

# Publizierbarer Endbericht

Gilt für Studien aus der Programmlinie Forschung

## A) Project data

General overview	
<b>Short title</b>	JustFair
<b>Long title:</b>	Balancing dimensions of vulnerability, coping ability and adaptive capacity for realising social justice in climate change adaptation policy
<b>Citation:</b>	Seebauer, S., Thaler, T., Dworak, T., Babicky, P., Winkler, C., Rogger, M., Matauschek, M. (2021). Balancing dimensions of vulnerability, coping ability and adaptive capacity for realising social justice in climate change adaptation policy. Final project report to the Austrian Climate and Energy Fund, Austria.
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<b>Project and cooperation partners (incl. federal state):</b>	University of Natural Resources and Life Sciences, Institute of Mountain Risk Engineering (W) Fresh Thoughts Consulting GmbH (W)
<b>Keywords:</b>	Social vulnerability; social justice; flood risk management; climate change adaptation; resilience; coping capacity
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General overview	
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## B) Project overview

### 1 Kurzfassung

#### **Motivation und Projektziele**

Hochwassergefahr und Risikomanagement sind in Gesellschaften oft ungleich verteilt und verstärken oft soziale und räumliche Ungleichheiten. Obwohl weitgehend akzeptiert ist, die vulnerabelsten Personen gezielt zu berücksichtigen, ist die politische Umsetzung durch ein unvollständiges Verständnis individueller Vulnerabilitätsmerkmale eingeschränkt. JustFair analysierte die Auswirkungen sozialer Gerechtigkeit im Hochwasserrisikomanagement, identifizierte grundlegende Faktoren für Vulnerabilität und Bewältigungskapazitäten bei privaten Haushalten sowie Klein- und Mittelunternehmen (KMU) und entwickelte Vorschläge für eine sozial gerechtere Klimaanpassungspolitik.

#### **Methode**

JustFair analysierte zwei KLAR!-Regionen: Ennstal (Steiermark) und Freistadt (Oberösterreich), letztere erweitert um den Bezirk Perg. Beide Regionen erlebten kürzlich schwere Hochwasserereignisse, weisen eine hohe Exposition von Gebäuden auf und sind im iterativen Risikomanagement und Resilienzaufbau aktiv.

JustFair integrierte qualitative und quantitative Ansätze. Umfangreiche Literaturrecherchen und Dokumentenanalysen erarbeiteten rechtliche Rahmenbedingungen und Strategien zum Hochwasserrisikomanagement. 27 halbstrukturierte Experteninterviews erfassten soziale Gerechtigkeit in Entschädigungssystemen für Hochwasserschäden. Eine standardisierte Befragung (postalisch und online) ergab eine Stichprobe von 1.127 Haushalten bei einer Rücklaufquote von 7,3%. 15 halbstrukturierte Interviews mit UnternehmerInnen und regionalen ExpertInnen sowie eine Online-Diskussion mit sechs NaturgefahrenexpertInnen analysierten KMUs im produzierenden Gewerbe. Die Interviewtranskripte wurden einer qualitativen Inhaltsanalyse unterzogen. Anhand der Befragungsdaten wurden in hierarchischen Regressionsanalysen die Determinanten und Erklärungskraft physischer, sozialer und psychologischer Vulnerabilitätsindikatoren auf verschiedene Hochwasserauswirkungen verglichen.

Relevante Stakeholder wurden gezielt identifiziert und über ein breites Spektrum an Kommunikationskanälen, Materialien und Publikationen erreicht.

#### **Zentrale Erkenntnisse**

Verschiedene europäische Länder verwenden unterschiedliche Ansätze von sozialer Gerechtigkeit in ihren Strategien zum Hochwasserrisikomanagement. Diese Ansätze geben unterschiedliche Antworten, wie Hochwasserrisikomanagement geplant und umgesetzt wird und wer gewinnt und wer verliert, wenn technische Schutzmaßnahmen umgesetzt oder Entschädigungen ausgezahlt werden.

Psychologische Vulnerabilitätsindikatoren spielen keine entscheidende Rolle für materielle Hochwasserauswirkungen, da sie kaum zusätzliche Varianz über physische und soziale Indikatoren hinausgehend erklären (Änderung in  $R^2$  um 1-3%). Psychologische Indikatoren haben jedoch einen beträchtlichen eigenständigen Erklärungswert für immaterielle Auswirkungen (Änderung in  $R^2$  um 5-7%). Im Gegensatz dazu bleibt der Einfluss sozialer Indikatoren erhalten, auch wenn psychologische Indikatoren einbezogen werden.

Die Verwundbarkeit und die Bewältigungskapazität von KMUs ergeben sich aus dem engen Zusammenspiel von (1) den politischen Rahmenbedingungen, v.a. der Katastrophenfonds, (2) unternehmensorientierten Faktoren, z.B. Verfügbarkeit von Kapital, Kundenbindung, Flexibilität der Arbeitskräfte, und (3) unternehmerorientierten Faktoren, z. B. psychologische Belastbarkeit, soziale Netzwerke, politische Wirksamkeit.

### **Schlussfolgerungen**

Soziale Gerechtigkeit wird in verschiedenen theoretischen Rahmen berücksichtigt (z.B. utilitaristisch, egalitär, libertär, prioritär/bedarfsbasiert, leistungsorientiert oder rechthebasiert), die unterschiedliche politische Strategien zur Erreichung von Resilienz vorsehen.

Eine Betrachtung von immateriellen Hochwasserauswirkungen erfordert gleichzeitig eine Einbeziehung von psychologischen Faktoren als Quellen von Vulnerabilität. Da verschiedene Auswirkungen von verschiedenen Vulnerabilitätsindikatoren abhängen, sollten Risikomanagementmaßnahmen gezielt auf jene Indikatoren ausgerichtet werden, die für bestimmte Auswirkungen prägend sind. Im Gegensatz zur derzeitigen bestimmenden Praxis in Österreich, erklären physische Vulnerabilitätsindikatoren nur einen kleinen Teil der erwarteten materiellen und immateriellen Auswirkungen. Um die soziale Gerechtigkeit zu verbessern, sollten Instrumente im Hochwasserschutz immaterielle Auswirkungen und psychologische Vulnerabilitätsindikatoren mit einbeziehen.

Bei der Vulnerabilität von KMUs sollten sowohl unternehmens- als auch unternehmerorientierte Faktoren berücksichtigt werden. Um die Bewältigungskapazitäten von KMUs zu verbessern, könnten z.B. ein Mentorenprogramm durch UnternehmerInnen mit früherer Hochwassererfahrung eingeführt, informelle geschäftliche und politische Netzwerke konsolidiert, UnternehmerInnen in der Risikobewertung geschult und private (Gruppen-)Versicherungen gefördert werden.

Die JustFair-Ergebnisse machen deutlich, dass Vulnerabilität als ein vielschichtiges Konzept verstanden und gemessen werden sollte, das physische, soziale und psychologische Merkmale, materielle und immaterielle Ergebnisse sowie unternehmens- und unternehmerorientierte Faktoren integriert. Folglich sollte die Kosten-Nutzen-Analyse von Schutzmaßnahmen soziale, psychologische und immaterielle Aspekte einbeziehen, etwa indem einkommensschwache Haushalte stärker gewichtet werden.

## 2 Executive Summary

### **Project rationale and objectives**

Flood hazard and risk management are often unequally distributed in societies, and policies often increase social and spatial inequalities that enhance flood risks. Even though the basic notion of targeting the most vulnerable seems fairly accepted, its implementation in policy practice suffers from an incomplete understanding which individual characteristics are constitutive for vulnerability. JustFair analyzed the social justice implications in flood risk management; identified constitutive drivers of vulnerability and coping capacities among private householders as well as small and medium enterprises (SMEs); and developed governance guidance for more equitable, socially just climate adaptation policy.

### **Methods**

JustFair analysed two KLAR! regions as study sites: Ennstal (Styria) and Freistadt (Upper Austria), the latter expanded by the district of Perg. Both regions recently experienced severe flood events, feature high exposure of buildings and are active in iterative risk management and resilience building.

JustFair integrated qualitative and quantitative approaches. Extensive literature reviews and document analyses compiled legal frameworks, flood risk management strategies and other policy documents. 27 semi-structured expert interviews assessed social justice issues in flood damage compensation schemes. Standardized self-completion questionnaires were distributed postally and online, yielding a sample of 1,127 households at a response rate of 7.3%. Fifteen semi-structured interviews with owner-entrepreneurs and regional experts plus an online discussion with six natural hazard experts analyzed SMEs in the manufacturing sector. Semi-structured interviews were transcribed and then subjected to qualitative content analysis. With the household survey data, hierarchical regression analyses identified the determinants of different vulnerability outcomes and compared the explanatory power of physical, social and psychological vulnerability indicators on different vulnerability outcomes.

Relevant stakeholders were identified and reached through a broad scope of communication channels and materials (e.g. website, webinars, scientific articles).

### **Main Findings**

Different European countries are using different social justice policy directions in their flood risk management strategies. These approaches provide different answers, how flood risk management is planned and implemented, and who gains and who loses if public administrations implement technical mitigation measures or pay out recovery compensation. Consequently, social justice in flood risk management also highly influences who is vulnerable or not.

Psychological sources do not play a critical role for tangible vulnerability outcomes of flood events, as they do not significantly add to the variance already explained by physical and social indicators (change in  $R^2$  by 1-3%). However, psychological

sources add unique explanatory power to intangible outcomes (change in  $R^2$  by 5-7%), and may supersede certain physical indicators. By contrast, social indicators retain their effect size even if psychological indicators are included.

SME vulnerability and coping capacity emerge from the close interaction of (1) the policy framework, foremost the public disaster compensation scheme; (2) enterprise-oriented factors, e.g. availability of capital, customer loyalty, labour force flexibility; and (3) entrepreneur-oriented factors, e.g. psychological resilience, social networks, political efficacy. Flood impacts may increase bankruptcy risk when coinciding with economic and personal challenges, but recovery may also enable business reorientation.

In order to make sure that future risk and emergency management activities do reach the most vulnerable groups, policy design should account not just for physical, but also for social and psychological indicators, e.g. by assigning higher weighting to low-income households when paying out the Austrian disaster fund or when conducting cost-benefit-analysis for the selection and prioritisation process of protection measures. However, as vulnerability cannot be reduced to economic disadvantage, policies should be tailored to multiple sources of vulnerability.

### **Conclusions and outlook**

Various theoretical frameworks have been developed to consider social justice (such as utilitarian, egalitarian, libertarian, prioritarian/needs-based, merit-based, or rights-based), which foresee different policy directions and support to reach the goal of resilience. Government activities to reach resilience depend on different philosophical schools.

Expanding the scope of vulnerability outcomes to intangible impacts calls for simultaneously expanding the scope of sources of vulnerability to psychological factors. Since different types of flood impacts depend on different sources of vulnerability, risk managers should address the vulnerability sources specific to particular outcomes. Contrary to assumptions in current Austrian policy decisions, physical sources of vulnerability only explain a small amount of expected tangible and intangible outcomes. To improve social equity, flood policy instruments should incorporate intangible outcomes and psychological sources of vulnerability.

Business vulnerability frameworks for SMEs should consider both enterprise- and entrepreneur-oriented factors. To improve SME coping capacities, flood risk managers could, e.g., introduce a mentoring scheme by entrepreneurs with previous flood experience, consolidate informal business and political networks, train entrepreneurs in risk assessment, and promote private (group) insurance.

The JustFair findings highlight that vulnerability needs to be understood (and measured) as a multi-faceted concept, integrating physical, social and psychological characteristics; tangible and intangible outcomes; and enterprise- and entrepreneur-oriented factors. Otherwise, vulnerable households or SMEs may be underrepresented or even overlooked.

### 3 Motivation and objectives

Flood hazard and risk management are often unequally distributed in societies. In some regions, it is more likely that deprived communities (who are more likely vulnerable to flood risks) are living in floodplain areas (Maldonado et al. 2016; Collins et al. 2018; Chakraborty et al. 2014). In addition, these groups are usually less well connected within their national political systems and decision-making processes to ensure their interests and needs are met (Thaler & Priest 2014; Thaler & Levin-Keitel 2016). Deprived communities also often receive less support (such as financial resources) from the public administration (Munoz & Tate 2016; Emrich et al. 2020). Scholars have referred to these unequal policies as discrimination perpetrated by many public administrations (Bolin et al. 2005; Maldonado et al. 2016). Consequently, flood risk management policies often encourage or increase social and spatial inequalities that enhance flood risks (Chakraborty et al. 2014; Thaler et al. 2018).

Hazard-related risks, needs and capacities arising from personal livelihoods are not equally distributed among all members of a community, but retrace the lines of social stratification (Parsons et al. 2016; Tierney 2014). Even though the basic notion of giving special consideration to those who are most vulnerable seems fairly accepted (Thaler and Hartmann 2016), its implementation in policy practice suffers from a vague and incomplete understanding which individual characteristics are constitutive for vulnerability. A social-psychological perspective can help to detail the multiple factors underlying individual vulnerability and more accurately identify the most vulnerable groups.

Household-level flood impacts are not restricted to tangible damage of physical assets and private possessions, which can be quantified in financial terms, but also comprise intangible effects in terms of trauma, emotional distress and disruption of livelihoods. Often, intangible effects turn out to be more stressful, more enduring and more difficult to recover from, compared to physical damage (Masson et al. 2019; Tapsell and Tunstall 2008). In her seminal work on social vulnerability, Susan Cutter and colleagues (Cutter et al. 2003) showed that not just the characteristics of physical structures, but also the characteristics of residents living in these structures contribute to their overall vulnerability. Thus, tangible, physical, building-related characteristics, such as building fabric or monetary value of exposed assets, need to be considered jointly with intangible, social, person-related characteristics such as age, gender or income (Rufat et al. 2015; Cutter and Finch 2008; Cutter et al. 2000).

The vulnerability logic also translates to small and medium sized enterprises (SMEs). SMEs are especially vulnerable to natural hazards (Zhang et al. 2009; Marshall et al. 2015; Karagiorgos et al. 2016a; Josephson et al. 2017). Losses by SMEs might include loss of customers, suppliers, employees or utility disruptions, which all may contribute to eventual business closures (Zhang et al. 2009; Sydnor et al. 2017). SMEs can be driven into bankruptcy more easily compared to large businesses (Marshall et al. 2015). The entrepreneur or company leader is critical

whether SMEs stay in business after a natural hazard event, compared to large companies (Stafford et al. 1999; Webb et al. 2002; Winter et al. 2004; Danes et al. 2008). SME business recovery after an external shock like a flood event crucially depends on entrepreneur risk perception and awareness, management strategies to recover, and owner characteristics (Webb et al. 2002). SMEs are not just economic entities driven by market forces: the livelihood of the entrepreneurs, their households, their employees and the employees' households are often directly tied to the continuance of the business (Winter et al. 2004; Marshall et al. 2015).

From these motivations, JustFair derives three main objectives:

First, to analyze and to understand the social justice implications in flood risk management. In particular, the project focuses on existing management approaches to reach a more cohesive managed retreat policy (Rauter et al. 2019; Thaler et al. 2020). A key challenge reflects the social justice implications of managed retreat, especially if private land owners in hazard-prone areas get compensated or not to remove their house. These open questions about whether we should compensate people, how should be the type of compensation, the level of compensation, or should people care about themselves as the cost-benefit analysis (CBA) shows a negative or low ratio with the results that the government does not provide any flood protection schemes, such as dams, for these communities.

Second, to expand the current physical and social perspective on vulnerability by psychological factors. This approach is considered to improve the knowledge about who are the most vulnerable people and to facilitate targeted flood risk management strategies. We do so on both sides of the relationship between (a) the outcomes caused by flooding, i.e. the impacts residents face when affected by a flood; and (a) the sources of vulnerability that lead to these outcomes, i.e. the needs and capacities of exposed residents. Therein, we set out to resolve the natural/social sciences dichotomy towards a multi-faceted understanding of risk spanning tangible as well as intangible aspects (Renn 2008). Pursuing this objective offers a threefold contribution to the methodological debate on assessing vulnerability: First, we demonstrate how psychological factors, which are at times criticised for being vague and unclear, can be operationalised in a compact questionnaire format. Second, for the Austrian context, we show which specific psychological indicators are most relevant for painting a more comprehensive picture of household-level vulnerability to flood hazards. Our second contribution also leads us to caution against the common practice of pooling indicators into composite vulnerability indices, as our results indicate that the same indicators vary widely in their influence (in other words, their index weight) on different vulnerability outcomes. Third, in line with the social vulnerability perspective on people instead of places, we employ disaggregated household-level data. Most social vulnerability approaches based on the hazard-of-place model (Cutter et al. 2003) use census statistics aggregated into geographical clusters or administrative districts. However, spatial and interpersonal aggregation obscures non-place-



based individual differences between households living in the same hazard-prone area.

Third, to investigate the determinants of vulnerability and coping capacity of SMEs to flood events. We assess these determinants from the interrelated triad of (i) the public policy framework for SME flood risk management; (ii) enterprise-oriented factors, i.e. aspects of capital structure, labour availability, supply systems and customer relations; and (iii) entrepreneur-oriented factors, underscoring the role of psychological resilience, social networks and political efficacy of the business leader. Therein, we expand on common business vulnerability frameworks such as Zhang et al. (2009), emphasising that qualitative characteristics of SMEs are as important towards recovering from disasters as business metrics such as cash flow or number of employees.

## 4 Content and results

*Note:* This report features selected core findings and excerpts from the scientific publications produced during the project (see Section 9). Sections 4, 5 and 7 mainly build on Thaler et al. (2020), Babczyk, Seebauer & Thaler (2021) and Winkler, Thaler & Seebauer (2021). For more detailed information and comprehensive results, please refer to the respective, mostly Open Access, publications and to the project website <https://justfair.joanneum.at/>.

### 4.1 Social justice in flood risk management

In the last decade, attention on questions of justice in the context of flood risk management has increased. This literature largely builds on two strands of literature that have emerged from different disciplines: climate justice and environmental justice. Climate justice has its roots in political philosophy, mostly focussing on the distributive questions that are raised by climate change, but also paying due attention to procedural aspects and aspects of recognition (Schlosberg et al. 2017; Patterson et al. 2018). Environmental justice originally emerged as a social movement in the late 1980s in response to unsafe waste disposal sites and rundown neighbourhoods in the US. Environmental justice as a field of academic research and a policy principle is of a more recent date (Doorn 2019). In the wake of its origin in environmental and civil rights activism, environmental justice language has provided a “vocabulary of political opportunity, mobilization and action” to bring to attention previously neglected or overlooked patterns of inequality that negatively impact people’s health, wellbeing and quality of life (Agyeman and Evans 2004).

Current research in environmental justice also includes the distribution of benefits, such as to green and blue spaces (Mutz et al. 2002). Although the more conceptual philosophy literature has so far paid relatively little attention to the justice aspects involved in flood risks (Doorn 2015), empirically informed literature on justice aspects of flood risk management is growing, focussing on the allocation of resources, wealth, responsibilities and burdens across different members of a community (Johnson et al. 2007; Doorn 2016; Doorn 2018; Kaufmann et al. 2018; Thaler et al. 2018). There are different philosophical schools (e.g., utilitarian, egalitarian, libertarian, proportional etc., see Table 1) which dictate different interpretations of distribution and engagement of a community in flood risk management politics (Doorn 2018; Kaufmann et al. 2018; Thaler et al. 2018; Hartmann 2018; Bennett et al. 2019). Most of these approaches could be seen as a response to a utilitarian approach which seeks to maximise the aggregated sum. Hence, how individuals fare within such a system, that is, how risks and benefits are distributed, does not matter within a utilitarian approach to justice. The other approaches all focus on the risks and benefits that are to be distributed. See Table 1 for a short description of each of these approaches to distributive justice. In addition to discussions of the actual distributional effects of flood alleviation schemes or payments (Campbell 2012; Neal et al. 2014), discussion focuses also

on the way in which these schemes or payments are achieved, which is usually captured under the heading of procedural justice (Johnson et al. 2007; Walker and Burningham 2011; May and Morrow 2012; Patrick 2014; Alexander et al. 2018). Whereas distributive justice is about the justness of distributions, procedural justice can be conceived as the fairness by which this distribution is decided upon and the question of whether all people have equal access to this procedure (Doorn, 2019). Procedural justice is strongly linked to the democratic principle that problems that affect a person or group of persons ought to be resolved by the persons affected, either directly or through their representatives (Vanderheiden 2008). Procedural justice denotes equal opportunity amongst stakeholders to influence the decision-making process and due consideration of all interests in the resulting outcome (Paavola and Adger 2006).

**Table 1: Concepts of social justice in flood risk management**

Concepts of social justice	Short description
Utilitarian	Allocation of resources so that the highest benefit for the community is obtained. Distribution of costs and benefits is not taken into account.
Egalitarian	Allocation of resources so that inequality between different actors is reduced.
Libertarian	Main focus lies on the individualistic role in flood risk management, where the public administration should not infringe on private property for the implementation of large flood alleviation schemes. Flood risk management limited to provision of hazard information.
Proportional	Dictates that an individual person should not have to carry a disproportional burden of something that benefits the collective as a whole
Prioritarian	Flood risk management policy should focus on the most vulnerable members within the community.

© Thaler et al. (2020); page 107

JustFair demonstrated how different European countries are using different social justice policy directions, which highly influence their national, regional and local flood risk management strategy. The different approach in each country demonstrated different answers how flood risk management are planned, implemented and managed; who takes the main responsibility and who takes the

lead in terms of funding risk reduction measures, emergency management or the recovery phase. JustFair also shows that different social justice policies (table 1) have highly implications on the question who gains and who loses by public policies. Consequently, social justice in flood risk management also highly influences the question who is vulnerable or not.

## 4.2 Vulnerability of private households

Vulnerability is considered a pre-existing condition that unfolds in manifold ways during a hazard event (Tapsell et al. 2010); therein, tangible disaster outcomes are distinguished from intangible disaster outcomes:

- *Tangible vulnerability outcomes* include, for instance, damage to buildings and their contents (Kind et al. 2020), or the loss of irreplaceable personal items and memorabilia (Penning-Rowsell and Green 2000). Tangible outcomes are usually quantified in monetary terms as the costs for repairing or re-purchasing damaged assets (Tapsell et al. 2002).
- *Intangible vulnerability outcomes*, by contrast, include, for example, being forced to leave one's home and seek emergency shelter (Fekete 2019), or distress caused by managing insurance claims and re-building damaged homes (Whittle et al. 2010). Flood victims face health impacts, including injury, illness or death, and mental impacts, such as post-traumatic stress disorder, anxiety, sleeping problems, or they may struggle with an exhausting and prolonged process of getting back to normal life (Walker-Springett et al. 2017; Karagiorgos et al. 2016b). Non-monetary impacts are significant and often more important to households than monetary impacts (Green and Penning-Rowsell 1989).

JustFair's perspective on vulnerability includes susceptibility (i.e. how people are affected), as well as coping and adaptation (i.e. how people are able to avoid or mitigate harm). Overall, vulnerability is caused by physical, social, and psychological sources; here, these sources are presented with exemplary indicators:

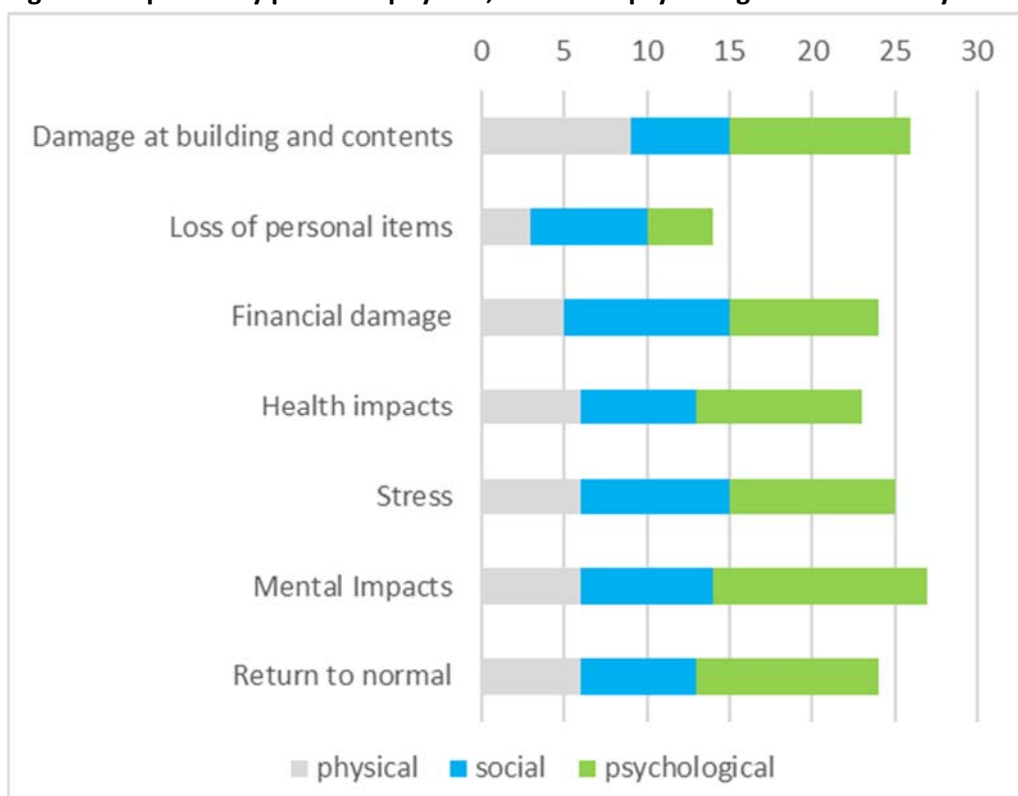
- *Physical vulnerability sources* primarily refer to building-related factors. Multi-storey buildings, for example, have a smaller damage-affected fraction than single-storey buildings (Merz et al. 2010). Buildings with basements are more susceptible to flooding (Papathoma-Köhle et al. 2019). Expensive homes (determined by building size, building value and contents value) are more costly to repair (Emrich et al. 2020).
- *Social vulnerability sources* refer to socio-demographic characteristics, such as age, gender and income (Fekete 2019; Cutter et al. 2003). Older people, for example, tend to be more fragile and financially weak (Morrow 1999), require more assistance during evacuation (Chakraborty et al. 2005), and often need special medical equipment at emergency shelters (McGuire et al. 2007). Women often have care responsibilities for others that keep them

from immediately seeking safety when a disaster strikes (Laska and Morrow 2007). Generally, women suffer from higher mortality (Alderman et al. 2012) as well as more severe posttraumatic stress, anxiety and depression (Goldmann and Galea 2014) after a flood event than men.

- *Psychological vulnerability sources* include various perceptual and behavioural factors. For instance, risk perception influences people’s intentions to undertake flood protective measures (Kievik and Gutteling 2011). Private flood preparedness is also influenced by self-efficacy – the belief to be able to carry out protective actions successfully (Botzen et al. 2019). High levels of self-efficacy protect against psychological distress and increase overall resilience.

The following figure illustrates the respective explanatory power of physical, social and psychological indicators, given as the share of explained variance in vulnerability outcomes in % R<sup>2</sup>. The subsequent tables show the effects of physical, social and psychological indicators on seven different tangible and intangible vulnerability outcomes, as determined in JustFair’s household survey.

**Figure 1: Explanatory power of physical, social and psychological vulnerability indicators**



**Table 2: Hierarchical regression results for physical, social and psychological vulnerability indicators and tangible vulnerability outcomes**

<i>Physical indicators</i>	Building & contents damage				Loss of personal items				Financial damage			
	<i>Phys (1)</i>	<i>Soci (2)</i>	<i>FIPr (3)</i>	<i>Psyc (4)</i>	<i>Phys (1)</i>	<i>Soci (2)</i>	<i>FIPr (3)</i>	<i>Psyc (4)</i>	<i>Phys (1)</i>	<i>Soci (2)</i>	<i>FIPr (3)</i>	<i>Psyc (4)</i>
Building type (house/apartment)	.01	-.01	-.03	-.02	.09**	.06	.04	.04	.00	-.06	-.08*	-.08**
Basement (no/yes)	.06**	.07**	.07**	.06**	.05*	.07**	.06**	.07**	.05	.06	.05*	.05*
Ground floor (no/yes)	.11***	.11***	.12***	.11***	.09***	.09***	.09***	.09***	.08***	.07**	.08*	.07**
Building and contents value	-.01	-.01	-.01	-.01	-.01	.00	.00	-.01	-.07**	-.05	-.05	-.04
Size of living area	.00	-.02	-.02	-.02	-.01	-.03	-.02	-.03	-.01	.01	.01	.01
Location (remote/central)	.07**	.10***	.09***	.09***	.08**	.11***	.10***	.10**	.04	.07**	.06**	.06**
Risk zone (no/yes)	.16***	.15***	.03	.00	.08**	.05*	-.01	-.02	.15***	.11***	.02	-.02
Flood experience (no/yes)	.10***	.12***	.06**	.04	.02	.05	.00	.00	-.05	-.02	-.07**	-.08**
Timely early warning	.00	.01	.01	.02	.02	.03	.03	.03	.06*	.06**	.06**	.08**
External shelter availability	.00	-.04	-.03	-.02	-.04	-.08***	-.08***	-.07**	-.01	-.05*	-.04	-.01
Building ownership (no/yes)	.01	.05	.05	.05	.00	.03	.04	.03	.03	.09**	.09**	.09**
Flood protective measures	.06**	.08**	.00	.02	.05	.07**	.02	-.03	.07**	.09***	.02	.02
Insurance (no/yes)	.06*	.07**	.06**	.08***	.00	.03	.02	.04	.04	.06**	.06**	.11***
<b><i>Social indicators</i></b>												
Age		-.07	-.07	-.07		-.05	-.05	-.03		-.07	-.07	-.06
# of hh members w/ disabilities		-.07**	-.07***	-.07***		-.06**	-.07**	-.06**		.00	.01	.00
# of very young children (< 3 y.)		.00	.05	.03		-.04	-.03	-.01		.00	.00	.00
# of children (3 to 13 y.)		.03	.05	.05		.03	.04	.06		.06	.07**	.08**
# of elderly hh members (> 60 y.)		-.08**	-.09**	-.08**		-.05	-.05	-.06		-.13***	-.13***	-.12***
# of hh members (total)		.03	.04	.03		.05	.06	.04		.01	.02	.00
Gender (f/m)		-.10***	-.09***	-.09***		-.16***	-.16***	-.15***		-.17***	-.16***	-.15***
Household income		-.05	-.02	-.01		-.09**	-.07*	-.04		-.15***	-.13**	-.11***
Education		.09***	.09***	.08***		.02	.02	.04		.02	-.02	.04
Length of residence		-.04	-.02	-.02		-.09**	-.08**	-.07*		-.06	-.04	-.02
# of vehicles		.03	.02	.02		.03	.02	.02		.00	-.00	-.00
<b><i>Psychological indicators 1</i></b>												
Perceived flood probability			.37***	.33***			.22***	.17***			.29***	.23***
<b><i>Psychological indicators 2</i></b>												
Protection intention				-.04				-.06				-.09**
Fear of flooding				.10***				.12***				.15***
Risk-taking				-.02				.04				.00
Social norms				.00				.06				.00
Social capital				.03				.00				.00
Institutional capital				-.02				.02				.00
Self-efficacy				.02				.04				.02
Collective efficacy: internal				-.05				.05				.04
Collective efficacy: external				.04				-.00				.04
Political efficacy: internal				.04				-.03				-.06*
Political efficacy: external				.03				-.05				-.08**
Wishful thinking				-.05				-.02				-.01
Trust in public flood protection				-.02				.00				.02
Trust in public compensation				-.03				-.01				-.10***
Perceived responsibility (pub./priv.)				-.00				-.00				-.05*
Structured style				-.03				.03				-.00
Tolerance of negative feelings				.00				-.06**				-.03
Spiritual influences				-.02				.02				-.01
R <sup>2</sup> adj.	.09	.15	.25	.26	.03	.10	.13	.14	.05	.15	.21	.24
ΔF	9.1***	7.7***	132.9***	1.4*	3.1***	7.8***	39.3***	1.6**	4.8***	12.1***	80.8***	2.7***

Standardised beta coefficients: \* p < .10; \*\* p < .05; \*\*\* p < .01; Phys = block one containing physical indicators; Soci = block two including social indicators; FIPr = block three including perceived flood probability; Psyc = block four including psychological indicators; hh = household; timely early warning is measured on a 5-step response scale indicating whether a household expects to receive early warning in case of flooding.

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**Table 3: Hierarchical regression results for physical, social and psychological vulnerability indicators and intangible vulnerability outcomes**

	Health impacts				Stress				Mental impacts				Struggle to return to normal			
	Phys (1)	Soci (2)	FIPr (3)	Psyc (4)	Phys (1)	Soci (2)	FIPr (3)	Psyc (4)	Phys (1)	Soci (2)	FIPr (3)	Psyc (4)	Phys (1)	Soci (2)	FIPr (3)	Psyc (4)
<b>Physical indicators</b>																
Building type (house/apartment)	.00	-.03	-.05	-.05***	.03	.00	-.02	-.02	-.01	-.06	-.07*	-.07*	-.02	-.05	-.06	-.07*
Basement (no/yes)	.02	.02	.02	.02	.05	.05*	.05	.05	.06**	.06**	.06**	.06**	.07**	.07**	.06**	.07**
Ground floor (no/yes)	.08**	.08**	.09**	.09***	.08**	.08**	.08***	.09***	.06*	.05	.06*	.06*	.05	.04	.05	.05
Building and contents value	-.05*	-.04	-.04	-.04	-.05	-.04	-.04	-.03	-.07**	-.06*	-.06**	-.05*	-.06*	-.04	-.04	-.03
Size of living area	-.03	.00	.00	.00	.00	-.02	-.01	.00	-.06*	-.02	-.02	-.01	-.06*	-.02	-.02	-.02
Location (remote/central)	.07**	.09***	.08***	.07*	.07**	.10***	.09***	.09***	.06*	.08***	.07**	.06**	.06**	.08***	.07**	.06**
Risk zone (no/yes)	.12***	.09***	.00	-.03	.14***	.11***	.03	-.02	.14***	.11***	.01	-.03	.12***	.09**	.00	.04
Flood experience (no/yes)	.05	.06*	.01	.00	.06*	.08**	.04	.00	.00	.00	-.04	-.07**	-.06*	-.04	-.08***	-.11***
Timely early warning	.03	.03	.03	.05	.04	.05*	.05*	.07**	.04	.05	.04	.07**	.08*	.09***	.09***	.10***
External shelter availability	-.08***	-.10***	-.09***	-.07**	.00	-.05*	-.05	-.02	-.06**	-.08***	-.07**	-.03	-.09***	-.10***	-.09***	-.06**
Building ownership (no/yes)	-.03	.00	-.01	.01	.00	.05	.05	.05	.01	.06	.06	.06	.01	.06	.06	.06
Flood protective measures	.14***	.15***	.09***	.08**	.08**	.10**	.04	.03	.10***	.12***	.06*	.07*	.13***	.14***	.08***	.05
Insurance (no/yes)	-.03	-.01	-.01	.00	.01	.03	.03	.05*	.04	.05	.04	.07**	-.01	.01	.00	.05
<b>Social indicators</b>																
Age		.08*	.08*	.09**		-.03	-.03	-.04		.02	.02	.03		.07	.07	.08*
# of hh members w/ disabilities		-.01	-.02	-.01		-.06**	-.06**	-.05*		-.02	-.03	-.01		-.02	-.02	-.00
# of very young children (< 3 y.)		-.07**	-.06*	-.05		-.05	-.04	-.03		-.05	-.04	-.02		-.06**	-.06*	-.03
# of children (3 to 13 y.)		.00	.00	.02		.00	.02	.03		-.01	.02	.02		.00	.01	-.04
# of elderly hh members (> 60 y.)		-.09**	-.10***	-.10***		-.12***	-.13***	-.12***		-.11***	-.11***	-.11***		-.09**	-.10***	-.09**
# of hh members (total)		.03	.04	.00		.05	.06	.03		.01	.02	-.02		.02	.02	.01
Gender (f/m)		-.20***	-.20***	-.16***		-.19***	-.18***	-.15***		-.23***	-.22***	-.16***		-.21***	-.20***	-.16***
Household income		-.13***	-.11***	-.09**		-.08*	-.06	-.04		-.15***	-.13**	-.08**		-.13***	-.11**	-.07*
Education		.03	.03	.06**		.09***	.10***	.12***		.05	.05	.09***		-.01	-.01	.02
Length of residence		-.11***	-.09***	-.09**		-.06*	-.05	-.04		-.06	-.05	-.04		-.13***	-.12***	-.11***
# of vehicles		.07*	.06	.07*		-.02	.01	.03		.04	.04	.05		.04	.04	.05
<b>Psychological indicators 1</b>																
Perceived flood probability			.27***	.18***			.27***	.18***			.28***	.18***			.27***	.16***
<b>Psychological indicators 2</b>																
Protection intention				-.04				-.05				-.07*				-.07*
Fear of flooding				.21***				.22***				.26***				.24***
Risk-taking				.00				-.03*				-.05*				-.04
Social norms				.00				-.04				-.01				.03
Social capital				.00				.00				-.00				-.04
Institutional capital				-.04				-.01				-.05				-.00
Self-efficacy				-.04				-.02				-.02				.00
Collective efficacy: internal				.03				-.04				.01				.02
Collective efficacy: external				.02				.02				.02				.04
Political efficacy: internal				-.06*				-.01				-.07*				-.04
Political efficacy: external				.03				.05				-.04				-.04
Wishful thinking				.04				.00				-.02				.00
Trust in public flood protection				-.04				-.05				.00				.00
Trust in public compensation				.04				.00				-.02				-.04
Perceived responsibility (pub./priv.)				-.02				-.02				-.01				-.03
Structured style				-.05*				-.06**				-.01				-.02
Tolerance of negative feelings				.00				-.03				-.09***				-.08***
Spiritual influences				.04				.00				.04				.03
R <sup>2</sup> adj.	.06	.13	.17	.23	.06	.15	.20	.25	.06	.14	.20	.27	.06	.13	.19	.24
ΔF	6.6***	7.9***	67.8***	3.1***	5.8***	11.0***	69.5***	3.7***	5.7***	9.9***	72.9***	5.8***	6.2***	8.5***	63.1***	4.7***

Standardised beta coefficients: \* p < .10; \*\* p < .05; \*\*\* p < .01; Phys = block one containing physical indicators; Soci = block two including social indicators; FIPr = block three including perceived flood probability; Psyc = block four including psychological indicators; hh = household; timely early warning is measured on a 5-step response scale indicating whether a household expects to receive early warning in case of flooding.

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The first block, only comprising physical indicators, explains about 9% of the variance of the tangible outcome building and contents damage. Adding social indicators in the second block, increases the explained variance to 15%, and after adding perceived flood probability (block three) 25% of the variance in building and contents damage can be explained. The addition of psychological variables (block four), only yields a marginal increase in explained variance (R<sup>2</sup> adj. = .26). A similar pattern is observed for the other two tangible outcomes, loss of personal items and financial damage. Expanding physical indicators by social indicators and perceived flood probability allows to explain up to four times more variance in tangible vulnerability outcomes. This confirms the importance of social factors for

vulnerability assessments. However, psychological indicators do not appear to play a critical role for tangible outcomes, as they do not significantly add to the variance already explained by physical and social indicators.

Physical indicators account for just 6% of the variance in the four intangible vulnerability outcomes, suggesting that physical indicators alone are insufficient to explain intangible outcomes. After adding social indicators in the second block, explained variance increases to 13–15%, which resembles the explanatory power of social indicators on tangible outcomes. However, explained variance in intangible outcomes improves significantly upon entering perceived flood probability (up to 20%) and the remaining psychological indicators (up to 27%). Together, perceived flood probability and other psychological indicators yield additional 10–13% in explained variance of intangible outcomes; this underscores the importance of psychological sources for a comprehensive perspective on flood vulnerability.

Interpreting the previous tables of the hierarchical regression analysis with regards to specific regression coefficients yields a highly differentiated picture of vulnerability.

With regards to tangible vulnerability outcomes, the role of physical indicators varies depending on the particular outcome. The presence of a basement and a ground floor, as well as the remoteness of the building, and whether a household has purchased flood insurance, all significantly increase tangible vulnerability outcomes. These indicators have a unique, stand-alone impact on tangible outcomes, because they remain significant even when social and psychological factors are added. Other indicators seem less relevant for vulnerability outcomes than expected: Building type, building and contents value, size of the living area, the expectation to receive timely early warning, the availability of external shelter and building ownership only turn significant in some models. Risk zone plays a particularly interesting role as its influence on tangible outcomes becomes insignificant as soon as perceived probability is included as a psychological indicator. This implies that risk zone could be a stand-in indicator for how likely households consider a flood, which in turn makes them expect more severe tangible outcomes. A similar shift in influence is found for flood protective measures regarding all three tangible outcomes and for flood experience regarding building and contents damage.

Among the social indicators, gender shows the most consistent effect, indicating that men expect to suffer less tangible outcomes than women. The presence of care-dependent household members and a higher number of elderly household members is associated with weaker tangible outcomes. Perhaps, those who depend on care are well-prepared for a range of everyday constraints and are therefore less concerned about a flood emergency situation; elderly people may have a greater experience with living in flood risk areas. Other factors such as education, the number of children and length of residence only determine selected tangible outcomes. Also, the role of income is less clear-cut than suggested by



previous research: While higher income leads to downplaying of financial damage, it has no effect on building and contents damage, and does not remain significant in the model on loss of personal items after adding psychological indicators. This differential result by damage type should caution to oversimplify and generalise the effect of income. Age, the presence of very young children, the total number of household members and the number of vehicles do not turn significant in any of the models on tangible outcomes. In contrast to physical indicators above, the social indicators retain their effect size even if psychological indicators are included in the models.

Among the psychological indicators, flood probability perception and fear strongly contribute to the expectation of more severe tangible flood outcomes. These two indicators seem to underlie the effects of the physical indicators risk zone, protective measures and flood experience. Other significant psychological indicators centre on the model on financial damage; here, households with higher protection intention, internal and external political efficacy, trust in public compensation and perceived private responsibility expect lower financial impacts. The majority of psychological indicators (e.g. social capital, self-efficacy, wishful thinking) does not reach statistical significance for any of the three tangible outcomes. This suggests that only very few psychological indicators are relevant to determine tangible flood damage.

With regards to intangible vulnerability outcomes, physical indicators do contribute to intangible outcomes; however, their impact is relatively weak and varies between specific outcomes. Among the physical indicators, a more central location of the residence exacerbates all four intangible outcomes. The existence of a ground floor and the expectation to receive a timely early warning increase three out of four intangible outcomes; living in a house instead of an apartment leads to more severe health and mental impacts and more struggle with returning to normal. Interestingly, the influence of several physical indicators drops or turns statistically insignificant when adding social and psychological indicators. A larger living area, for instance, is associated with less mental impacts and less struggle to return to normal in the model with just physical indicators, but this indicator turns statistically insignificant once social indicators are added. Possibly, the effect of living area is better captured by social indicators of household size and structure. Risk zone increases all intangible outcomes when analysed together with physical and social indicators, but its effect disappears as soon as the scope is widened to psychological indicators; this resembles the stand-in role of risk zone for perceived flood probability in regards to tangible outcomes. The behaviour of flood experience is ambivalent: Regarding health impacts and stress, the effect of flood experience is substituted by psychological indicators, but flood experience seems to have a unique strengthening effect on coping capacities, since it remains relevant for mental impacts and struggle to return to normal, even if psychological indicators are added.

A range of social indicators are associated with weaker intangible outcomes: Male gender, a higher number of elderly household members, and a higher income

buffer flood impacts in terms of physical and mental health, stress, and the struggle to return to normal. Social indicators generally retain their strength of influence when psychological indicators are added in the third and fourth blocks of the models. In summary, contrary to physical indicators, social indicators seem to play an independent role for intangible outcomes, and they seem to be robust against overlap with psychological indicators.

Perceived flood probability and fear of flooding have a significant and, compared to physical and social indicators, sizeable influence on all four intangible outcomes, implying more severe outcomes if households consider a flood more likely and have stronger feelings of worry and concern. The other psychological indicators have weaker influences, which are associated with specific outcomes. Intending to take some – yet unspecified – flood protective measures, makes households anticipate fewer mental impacts and a smoother return to normal. Risk-taking behaviour is associated with lower levels of stress and mental impact. Respondents who believe in their ability to understand and participate in politics (internal political efficacy), expect fewer health and mental impacts from flooding. Those who are able to uphold daily routines to plan and organise (structured style) anticipate fewer health impacts and stress. People who are able to tolerate negative feelings expect fewer mental impacts and a smoother return to normal after flooding. The remaining psychological indicators, including social capital, self-efficacy, wishful thinking and others are not related to the four intangible outcomes.

### 4.3 Vulnerability of small businesses

The experienced flood events caused significant direct and indirect losses for the interviewed SMEs. Largest losses were suffered in terms of fixed assets (mainly production machines and damages on factory buildings) and inventories (mainly raw materials, intermediate and finished products). In terms of indirect losses, the operational closure and resulting sales losses increased the longer the flood event and recovery activities persisted, especially if there was no alternative production site. However, the duration of business closure showed a wide variation between SMEs.

Nevertheless, in most SMEs the business closure hardly affected neither downstream/supplier nor upstream/customer supply chains, not even among SMEs manufacturing highly specialised products. Reasons for that are long-standing relationships with suppliers and customers, which facilitate reciprocal understanding for each other's restrictions and possibilities during a crisis, and a strong regional embeddedness and tradition. In some cases, the SMEs fulfilled their delivery contracts by purchasing and re-selling products from other providers, or by temporarily renting substitute production sites. However, if these strategies were not possible, SMEs faced penalty demands from upstream customers who had to stop their own production because of delivery shortfalls.

Availability of capital was critical for successful recovery. Key financial sources were bank loans, insurance payments (if any), compensation payments from the Austrian national disaster funds, private donations, and business equity. These financial sources were counter-balanced by the current indebtedness of the SME. Apart from an overall difficult economic situation (such as the aftermath of the global economic crisis in conjunction with a severe flood event), financial challenges arose if flood recovery coincided with investment activities after business succession or branching out in new markets.

At the same time, investments in reaching new markets, new business products, or innovation activities were welcomed by banks when deciding on recovery loans. SMEs generally did not lack access to bank loans because of long-term relationships of good reputation with their bank. Public compensation payments or the prospect of state funded loans play a double role: on the one hand, they act as additional securities for loans; on the other hand, for public compensation to be granted banks have to commit not to call in pre-flood loans in the near future, as only economically viable businesses should be financed with public money.

Insurance claims played a mixed role in SME recovery: in case of large damages, insurance contributed substantially to business recovery, and insurance agencies were seen as supportive and cooperative. In case of small damages, SMEs did not even claim insurance payments, as it did not seem worth the administrative effort. SMEs are currently not obligated to take out insurance against flood damages, but federal state authorities consider introducing stricter regulations. Instead, the Austrian flood risk insurance sector focuses on large businesses as they are in general financially stronger and at the same time excluded from public compensation schemes. Yet, business locations outside designated high-risk zones are not eligible for insurance coverage, which leaves SMEs in low-risk zones short of this option.

SME employees provided essential workforce for evacuating production assets before the flood hits, as well as for clean-up and reconstruction afterwards. As opposed to external helpers, employees are familiar with the SME premises and know what is of value, what to evacuate first, how to repair the machines, how to decide which tools to salvage or discard, and how to re-start the factory. Only in larger-scale flood events SMEs faced labour shortages because employees had to secure and clean their own homes. Additionally to the employees, also family members, relatives, neighbours, other business crews or even volunteers from other regions supported the SMEs in the aftermath of the flood. Altogether, SMEs experienced an immense wave of solidarity by the public as well as by political institutions.

The implementation of property-level flood risk adaptation (PLFRA) measures or other actions to increase business preparedness is highly driven by the entrepreneur. Prior to the 2002 flood, the interviewed entrepreneurs showed hardly any risk awareness because of the long hiatus of severe flood events since the 1950ies. However, even entrepreneurs with flood experience were

insufficiently prepared for the magnitude of the 2002 flood event as their coping strategies were designed for lower-impact events. In general, the highest flood level experienced in the past was taken as reference point and worst possible scenario for the future.

After the event, some businesses realised comprehensive PLFRA measures, while other non-structural activities, such as trainings, process optimization or emergency management plans were not implemented as they were considered activities that could be improvised when the need arises, or useless in the case of high-impact flood events. After the flood, overall entrepreneurial risk awareness increased and initiated the implementation of preparedness measures. In particular, larger SMEs with higher cash flows and severe damages made comprehensive investments in built flood protection. Others adjusted their business just enough to be safe in case of smaller events, showing fatalism regarding large events.

Despite the substantial physical and mental burden during recovery, the entrepreneurs showed high psychological resilience. They upheld a self-image of independent and responsible entrepreneurship, drawing on implicit values of diligence and hard work, and retaining a high level of self-confidence for eventually rebuilding their business and for risking investments crucial for future business activities.

Psychological resilience and self-efficacy beliefs even increased after the flood, as entrepreneurs transferred their sense of achievement in tackling flood recovery to other potential crises. While being aware of the fact that their lessons were learnt at very high costs, some entrepreneurs even emphasised the positive sides of the flood event. Besides restructuring and revising business facilities for future markets, they now were convinced that they would prevail under similar difficult circumstances. For example, flood-resilient entrepreneurs also showed a high level of resilience towards the Corona pandemic.

An individual factor for SME recovery were the entrepreneurs' social networks. The interviewees leveraged extensive private and business networks; here, enterprise- and entrepreneur-oriented factors intersect, as customer and supplier relationships often overlap with informal personal contacts. Contrary to the usual competitive attitude of prioritizing the interests of one's own company, solidarity among local and regional businesses was huge shortly after the hazard event. Informal contacts between single entrepreneurs were extended by the regional chamber of commerce and regional business associations, for example by matching specific needs and offers for technical assistance or workforce.

These networks also provided entry points for entrepreneurs to lobby at local and regional decision makers for achieving attractive bridging loans, generous settlements of insurance claims, or public financing of structural flood protection upriver or even on the SME's premises. Outspoken and tangible support by influential policymakers signalled financial security to banks, that affected SMEs will be (better) able to pay their bills. Especially larger SMEs showed high proximity

to political and administrative bodies, which was backed by political interest to keep companies and their workplaces in the region. Entrepreneurs with high political efficacy, i.e. who knew administrative structures and key contact persons and effectively made their demands heard, managed the situation after the flood significantly better. Most interviewed entrepreneurs fostered these contacts as an asset for future flood events. Experts emphasised the importance to maintain and update interpersonal networks with, e.g., fire chiefs, insurance agents, disaster aid administrators, or elected representatives.

#### 4.4 Policy implications

The research results of the JustFair project clearly highlight the importance of a more differentiated view on vulnerability in disaster risk management to reach a more effective policy to reduce inequalities within a country instead of increasing them. In order to make sure that future risk and emergency management activities do reach the most vulnerable groups, individual physical, social and psychological indicators need to be accounted for in policy design.

For private households this is particularly important considering that low-income families are more likely to be affected by flooding, physical damage may amount to a disproportionately high share of their belongings, they receive less compensation and consequently take longer to recover than more affluent residents. Social vulnerability indicators for private households can be derived from existing population statistics. Psychological vulnerability indicators could be collected by surveys among households in the risk area as part of the planning of flood risk management measures. Psychological factors can be changed more easily by risk managers than physical and social factors. Therefore, more emphasis should be placed on awareness raising, training of individuals and neighbourhood groups to reduce individual vulnerability.

For SMEs an integrative flood risk management should also consider not only physical but social and psychological vulnerability indicators as well as operational capacities of SMEs. Existing indicator systems need to be expanded accordingly and support measures should be adapted in a targeted manner. Measures such as the support of business networks, the (increased) inclusion of natural hazard management in education and training as well as continuous awareness raising (positive communication, best practice) can help to reduce business vulnerability.

Cost-Benefit Analyses in flood risk management usually uses physical damage as the most important indicator to evaluate flood risk management projects. However, this may cause an uneven development, as in structurally weak municipalities usually far lower monetary values are at risk than in dense settlement centres. A reorientation of cost-benefit analysis is therefore needed, complementing building-level variables (e.g. average building value) with household-level variables such as socio-economic factors (e.g. income of households) and psychological vulnerability.

Furthermore, an analysis of the measures taken during the COVID pandemic to support businesses shows the following opportunities for improvement of the Austrian disaster fund with regard to business support: (a) a uniform regulation of the disaster fund at the federal level is desirable; (b) the expansion of the disaster fund to include support for running costs of businesses and (c) the possibility of advance payments in all federal provinces could be useful.

## 5 Conclusions and recommendations

### Introducing social justice in flood policy

JustFair showed that social justice plays a crucial role in all stages of flood risk management: flood defense, flood risk prevention, flood risk mitigation, flood preparedness and flood recovery. Emphasizing the normative aspect of social justice raises the key question who should be protected as first. Continuing the current flood risk management system creates the risk of reproducing already existing inequalities or even increasing them. This implies that, complementary to a market-oriented focus, strong state regulation should cater for specific vulnerable groups of households. JustFair clearly supports the normative position that flood risk management needs to address the most vulnerable groups within our society as there are highly affected by a flood hazard event.

This would require a more systematic perspective on the question who is vulnerable within the public policy. This new perspective would encourage also a new point of view about the design of public policy, the implementation as well as policy feedback contingent on centralized and decentralized implementation structures like the Austrian case (Howlett & Mukherjee 2018). However, the focus on the most vulnerable groups would also increase the complexity in terms of using a wide range of indicators to focus on these groups as well as reconciling diverse, possibly contradictory policy outcomes. Key consequences would be a change in the current decision-making processes, such as revising current procedures in Cost-Benefit Assessment and recovery payments (see below). In sum, there is need for a transition within the current structure towards a more inclusive and fairer flood risk management system in Europe.

### Acknowledging social justice philosophies

Social justice shows different implications for the European countries in terms of how to manage and to organize flood risk management. The various countries follow a different social justice philosophy with different – but strong – social and political implications. However, the acknowledgment of social justice in flood risk management is only discussed at a larger round in the English and Welsh flood risk management policy. Other European countries implicitly acknowledge the social justice discourse. Nevertheless, each country does not follow one particular social justice philosophy, but a mixture of different concepts and understandings. Consequently, one flood risk management strategy might follow a clear liberalism understanding, where the market-mechanism is a central aim and goal for the government. On the other hand, the selection and implementation of technical mitigation measures might be based on cost-benefit assessment with the goal to increase the social welfare of the society, which is a strong utilitarianism understanding (see for example Thaler et al. 2020). Nevertheless, the project shows that the different social justice philosophy used in the flood risk management has strong societal implications in terms of who gains and who loses

if public administration implement technical mitigation measures or who gets compensated in terms of recovery.

In future research, there exist several aspects that need to be addressed. In overall, there have been many different theoretical conceptual frameworks developed over the centuries to consider social justice (such as utilitarian, egalitarian, libertarian, prioritarian/needs-based, merit-based, or rights-based), which foresee different policy directions and support to reach the goal of resilience. Some theoretical concepts include a strong focus on the support of the most vulnerable groups within our society in terms of capacity building by the government to reach resilience in these groups. Other concepts foresee a strong individualistic approach, which states that each household is self-responsible to be resilient against flood hazards. Therefore, implementation of resilience or activities by the government to reach such resilience depends on different philosophical schools.

### Adopting a differentiated perspective in vulnerability

The results on household vulnerability caution against a generalised concept of overall vulnerability and against uniform, catch-all risk-reducing measures. Instead, different types of flood impacts (or: vulnerability outcomes) depend on different sources of vulnerability. Building and contents damage, for instance, is driven by a different set of factors than mental impacts. This implies that in a very first step, risk managers should prioritise the particular vulnerability outcomes they want to mitigate, before planning and implementing measures tailored to the specific sources influencing the outcomes. For example, more affluent households expect fewer mental impacts but income does not play a role for expected building and contents damage. Consequently, if the policy objective was to mitigate mental impacts, welfare benefits might be effective, while they would not alleviate damage at buildings and contents. Similarly, providing external shelter may cushion mental and health impacts and support the return to normal, but would not contribute to mitigating material damage to private possessions. However, there are universal factors which are sources of several outcomes. Fear of flooding, for example, increases all seven vulnerability outcomes assessed in this study. Thus, risk communication efforts towards expressing, appraising and ultimately tackling the worries and concerns of the inhabitants of flood risk areas could reduce multiple outcomes with one single intervention.

Contrary to the assumptions that currently drive policy decisions in Austria (and beyond), physical sources of vulnerability only explain a small amount of expected tangible and intangible outcomes. The integration of social sources significantly improves the explained variance in all types of flood outcomes. Psychological sources have substantial unique explanatory value for intangible outcomes, and may supersede specific physical indicators (e.g., risk zone is a physical proxy indicator for the underlying psychological factor perceived flood probability). Overall, our findings highlight that vulnerability needs to be understood (and



measured) as a multi-faceted concept, integrating both physical, social and psychological characteristics as well as tangible and intangible outcomes; otherwise, vulnerable groups may be underrepresented or even overlooked.

## Expanding cost-benefit-analysis by social factors

Decision-making processes in flood risk management highly rely on cost-benefit assessment. Cost-benefit analyses usually use the physical damage as the main proxy for evaluating the implementation of structural and non-structural flood protection schemes. Consequently, this approach might increase the social inequality within a country as structurally weak municipalities usually show lower physical damages in comparison to urban municipalities. We argue that there is a need to adapt the current selection and prioritisation process of protection measures. The well-established method of cost-benefit analysis needs to include social, psychological and intangible aspects in order to reach a better picture of the most vulnerable groups in a country.

## Measuring the vulnerability of households and businesses

As an essential methodological conclusion, vulnerability needs to be measured at the household level, since it is linked to the needs and capacities of individuals. Traditional social vulnerability approaches employ geographical regions as unit of analysis and sum up all households living in the same country, district or community. The higher the level of spatial aggregation, the higher the risk of levelling out inter-individual differences and failing to account for constitutive factors of individual vulnerability. Often, spatial aggregation arises from necessity: Vulnerability assessments might have to accept less granular but readily available census data because these assessments cannot engage in the extra effort of conducting a dedicated household survey. Our results clearly suggest that it is worthwhile to conduct household vulnerability surveys.

Household self-responses in surveys are inherently coloured by subjective perceptions. While psychological indicators are subjective by nature, physical indicators such as risk zone or flood-proofing of the building fabric may be biased if elicited from respondents who lack hazard and technical literacy. Thus, measuring the full scope of physical, social and psychological indicators at the household level might require to complement standardised questionnaires with time- and cost-intensive on-site expert assessments, and/or with interviews with flood victims who may report their own real-world experiences in retrospect.

As vulnerability is multi-faceted, adding up indicators to a composite index can only deliver an oversimplified picture. Our results show that indicators perform differently depending on the other indicators included, and the considered vulnerability outcome. Lumping together indicators and outcomes into a single score most likely obscures the details essential for effective risk management providing, for instance, targeted support to disadvantaged groups. If a total vulnerability index is nevertheless deemed necessary, decisions need to be made

regarding how much each indicator contributes to the total index. Regression coefficients, as calculated in our study, may inform realistic weights since they directly state an indicator's influence on the magnitude of a particular impact.

Future integrative assessments of business vulnerability should comprise enterprise- and entrepreneur-oriented factors. Not only is an SME business crisis at the same time a personal crisis, but business capacities on the one side (financial savings, labour force, built flood protection etc.) and the entrepreneur's personal capacities on the other side (psychological resilience, social network and political efficacy) are two faces of the same coin. Improving SME flood risk management and avoiding business closures needs to take all these facets into account.

## Supporting flood preparedness and recovery of small businesses

While other countries rely on market forces to restore business and employment opportunities in the wake of a disaster, the Austrian policy framework includes a well-budgeted public disaster compensation scheme. This political support allows SMEs to more easily access bank loans to finance their recovery. Social and business networks for counselling and support can be seen as an overall asset, as the SME embeddedness within the municipality and region play a central role in their recovery success. How SMEs fare after a flood event highly depends on the entrepreneurs' personal resilience as well as connection to regional politics and administration. However, SMEs design flood preparedness measures to mitigate flood events of previously experienced magnitudes, and these measures do not suffice in case of rare high-impact events. These events constitute a 'radical surprise moment' for the entrepreneur. Nevertheless, the entrepreneurs demonstrate strong psychological resilience to overcome the crisis at hand, in particular with regards to self-efficacy beliefs and confidence to successfully recover

The SME findings indicate possible approaches how to reduce the business and personal vulnerability and to increase coping capacities. On the personal level, support from entrepreneurs from previously affected companies, e.g. as mentoring, can make a significant contribution to the entrepreneurs' personal resilience especially during the hard time of reconstruction. In addition to exchanging information about successfully implemented operational protective measures, concrete assistance in reconstruction planning, filling out applications, etc. could be provided, as well as personal conversation for mental support. Further, the targeted, formalized promotion of personal, informal business as well as political networks would be beneficial for faster and unbureaucratic support, e.g. in terms of machine and tool replacement, alternative locations, as well as in terms of easy contact to key persons in the event of an incident, etc.

## Improving the Austrian Disaster Funds

From discussing the current administration of the Austrian disaster funds, the following recommendations have been developed together with stakeholders:

- Uniform regulation of damage compensation rates and maximum amounts paid out at national level. This could be achieved through a voluntary agreement of all federal states.
- The disaster fund should allow for grants for running costs of businesses depending on the losses to better mitigate economic damages and avoid bankruptcies if necessary.
- Unlike the Non-Profit Organisations Relief Fund, there is no structural support for businesses in the Covid-19 relief packages so far. Also in the disaster fund, payments are earmarked for recovery/damage repair. It should be considered whether the commitment of funds should not be removed and companies have the possibility to use the funds for installing/upgrading structural protection or for investments and thus be able to set impulses for growth.
- In line with the administrations' focus on asking entrepreneurs to take personal responsibility regarding damages through business interruptions, enterprises should be supported by more/better counselling, especially regarding their damage minimization obligation or insurance solutions. Promoting preventive activities would reduce potential damages and thus later need for compensation payments.

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## C) Project details

### 7 Methods and concepts

JustFair comprises a multi-methods portfolio, integrating qualitative and quantitative approaches designed to take up similar concepts from different methodological and disciplinary perspectives. The following sections describe data and methods used; for details, please refer to the respective publications. All WPs build on extensive literature reviews and document analyses, compiling e.g. legal frameworks, flood risk management strategies and other related policy documents published at the national and regional levels.

#### 7.1 Description of the study region

JustFair builds on two study sites in Austria: The Ennstal region in the province of Styria, and the districts Freistadt and Perg in the province of Upper Austria. These study sites share a range of similar characteristics related to flood risk: Both regions recently experienced severe hydro-meteorological events (Hübl and Beck 2018; Thaler et al. 2017). Ennstal was severely affected in 2010, 2013 and 2017 by river and torrential flood events with large financial and economic losses in the affected villages; Freistadt and Perg were strongly affected by a riverine flood in 2002. Both study sites feature numerous exposed residential and non-residential buildings and infrastructure in hazard-prone areas due to their topography and high accumulation of assets. In both study sites, flood risk is likely to increase due to future land use and climate change (Blöschl et al. 2019; Fuchs et al. 2017; Löschner et al. 2017), Both study sites are already active in iterative risk management and resilience building in the past years as a response to the various past flood events; they implemented a range of structural and non-structural risk management strategies and participate in the Austrian climate change adaptation pilot regions scheme called KLAR! regions.

#### 7.2 Interviews with flood risk management experts

WP1 conducted semi-structured, in-depth interviews with 27 experts at the national, regional and local level to determine the practical use of compensation schemes. The selection process was based on a snowball technique. The interviews were conducted face-to-face or by phone and lasted (on average) between 60 and 90 min. each. Interviewees were questioned about the planning and decision-making process, the role of different stakeholders within the planning and decision-making process, procedures within the negotiation process and the influence of the legal framework in the implementation process. Each of the interviews was recorded, transcribed and coded with Atlas.ti.

### 7.3 Standardised household survey

From December 2019 to February 2020, a household survey was conducted at the study sites. In five Ennstal municipalities and in four Freistadt/Perg municipalities, standardised self-completion questionnaires were distributed as inserts in municipal newspapers. In three additional Freistadt municipalities, as only few at-risk households live there, residential areas located in or nearby flood risk zones were geo-targeted by direct mailing. Respondents were instructed to return questionnaires in a prepaid envelope or drop them off at local municipal offices. Simultaneously, an identical online survey was promoted via the municipalities' online channels, local associations (e.g. fire brigade) and in sponsored articles on social media. Redeemable vouchers and small gift donations (sponsored by the municipalities) were used to incentivise survey participation. Municipal newspapers were distributed throughout the surveyed areas; therefore, this method enabled all members of the local population to participate in the survey.

Overall, more than 15,000 printed questionnaires were distributed, and 1,127 valid questionnaires were returned in print or online, which corresponds to a response rate of 7.3% compared to the population count in the surveyed areas. The surveyed households are fairly equally distributed across municipalities (2–18%), with a larger share contributed by more populated municipalities. The distribution of socio-demographics in the sample is largely in line with census data, except for an overrepresentation of male respondents. About 30% of the households stated that they had already experienced a flood event in the past, and 21% reported to live in a flood risk zone.

**Table 4: Sample and population composition in the household survey**

Municipality		Percentage	Gender	Age (years)					Monthly net household income (€)					Flood experience	Risk zone	
		of total sample	Female	18-34	35-49	50-64	65-79	≥80	≤1,300	1,301-1,900	1,901-3,000	3,001-4,700	4,701-6,500	>6,500	Yes	Yes
Gröbming	SD	14%	38%	34%	29%	22%	13%	3%	9%	13%	44%	16%	12%	7%	14%	20%
	PD	n.a.	53%	25%	27%	25%	17%	6%	13%	13%	26%	28%	13%	8%	n.a.	n.a.
Irdning-Donnersbachtal	SD	16%	32%	23%	29%	32%	12%	4%	6%	18%	35%	31%	6%	5%	24%	13%
	PD	n.a.	53%	24%	23%	28%	17%	7%	13%	13%	26%	28%	13%	8%	n.a.	n.a.
Öblarn	SD	10%	41%	26%	33%	29%	10%	2%	7%	13%	33%	35%	6%	6%	28%	24%
	PD	n.a.	51%	24%	26%	26%	18%	7%	13%	13%	26%	28%	13%	8%	n.a.	n.a.
Sölk	SD	5%	42%	26%	12%	44%	14%	4%	11%	22%	41%	19%	8%	0%	50%	41%
	PD	n.a.	48%	23%	22%	30%	18%	7%	13%	13%	26%	28%	13%	8%	n.a.	n.a.
Stainach-Pürgg	SD	8%	44%	19%	28%	18%	30%	5%	8%	24%	39%	23%	2%	5%	14%	18%
	PD	n.a.	53%	22%	23%	28%	20%	8%	13%	13%	26%	28%	13%	8%	n.a.	n.a.
Grünbach	SD	3%	24%	10%	21%	55%	14%	0%	0%	17%	42%	21%	17%	4%	55%	17%
	PD	n.a.	49%	27%	24%	29%	15%	5%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
Gutau	SD	4%	20%	12%	38%	36%	14%	0%	3%	12%	39%	36%	9%	0%	17%	5%
	PD	n.a.	49%	23%	25%	31%	15%	6%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
Leopoldschlag	SD	3%	26%	18%	24%	38%	21%	0%	4%	32%	20%	40%	4%	0%	47%	18%
	PD	n.a.	49%	24%	21%	33%	15%	7%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
Pregarten	SD	14%	27%	16%	24%	33%	23%	4%	6%	14%	41%	25%	8%	6%	19%	8%
	PD	n.a.	51%	26%	25%	28%	16%	6%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
Rainbach	SD	4%	20%	10%	41%	37%	10%	2%	3%	14%	22%	38%	22%	3%	18%	0%
	PD	n.a.	49%	24%	26%	25%	18%	7%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
Schwertberg (Perg)	SD	18%	36%	21%	25%	32%	20%	3%	3%	11%	35%	30%	13%	8%	59%	44%
	PD	n.a.	51%	25%	24%	27%	17%	6%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
Windhaag	SD	2%	27%	19%	35%	31%	15%	0%	18%	14%	32%	36%	0%	0%	19%	0%
	PD	n.a.	50%	21%	26%	32%	15%	6%	8%	14%	26%	27%	15%	11%	n.a.	n.a.
All regions	SD	100%	33%	22%	28%	31%	17%	3%	6%	15%	37%	28%	9%	5%	30%	21%
	PD	n.a.	51%	24%	24%	28%	17%	6%	10%	13%	26%	28%	14%	10%	n.a.	n.a.

Data: Non-imputed original sample; SD = sample data; PD = population data; gender and age data: Statistics Austria (2019); household income data refer to the province of Styria and Upper Austria: Statistics Austria (2018); risk zone = flood return period of 300 years or less, or yellow/red risk zone; risk zone was coded "0" if respondent answered with "no" or "don't know"; percentages may not add up to 100 due to rounding.

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## 7.4 Interviews with small business entrepreneurs and stakeholders

Semi-structured interviews were conducted with eleven SME owner-entrepreneurs and four key experts from the Freistadt case study region. WP3 focused on the manufacturing sector because it plays a crucial role in the case study region and is capital-intensive in terms of production, machines, employees and inventory. Within the manufacturing sector, SMEs were purposefully selected to cover a broad scope of commercial activities. All selected age SMEs were affected by a flood event; have a single business location for production and storage (except for one SME); were mostly founded several decades, two of them even centuries ago; and are single-family owned businesses. The interviewed key experts represented regional associations and governmental agencies; they had been directly involved in flood-related activities, such as evacuation, counselling or reconstruction. For recruiting entrepreneur interviewees, study site representatives established contact with flood-affected entrepreneurs, who then recommended further affected SMEs they knew in the region (snowballing method).

The face-to-face interviews were conducted between July and September 2020 and lasted 60-90 minutes each. Interviewees were instructed to refer to their last severe flood experience when describing impacts and reactions. Interview audio recordings were transcribed for analysis and then subjected to qualitative content

analysis. For subsequent validation of findings and implications, an online discussion was held with six natural hazard experts from federal and municipal government agencies as well as regional associations. The expert interviewees from the preceding step were not involved in this discussion. The online discussion took place in January 2021 within the WP5 webinar series.

**Table 5: List of SME interviewees and discussion participants**

<b>Interviewees / participants</b>	<b>Business sub-sector (according to NACE Rev.2) / Type of institution</b>
Entrepreneur SME 1	C10: Manufacture of food products
Entrepreneur SME 2	C32: Other manufacturing
Entrepreneur SME 3	C10: Manufacture of food products
Entrepreneur SME 4	C16: Manufacture of wood and of products of wood and cork, except furniture
Entrepreneur SME 5	C32: Other manufacturing
Entrepreneur SME 6	C16: Manufacture of wood and of products of wood and cork, except furniture
Entrepreneur SME 7	C16: Manufacture of wood and of products of wood and cork, except furniture
Entrepreneur SME 8	C25: Manufacture of fabricated metal products, except machinery and equipment
Entrepreneur SME 9	C11: Manufacture of beverages
Entrepreneur SME 10	C10: Manufacture of food products
Entrepreneur SME 11	C28: Manufacture of machinery and equipment
Key Expert 1	regional association
Key Expert 2	regional association
Key Expert 3	municipal government agency
Key Expert 4	regional authority
Expert Discussion Participant 1	federal government agency
Expert Discussion Participant 2	federal government agency
Expert Discussion Participant 3	provincial government agency
Expert Discussion Participant 4	regional association
Expert Discussion Participant 5	provincial government agency
Expert Discussion Participant 6	federal government agency

## 7.5 Hierarchical regression analysis of household survey data

Employing the WP2 household survey data, a series of hierarchical regression analyses identified the determinants of different vulnerability outcomes and compared the explanatory power of physical, social and psychological vulnerability indicators on different vulnerability outcomes. Each outcome was regressed separately on the same set of vulnerability indicators. Indicators entered the models stepwise in four blocks of predictors: (1) physical, (2) social, (3) perceived flood probability, (4) psychological. Perceived flood probability and perceived consequences (here: vulnerability outcomes) are both components of risk perception and are closely interrelated. Therefore, perceived flood probability entered the regressions in a separate block in order to avoid a suppression effect obscuring the unique influences of other psychological indicators of vulnerability. Block 4 included all remaining psychological indicators. The adjusted  $R^2$  represents the explained variance in each step while correcting for the increasing overall number of predictors. The  $\Delta F$  indicates whether the model fits significantly better to the data than the model of the preceding step; in the block 1 model,  $\Delta F$  compares to the null, intercept-only model.

In order to avoid diminished sample size and potential bias from listwise deletion of missing values, we apply multiple imputation (Manly and Wells 2015). The imputation procedure estimates missing values from the distribution of observed values, thereby utilising the available, yet partial data of the original sample for full effect. We estimate missing values by predictive mean matching with a Markov chain Monte Carlo algorithm, using all other variables included in the regression analysis as predictors (van Buuren 2018). By repeating this estimation 40 times, we construct 40 imputed samples (pursuant to Graham et al. 2007). The correlation and regression analyses are conducted separately for each imputed sample, and the respective results are then joined by a pooling procedure using Rubin's rule to a final result (van Buuren 2018). All result tables give coefficients pooled from 40 imputed samples.

## 7.6 Stakeholder involvement

Communication activities within the JustFair project were targeted at reaching the most important stakeholder groups affected by or involved in the management of natural hazards:

- Policy and decision makers at the national, regional and local level such as representatives of the sections of Torrent and Avalanche Control (Wildbach- und Lawinerverbauung) and Water Management (e.g. Wasserbau, Schutzwasserwirtschaft) who are involved in developing and implementing coping strategies to raise their awareness towards the issue of social justice
- The research community at national and international level involved in understanding and dealing with natural hazard events who deliver valuable scientific-technical information to enhance their dialogue with policymakers

- Civil society stakeholders who represent those directly affected by natural hazard to inform them about project findings and policy recommendations
- Socially and environmentally oriented organizations and NGOs such as the Red Cross and firefighter organizations (Freiwillige Feuerwehr) to increase their awareness and involvement towards coping with issues of social justice related to natural hazard events
- The general public to increase public awareness and understanding of social justice issues in policy practice

The following table provides an overview how the different stakeholder groups were reached through communication channels and communication materials.

**Table 6: Overview of main communication channels and materials concerning stakeholders**

<b>Stakeholder group</b>	<b>Communication channel/material</b>	<b>Type of information</b>
Policy and decision makers at the national, regional and local level	Online webinars Policy briefs Professional journal articles Website	Options in policy design
The research community	Peer-reviewed journal articles Conference presentations Website	Scientific results
Civil society stakeholders	Policy briefs Website	Options in policy design
Socially and environmental oriented organizations and NGOs	Policy briefs Professional journal articles Website	For equity aspects and impacts of measures for vulnerable groups in society
General public and professionals	Professional journal articles Policy briefs Website	Information for engineer, consultants, teachers, lecturers and students on climate change and socio-natural hazards

## 8 Work and time schedule

The project JustFair started in June 2018 and ended in March 2021 (project duration 34 months). It comprised of six interlocking work packages, each structured by tasks and methodological steps.

	2018												2019																	
	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12											
<b>WP1: Social justices in climate change adaptation</b>							M 1.1	M 1.2						M 1.3																
<b>WP2: Integrative assessment households</b>													M 2.1			M 2.4			M 2.2											
<b>WP3: Integrative assessment small businesses</b>																														
<b>WP4: Identification of disadvantaged groups</b>																														
<b>WP5: Policy recommendations</b>	M 5.2 M 5.3																								M 5.2					
<b>WP6: Project management</b>	M 6.1																		M 6.2			M 6.2 M 6.3						M 6.2		

### MILESTONES

#### WP1

M1.1: Risk governance practice in Austria compiled  
 M1.2: Risk governance practice in other countries compiled  
 M1.3: List of potential policy approaches

#### WP3

M3.1: Indicator set and respective data sources established  
 M3.2: Secondary data compiled  
 M3.3: Qualitative interviews completed and transcribed

#### WP2

M2.1: Indicator set and respective data sources established  
 M2.2: Secondary data compiled  
 M2.3: Postal survey including data entry and verification completed  
 M2.4: Qualitative interviews on the political domain completed and transcribed

#### WP4

M4.1: Disadvantaged groups identified  
 M4.2: Scope of balancing between domains established  
 M4.3: Upscaling completed

	2020												2021					
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3			
<b>WP1: Social justices in climate change adaptation</b>																		
<b>WP2: Integrative assessment households</b>	M 2.3																	
<b>WP3: Integrative assessment small businesses</b>							M 3.1			M 3.2			M 3.3					
<b>WP4: Identification of disadvantaged groups</b>							M 4.1			M 4.2			M 4.3					
<b>WP5: Policy recommendations</b>										M 5.2 M 5.5			M 5.1			M 5.4 M 5.5		
<b>WP6: Project management</b>	M 6.2			M 6.2						M 6.2			M 6.2			M 6.4		


#### WP5






M5.1: Policy briefs published  
 M5.2: Dissemination plan to define targeted communication channels  
 M5.3: Project website set up  
 M5.4: Scientific publications submitted  
 M5.5: Participation in scientific events

#### WP6

M6.1: Kick-off meeting  
 M6.2: Project team meetings  
 M6.3: Interim report to Climate & Energy Fund  
 M6.4: Final report to Climate & Energy Fund



## 9 Publications and dissemination activities

All publications are linked and available at <https://justfair.joanneum.at/>. Open Access publications are indicated by the  symbol.

Scientific publications	
<i>Authors, title</i>	<i>Available at</i>
Thaler, T., Doorn, N., Hartmann, T. (2020). Justice of compensation for spatial flood risk management – comparing the flexible Austrian and the structured Dutch approach.	<i>DIE ERDE – Journal of the Geographical Society of Berlin</i> , 151 (2-3), DOI:10.12854/erde-2020-467. 
Thaler, T. (2021). Just retreat – how different countries deal with it: examples from Austria and England.	<i>Journal of Environmental Studies and Sciences</i> . doi: 10.1007/s13412-021-00694-1. 
Slavikova, L., Hartmann, T., Thaler, T. (2021). Paradoxes of financial schemes for resilient flood recovery of households.	<i>WIREs Water</i> . DOI:10.1002/wat2.1497. 
Babcicky, P., Seebauer, S., Thaler, T. (2021). Make it personal: Introducing intangible outcomes and psychological sources to flood vulnerability and policy.	<i>International Journal of Disaster Risk Reduction</i> , 58. DOI:10.1016/j.ijdrr.2021.102169.
Thaler, T. (2021). Justice and resilience in flood risk management: what are the socio-political implications?	In: Hutter, G., Neubert, M., Ortlepp, R. (eds.): <i>Building resilience to natural hazards in the context of climate change – knowledge integration, implementation, and learning</i> . Wiesbaden: Springer.
Thaler, T. (2021). Social justice in sociohydrology—how we can integrate the two different perspectives.	<i>Hydrological Sciences Journal</i> , 66, 1503-1512. DOI: 10.1080/02626667.2021.1950916
Babcicky, P., Seebauer, S. (2021). People, not just places: Expanding physical and social vulnerability indices by psychological indicators.	<i>Journal of Flood Risk Management</i> . DOI: doi:10.1111/jfr3.12752. 
Winkler, C., Thaler, T., Seebauer, S. (2021). The interplay between enterprise and entrepreneur in the flood risk management of small and medium sized enterprises in Austria.	JustFair Working Paper No. 3 
Scientific conferences	
<i>Authors, title</i>	<i>Presented at</i>
Oral presentations	



Winkler, C., Thaler, T., Seebauer, S. (2021). The interplay between enterprise and entrepreneur in the flood risk management of small and medium sized enterprises in Austria.	Risk-SoS Conference, 21-22 Oct 2021, Paris.
Babcicky, P., Seebauer, S., Thaler, T. (2021). Make it personal: Introducing intangible outcomes and psychological sources to flood vulnerability and flood policy.	International Conference on Environmental Psychology, Oct 5-8, 2021, Siracusa.
Thaler, T. (2021). Just retreat – how different countries deal with it: examples from Austria and England. At what point managed retreat?	Resilience, relocation and climate justice. University of Colombia, 22-25 June 2021, New York, USA.
Babcicky, P., Seebauer, S. (2021). People, not just places: Expanding physical and social vulnerability indices by psychological indicators.	4th European Conference on Flood Risk Management, 21-25 June 2021, Budapest.
Thaler, T., Hutter, G. (2020). Social justice and link to resilience: how flood risk management can (need to) include both concepts. Presented as part of the special session Hartmann, T., Thaler, T. (2020). Urban-resilient city: how to integrate justice in re-naturing urban areas.	Sustainable & Resilient – Urban-Rural Partnerships, 25-27 Nov 2020, Leipzig.
Thaler, T. (2020). Resilience and social justice: how current flood risk management policy encourage inequalities. Presented as part of the special session Hartmann, T., Thaler, T. (2020). Urban-resilient city: how to integrate justice in re-naturing urban areas.	Sustainable & Resilient – Urban-Rural Partnerships, 25-27 Nov 2020, Leipzig.
Thaler, T., Doorn, N., Hartmann, T. (2019). Just compensation for spatial flood risk management measures – Comparing the Austrian and Dutch approaches.	Land4Flood – Regional Workshop: Multi-purpose land use agreements in floodplains and flood water storage reservoirs. 30 September-1 October, Szolnok, Hungary.
Thaler, T. (2019): Social justices in natural hazard management – how policy change influence financial distribution and contribution in Austria.	Narratives and Practices of Environmental Justice. Enjust Workshop, University of Kiel, 06-08 June 2019, Kiel.
Poster presentations	
Seebauer, S., Babcicky, P., Thaler, T. (2020): Erweiterung von Vulnerabilitätsanalysen um soziale und psychologische Faktoren.	Disaster Research Days 2020, Oct 13-22, Book of Abstracts, pp. 98-101, ISBN 978-3-900932-77-0.
Seebauer, S., Thaler, T., Dworak, T., Babcicky, P., Winkler, C., Matauschek, M. (2019): Balancing dimensions of vulnerability, coping ability and adaptive capacity in natural hazard management.	International Conference on Environmental Psychology, Sept 4-6, Plymouth.

Seebauer, S., Thaler, T., Dworak, T., Winkler, C., Matauschek, M. (2019): Balancing dimensions of vulnerability, coping ability and adaptive capacity for realising social justice in climate change adaptation policy.	Proceedings 20th Austrian Climate Day, April 25-26, pp. 136-137.
Thaler, T., Seebauer, S., Winkler, C., Fuchs, S. (2019). Balancing dimensions of vulnerability and social justice in climate change adaptation policy.	European Geosciences Union, General Assembly 2019, April 07-12, Vienna. Geophysical Research Abstracts, 21, EGU2019-7309.
<b>Materials for professional and non-academic audiences</b>	
Thaler, T. (2020). Anpassungsstrategien im Hochwassermanagement zwischen Gerechtigkeit und technischen Möglichkeiten.	<i>Wasser und Abfall</i> , 22 (9), 13-16. DOI:10.1007/s35152-020-0258-x.
Thaler, T. (2021). Umweltgerechtigkeit im alpinen Risikomanagement: Zielsetzungen und Handlungsmöglichkeiten in Österreich.	<i>Geographische Rundschau</i> , 6-2021, 40-43.
Thaler, T., Seebauer, S., Rogger, M., Dworak, T., Winkler, C. (2021). Erweiterung von Kosten-Nutzen-Analysen im Hochwassermanagement durch Berücksichtigung sozialer und psychologischer Verwundbarkeit.	<i>Österreichische Wasser- und Abfallwirtschaft</i> . DOI:10.1007/s00506-021-00780-2. 
Thaler, T., Bründl, M., Seebauer, S. (scheduled for Nov 2021). Wie kann soziale Gerechtigkeit im Hochwasserrisikomanagement umgesetzt werden? Eine Gegenüberstellung von Gerechtigkeitskonzepten und Umsetzungspraxis in England, Österreich und der Schweiz.	<i>Wasser Energie Luft</i> 
Seebauer, S., Babicky, P., Rogger, M., Dworak, T., Thaler, T., Winkler, C. (2021). Erweiterung des Hochwasserrisikomanagements durch soziale und psychologische Vulnerabilitätsindikatoren.	JustFair Policy Brief 1
Winkler, C., Thaler, T., Seebauer, S., Rogger, M., Dworak, T. (2021). Integrative Analyse der Hochwasser-Vulnerabilität von Klein- und Mittelunternehmen.	JustFair Policy Brief 2
Dworak, T., Rogger, M., Thaler, T., Seebauer S., Winkler, C. (2021). Was können wir aus den Maßnahmen während der Covid-19 Krise für die Unterstützung von Unternehmen für den österreichischen Katastrophenfonds lernen?	JustFair Policy Brief 3
Thaler, T., Dworak, T., Rogger, M., Seebauer, S., Winkler, C. (2021). Der Zusammenhang zwischen sozialer Gerechtigkeit und Kosten-Nutzen-Analyse.	JustFair Policy Brief 4
Seebauer, S., Sessig, E. (2020): Befragung von Bürgerinnen und Bürgern zum Thema Hochwasser. Specific factsheets on household survey results.	Available for the municipalities of Gröbming, Irdning-Donnersbachtal, Öblarn, Sölk,

	Stainach-Pürgg (Styria); Pregarten, Rainbach, Schwertberg (Upper Austria); and as overall results
<b>Stakeholder involvement and outreach</b>	
“Differenzierter, fairer, treffsicherer: Neue Perspektiven für das Hochwasserrisikomanagement in Österreich“	Webinar series on 19-21 Jan 2021

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