectnet.files.wordpress.com/2019/06/p02-respect_poster_klimatag_2019.pdf	Conference presentation
Kienberger, S. (2019). Wo sind Brennpunkt des Klimawandelrisikos in Österreich, und wie sind diese charakterisiert? Eine räumlich-integrative Perspektive am Beispiel des Hochwasserrisikos. 20. Österreichischer Klimatag, April 25, 2019, TU Vienna, Austria. Available at: https://respectprojectnet.files.wordpress.com/2019/06/kienberger_brennpunkte-klimatag_.pdf	Conference presentation
Mechler, R. (2019). Limits to Adaptation. Case Study Evidence from around the World. Österreichischer Klimatag, April 26, 2019, TU Vienna, Austria.	Conference presentation
Leitner, M., Schinko, T., Lintschnig, M., Ortner, S. (2019). Roles and Responsibilities in Climate Risk Management in Austria – the RESPECT research project. Poster presentation at 4th European Climate Change Adaptation conference, ECCA 2019, May 28-31, 2019, Lisbon, Portugal.	Conference presentation

Mechler, R. (2019). Understanding transformation. Session Decision-making options for managing risks. ECCA 2019, May 28-31, 2019, Lisbon, Portugal.	Conference presentation
Mechler, R. (2019). Evolution of discourses on climate risks. Session New developments in risk governance: exploring risk attitudes and preferences for climate adaptation. ECCA 2019, May 28-31, 2019, Lisbon, Portugal.	Conference presentation
Schinko, T, Leitner, M/ (2019). Rollen und Verantwortlichkeiten im Klimarisikomanagement in Österreich – das RESPECT Forschungsprojekt. Poster presentation, URAT Tagung 2019, Understanding Risk – Starkregen. October 18, 2019, Vienna, Austria.	Conference presentation
Schinko, T. (2017). Kick-starting proactive management of climate-related disasters. IIASA Nexus Blog. Available at: https://blog.iiasa.ac.at/2017/11/14/how-to-kick-start-proactive-management-of-climate-related-disasters/	Blog post
Schinko, T. (2018). Kick-starting proactive management of climate-related disasters. PLACARD interchange Blog. Available at: https://www.placard-network.eu/kickstarting-proactive-management-of-climate-related-disasters/	Blog post
Pumhösel, A. (2019). Klimawandel beschleunigt das Baumsterben. Newspaper article in der Standard. Available at: https://www.derstandard.at/story/2000101912182 /klimawandel-beschleunigt-comeback-des-baumsterbens	Newspaper coverage
Mechler, R., Wolf, A., Michl, C., Haas, W., Schinko, T., Uhl-Hädicke, I., Wotatwa, G. (2018). Handlungsbedarf beim Klima: Die Perspektive der Wissenschaft. Guest commentary in Wiener Zeitung, December 18, 2018. Available at: https://www.wienerzeitung.at/meinung/gastkommentare /1008271-Handlungsbedarf-beim-Klima-Die-Perspektive-der-Wissenschaft.html?em_cnt_page=2	Newspaper guest commentary
Stachl, M. (2019). The RESPECT role-play simulation workshop in Freistadt. TV show *Thema* on ORF2, May 28, 2019.	TV coverage

Workshops organized	**National**	**International**
1st national RESPECT stakeholder workshop "Klimarisikomanagement (KRM) in Österreich", March 21, 2018, Environment Agency, Vienna, Austria.	X	
2nd national RESPECT stakeholder workshop "Klimarisikomanagement (KRM) in Österreich – Entscheidungsfindung unter Unsicherheit", April 11, 2019, Environment Agency, Vienna, Austria.	X	
1st international back-to-back expert workshop "Responsibility and Risk: Operationalizing comprehensive climate risk layering in Austria and internationally among multiple actors – 1st international expert workshop", October 13, 2017, Deltares, Delft, The Netherlands.		X
2nd international expert workshop back-to-back with the "OECD High Level Risk Forum Expert Workshop: Investing in infrastructure resilience", September 18-19, 2019, OECD Headquarters – Château de la Muette, Paris, France		X
Pre-test of the RESPECT role-play workshop, April 6, 2018, Wegener Center of Climate and Global Change, Graz, Austria.	X	
1st RESPECT role-play workshop on flood risk, June 7, 2018, Nussdorf-Debant near Lienz, Austria.	X	
2nd RESPECT role-play workshop on drought risk, December 10, 2018, University of Innsbruck, Innsbruck, Austria.	X	
3rd RESPECT role-play workshop on drought risk, May 16, 2019, Freistadt, Austria.	X	

Invited talks	**National**	**International**
Schinko, T., Leitner, M. (2017). Climate Risk Management: Linking disaster risk reduction (DRR) and climate change adaptation (CCA) in practice. Invited talk at PLACARD Workshop – Joining forces to improve DRR-CCA interaction, Red Cross EU Office, Brussels, Belgium, October 24, 2017.		X
Mechler, R. (2017). Disaster losses, risks and decision-making. 7th OECD High Level Risk Forum. Paris, December 7, 2017		X
Schinko, T. (2019). RESPECT - Rollen und Verantwortlichkeiten im Klimarisikomanagement in Österreich. Invited talk at 3. Dialogveranstaltung Anpassung an den Klimawandel in Wien, town hall Vienna, Vienna, Austria, March 11, 2019.	X	
Mechler, R. (2018). Understanding systemic risk and limits to adaptation. Workshop "Reducing Disaster Risks under Environmental Change," Knowledge-Action Network on Emergent Risks and Extreme Events, ICSU, Paris, June 28, 2018		X
Mechler, R. (2018). Climate Loss and Damage? Perspectives on the science and policy debate (with Laurens Bouwer), European Geophysical Union Conference, Vienna, April 9, 2018		X
Mechler, R. (2019). Understanding the costs and benefits of disaster risk reduction. European Commission DG Regio workshop. Brussels, March 5, 2019		X

9 Referenzen / References

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