Publizierbarer Endbericht

Gilt für Studien aus der Programmlinie Forschung

A) Project data

General overview	
Short title	Build Back Better
Long title:	Leveraging systemic shocks for integrated climate change adaptation and mitigation
Citation:	Seebauer, S., Thaler, T., Mitter, H., Steiger, R., Dreisiebner-Lanz, S., Ellmer, H.P., Winkler, C., Kropf, B., Gorbach, T., Posch, E. (2024). Leveraging systemic shocks for integrated climate change adaptation and mitigation. Final project report to the Austrian Climate and Energy Fund, Austria.
Research program (year):	ACRP, 13th Call for Proposals (2020)
Duration:	from 01.11.2021 to 30.04.2024
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Project and cooperation partners (incl. federal state):	University of Natural Resources and Life Sciences, Institute for Mountain Risk Engineering, Institute for Sustainable Economic Development (W) University of Innsbruck, Department of Public Finance (W)
Keywords:	Climate resilient development pathways; shocks; natural disasters; risk management; climate change adaptation; climate change mitigation
Total project costs:	323,790 €

General overview	
Funding:	299,880 €
Klimafonds-Nr:	KR20AC0K18173 / C163295
Issued on:	20.01.2025

B) Project overview

1 Kurzfassung

Motivation und Projektziele

Die Schocks von klimabedingten Katastrophen können die Transformation zur Dekarbonisierung und Resilienz unserer Gesellschaft ermöglichen, wenn die Wiederaufbauphase nach einem Ereignis für einen breiten gesellschaftlichen Transformationsprozess genutzt wird. Bei der Bewältigung von Schocks fehlt in der Regel eine integrierte Perspektive für Klimawandelanpassung und –minderung („Klimaresilienz"). Build Back Better verfolgt einen fallstudienbasierten Forschungsansatz, um die Rolle von Schocks zu analysieren. Das Projekt analysiert die Interaktion zwischen den einzelnen betroffenen Akteuren, und den politischen Instrumenten, die vor und nach einem Schock zum Einsatz kommen, für drei Fallstudien: Wiederaufbau nach einer Hochwasserkatastrophe; landwirtschaftliches Wassermanagement nach mehrjährigen Dürreereignissen; Hoteltourismus während der COVID-19-Pandemie.

Methode

In jeder Fallstudie wurden halbstrukturierte Interviews mit Stakeholdern geführt, um die relevanten politischen Instrumente zu ermitteln und die Entwicklung der regionalen Strategien zu verfolgen (Hochwasser: n=14; Dürre: n=14; COVID-19: n=12). In jeder Fallstudie wurden halbstrukturierte Interviews mit Betroffenen geführt, um ihre Wahrnehmung und ihre Reaktionen auf die umgesetzten Strategien und Instrumente zu verstehen (Hochwasser: n=17; Dürre: n=20; COVID-19: n=18).

Zusätzlich wurden halbstrukturierte Interviews mit 32 Experten und politischen Entscheidungsträgern im Hochwasserrisikomanagement geführt. Ein sozio-hydrologisches, auf Systemdynamik basierendes Modell wurde entwickelt und mit Hilfe von Erhebungsdaten von 3770 Haushalten aus hochwassergefährdeten Gemeinden in Österreich kalibriert. In der Hochwasserfallstudie wurden die Merkmale von 126 Gebäuden im Überschwemmungsgebiet kodiert und hinsichtlich Hochwasserschutz und Energieeffizienz eingestuft.

Zentrale Erkenntnisse

Mit dem Strategy Shock Implementation Reaction Framework (SSIR) kann der Prozess nachvollzogen werden, wenn ein politisches Problem einen Punkt erreicht, an dem es nicht mehr durch individuelle Bewältigungskapazitäten abgefedert werden kann; eine politische Strategie für den Umgang mit dem Schock vorgeschlagen wird; und die Strategie spezifische individuelle Reaktionen fördert oder untergräbt. Die politische Strategie wird während und nach einem Schock gefiltert und leitet Haushalte oder Unternehmen zu bestimmten Reaktionen an.

Alle drei Fallstudien sind durch ein politisches Problem gekennzeichnet, das bereits lange vor dem Schock bestand. Der Schock zeigte, dass bestehende politische

Strategien das Problem zwar kurzfristig beheben oder zumindest abmildern können, aber keine klimaresilienten Entwicklungspfade einschlagen. Wir können für unsere drei österreichischen Fallstudien nicht bestätigen, dass klimatische und nicht-klimatische Schocks eine wesentliche transformative Kraft haben.

In der Phase der Strategieentwicklung wurde die Leistungsfähigkeit des Systems in allen drei Fallstudien durch vorherrschende Interessenkonflikte, fragmentierte sektorale Perspektiven und die mangelnde Verbindung zwischen den Governanceebenen beeinträchtigt. Verwaltungsabteilungen handeln innerhalb ihres engen Zuständigkeitsbereichs und stimmen sich nicht mit anderen Abteilungen ab. Höhere Governanceebenen verfolgen eine langfristige Planungsperspektive, während die lokale Ebene hauptsächlich kurzfristige Bedürfnisse berücksichtigt.

Der Mangel an politischer Koordinierung vor dem Schock wirkt sich auf die Phase der Strategieanwendung aus, da die politischen Instrumente, die zur Bewältigung des Schocks eingesetzt werden, nicht auf Klimaresilienz ausgerichtet sind. Die jeweiligen Schocks haben keine neuen politischen Instrumente angestoßen, sondern Optionen auf den Tisch gebracht, die bereits vor dem Schock diskutiert, aber nicht umgesetzt wurden. Die Phase der Strategieauswirkungen zeigt, dass die politischen Strategien keine Klimawandelanpassungs- und Minderungsmaßnahmen gemeinsam umsetzen.

Durch die Kopplung von Hochwasserschäden und menschlichen Reaktionen macht das sozio-hydrologische Modell deutlich, dass neben oft reaktiven und verzögerten öffentlichen Schutzmaßnahmen auch Eigenvorsorge durch Haushalte erforderlich ist, um die Zeitspanne bis zur Fertigstellung öffentlicher Schutzbauten zu überbrücken. Die Gebäudekodierung zeigt, dass klimaresiliente Transformation auf Neubauten beschränkt ist. Betroffene Haushalte setzen nach dem Schock kaum Reaktionen, um sich vor Hochwasser zu schützen.

Schlussfolgerungen

Klimaresistente Entwicklungspfade bleiben vor allem wegen mangelnder politischer Koordination aus. Politische Strategien werden innerhalb ihrer jeweiligen politischen Silos entworfen und umgesetzt und nutzen keine Synergien, um Klimawandelanpassung und –minderung gemeinsam zu verfolgen. Sofern sie nicht durch EU-Anforderungen vorangetrieben werden, fehlt es den nationalen und regionalen Strategien an einer konsistenten, zielgerichteten Entwicklung. Neben einer sektorübergreifenden Perspektive sollten klimaresiliente Politikstrategien verbindliche Regelungen, regionale Differenzierung und Flexibilität für individuelle Bedürfnisse beinhalten. Würden solche Politikstrategien vorausschauend umgesetzt, könnten künftige Schocks, die wahrscheinlich häufiger und stärker auftreten werden als bisher, genutzt werden, um die Klimaresilienz zu fördern.

2 Executive Summary

Project rationale and objectives

The shocks of climate-driven catastrophes may enable the transformation to decarbonisation and resilience of our society, if the rebuilding phase after an event is used for a broad societal transformation process and not only quickly restores the pre-shock situation. Recovery from shocks typically lacks an integrated perspective on climate change adaptation and mitigation policies ('adaptigation' or 'climate resilience'). Build Back Better takes a bottom-up, case study driven research approach to analyse the role of shocks. The project analyses the interaction between the individual actors affected by a shock, and the policy instruments in place before and after a shock for three case studies, which recently encounter(ed) distinct shocks: recovery and reconstruction after a flood disaster; agricultural water management after multi-seasonal drought events; hotel tourism during the COVID-19 pandemic.

Methods

In each case study, semi-structured interviews were conducted with key stakeholders to identify relevant instruments within the policy strategies, and to track regional strategy development (flood: n=14; multi-seasonal drought: n=14; COVID-19: n=12). In each case study, semi-structured interviews were conducted with affected individuals to understand their perception of as well as their reactions to implemented strategies and instruments (flood: n=17; multi-seasonal drought: n=20; COVID-19: n=18).

Additionally, semi-structured interviews were conducted with 32 experts and policy-makers who are responsible for flood risk management policy at the national, regional, and local governance levels. A socio-hydrological, systems dynamics-based model was developed and calibrated using survey data of 3770 households from flood-prone municipalities in Austria, taken during four survey campaigns between 2014 and 2020. In the flood case study, features of 126 buildings on the floodplain were observed from the streetside, and then classified into a high, mid or low level of flood protection and energy efficiency.

Main findings

We present the Strategy Shock Implementation Reaction framework (SSIR) to trace the process when a policy problem culminates to a point where it can no longer be buffered by the individual coping capacities of those affected; a policy strategy is put forward to deal with the resulting shock; and, critically dependent on how it is implemented, the strategy fosters or undermines specific individual motivations and reactions. The framework proposes a sequence of how the prevalent policy strategy is filtered during and after a shock, directing households or businesses to specific individual reactions.

All three case studies are characterised by a policy problem that had been present and (to some degree) acknowledged by policy actors and affected individuals long

before the shock. The shock revealed that the existing policy strategies may fix or at least alleviate the policy problem in the short term, but are insufficient to enter Climate Resilient Development Pathways. While existing strategies were adapted and implemented to support affected individuals to cope with the shock, we cannot confirm, within the Austrian policy environment of our three case studies, that climatic and non-climatic shocks have substantial transformative power.

In the strategy development phase, across all three case studies, system performance was impaired by prevailing conflicts of interests, fragmented sectoral perspectives and disconnection between governance levels, especially between the national and regional level. Administrative departments act within their narrow area of responsibility and are not encouraged or obliged to coordinate with other departments in neighbouring fields. Higher governance levels pursue a long-term planning perspective, whereas the local level considers mainly short-term needs.

The lack of pre-shock policy coordination spills over to the strategy application phase in that the policy instruments which are implemented to deal with the shock do not account for climate resilience. The respective shocks did not induce new policy instruments but brought options to the table that had been debated but not realised before the shock. However, these emergent instruments are not coordinated with other instruments that are already in place.

The strategy impact phase shows that the policy strategies do not jointly realise mitigative and adaptive measures. The policy strategies of all three case studies prefer funding schemes over regulations. If regulations are present, they serve as trigger for individuals to reflect on how they plan to prepare for future risk.

By specifically examining the coupling between floods and human responses, the socio-hydrological model highlights that besides reactive and protracted investments in public flood protection, there is a need for promoting household measures that reduce vulnerability in the time-period before public measures have been implemented. The streetside observation in the flood case study shows that transformation to climate resilience is limited to new construction. Affected households show widespread inertia in their reactions to the shock of the flood.

Conclusions and outlook

Climate Resilient Development Pathways are mainly absent because of a lack of policy coordination. The policy strategies are designed and implemented within their respective policy silos and do not leverage synergies for advancing climate change adaptation in concert with mitigation. Unless driven by EU-level requirements and goals, national and regional strategies fall short of a concise, target-oriented development. Besides a cross-sectoral perspective, climate-resilient policy strategies should include binding regulations, regional differentiation, and flexibility for individual needs. If such policy strategies were implemented in a foresightful manner, future shocks, which will most likely occur more frequently and more severely than in the past, could be used to facilitate climate resilience.

3 Motivation and objectives

Various extreme events in recent years had severe impacts on our social, economic, and ecological systems. Typical government reactions to these events are to provide insurance, charity, and aid payments (Thaler & Fuchs 2020). Usually, these financial compensations strive for fast bounce-back without changing the current physical and social vulnerability of individuals or businesses, and without using the momentum for a broader transformation towards a climate-neutral and resilient society (Slavikova et al. 2021). A rushed return to normality may cater only to the short-term demands of those affected, as the flood disaster-aid payments in Germany did (Osberghaus & Fugger 2022). Because of climate change, extreme weather events will continue to happen, will most likely increase in the future (Dottori et al. 2018; IPCC 2022; Raymond et al. 2020), and will eventually overstretch current system capacities. This raises the question of how to develop policy strategies that foster long-term resilient reactions and transformative recovery in the aftermath of shocks such as extreme weather events. However, on the other side, catastrophic shocks may enable the transformation to decarbonisation and resilience of our society, if the rebuilding phase after an event is used for a broad societal transformation process and not only quickly restores the pre-shock situation.

Designing policy strategies from an adaptigation perspective, that is, integrating climate change adaptation and mitigation (Langlais 2009; Göpfert et al. 2019), could lead to more sophisticated responses to shocks. Generally, climate change adaptation and mitigation follow different strategies, institutional frameworks, and implementation actions. This does not only cause different aims and competing approaches to reaching these aims, but may also create conflicts or discrepancies (Landauer et al. 2019; Kondo et al. 2021) and may result in clumsy solutions (Hartmann 2011). Actions in climate change adaptation may, however, encourage climate change mitigation activities and vice versa (Langlais 2009). Climate resilient development pathways (CRDPs) are trajectories for integrating climate change adaptation and mitigation to realize the goal of sustainable development, navigating the complex interactions between climate, social and ecological systems (IPCC 2022). Climatic or non-climatic shocks, e.g. droughts, floods or COVID-19, might disrupt these pathways. Especially the COVID-19 pandemic revealed the vulnerability of current societal and economic systems to shocks and stresses (IPCC 2014, 2022).

Shocks can provide opportunities for advancing adaptigation and climate resilience and for building back better in order to withstand future climate change impacts and reduce carbon emissions. Shocks often enable substantial reorientation of policy strategies (Thaler et al. 2020) by opening a policy window where existing policy arrangements that are designed only for managing routine developments may be discarded for a period of rapid policy evolution (Penning-Rowsell et al. 2006; Jones et al. 2016). By means of policy strategies, governments set the regulatory boundaries and the incentives within which households and businesses

act. Thus, if policy strategies are designed and implemented with a dedicated adaptigation perspective, it is more likely that recovery after a shock will result in more climate-resilient and less carbon-intensive outcomes.

Build Back Better takes a bottom-up, case study driven research approach to analyse how shocks may initiate a transformative change to lower carbon emissions, higher climate resilience, and encompassing adaptigation policy. The project analyses the interaction between the individual actors affected by a shock, and the policy instruments in place before and after a shock for three case studies, which recently encounter(ed) distinct shocks: recovery and reconstruction after a flood disaster; agricultural water management after multi-seasonal drought events; tourism during the Covid-19 pandemic. Across all case studies, Build Back Better reconstructs how these shocks unfolded and instigated reactions at the level of individual actors (private households, farmers, and hotel owners) and decision-makers. From this analysis, the project derives guidance on how to leverage the transformative potential of shocks by dedicated policy strategies.

4 Content and results

Note: This report features selected core findings and excerpts from the working papers produced during the project (see Section 9). For more detailed information and comprehensive results, please refer to the respective publications and to the project website https://buildbackbetter.joanneum.at/.

4.1 Designing policies for transformative recovery: The SSIR framework

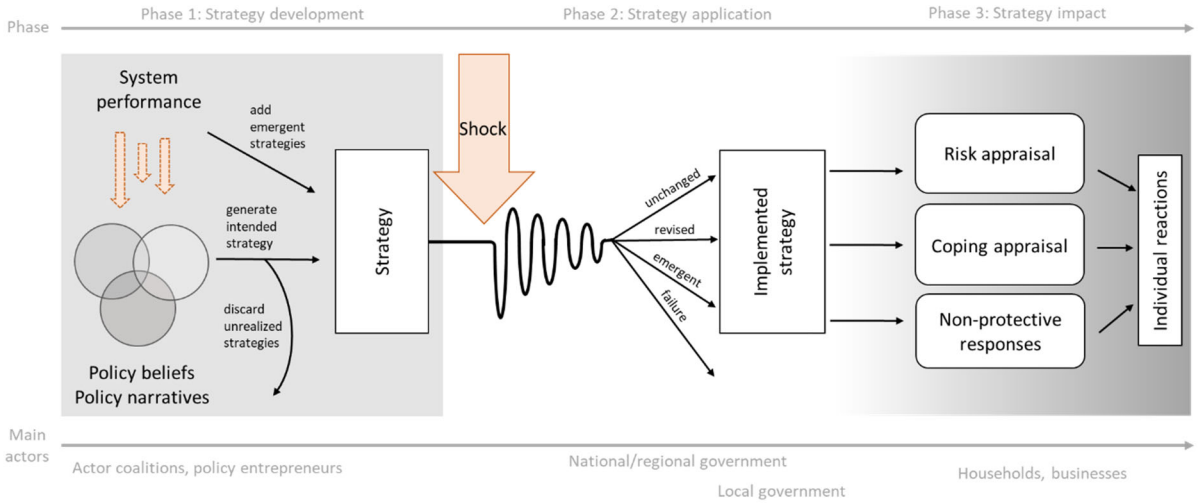
A conceptual framework bridging the design of policy strategies to their implementation after a shock and the following reactions of the affected individuals and businesses is still missing. We present the Strategy Shock Implementation Reaction framework (SSIR) to close this gap and to enhance our understanding how individual climate resilience and ultimately, as the reactions of many individuals add up, societal resilience develops after a shock. The SSIR framework allows to trace the process when a policy problem (despite cursory remedies) culminates to a point where it can no longer be buffered by the individual coping capacities of those affected; a policy strategy is put forward to deal with the resulting shock; and, critically dependent on how it is implemented, the strategy fosters or undermines specific individual motivations and reactions. The SSIR framework links three strands of research: (1) environmental governance theories on how policy strategies are developed and implemented; (2) empirical studies on the role of shocks in opening policy windows; and (3) psychological action theories on how households or businesses prepare for future shocks.

The SSIR framework's added value is twofold: First, it highlights that governmental action can indeed shape and guide individual reactions, but only if strategies are designed to hold under different conditions and shocks. Second, it re-conceptualizes the role of shocks from mere policy windows to policy filters; in other words, that shocks do not just enable and accelerate, but create and modify actions by governments and households, or businesses. The SSIR framework's target audience are researchers and governance actors who strive to understand the factors that enable or prevent effective policy strategies for climate resilience of households and businesses when navigating the aftermath of shocks.

The Strategy Shock Implementation Reaction (SSIR) framework depicts the nexus between policy strategy, shock, and individual reactions. The conceptual framework proposes a sequence of how the prevalent policy strategy is filtered during and after a shock, directing households or businesses to specific individual reactions. The framework is divided into three phases: In the first phase of strategy development, a policy problem appears when actual conditions no longer comply with stated goals and objectives, and a dedicated strategy is developed to respond to the problem. The second phase of strategy application begins when a shock occurs, necessitating the implementation of the strategy. In the policy window following the shock, strategies are either implemented as intended, are revised,

or emerge. The phase ends when all relevant policy solutions of the strategy have been implemented. The third phase of strategy impact begins when emergency measures are completed, and households and businesses start considering long-term recovery and prevention of future shocks. It ends when these individual actors have taken specific reactions regarding their well-being, properties, and assets.

Figure 1. The Strategy Shock Implementation Reaction (SSIR) framework



The SSIR framework is generic such that it can be applied to different socio-technical systems and shocks. It may structure retrospective, historical research that aims to reconstruct why individual reactions occurred against the background of a historically grown policy environment, or may be employed for comparative analysis of regions where the same or different policy strategies were implemented after shock events. The framework may also guide prospective, forward-looking studies that aim to anticipate how current policy strategies will perform when put to the test by a shock.

4.2 Case 1: Flood in Eferding Basin

Phase 1 – Strategy development

In the flood case, the European, national, and regional governance levels intersect but lack coordination between levels and between adaptation and mitigation efforts. Various European directives demand integrated flood risk management and strict reductions in carbon emissions. At the level of residential buildings, the EU Floods Directive and the EU Energy Efficiency Directive call for property-level flood risk adaptation measures and improved energy efficiency (EU 2007, 2023). In Austrian flood risk management, the main responsibility lies with the federal states under the umbrella of the non-binding National Adaptation Strategy (BMK 2024). Municipalities at the lowest governance level decide on spatial planning but

otherwise have only a consulting role. By contrast, the reduction of carbon emissions from housing is assigned to the national level, and federal and municipal stakeholders are expected to promote the roll-out and uptake of national policy instruments. Insufficient coordination between these strategies leads to inconsistent policy objectives, funding schemes, and involved stakeholders. Flood risk management follows a paradigm of public structural measures (Seebauer et al. 2023). There exist no funding schemes for flood-proofing of private buildings, only disaster aid payments which are available after a flood event but focus on recovery from flood damages and on rebuilding as before the flood. A national subsidy scheme supports building insulation, retrofitting of roofs and windows, and changing to a non-fossil heating system; however, the overall renovation rate is low because of unattractive incentives (Umweltbundesamt 2023).

Before the 2013 flood, it was already evident to the regional administration that the (implicitly) agreed protection level of a 100-year flood return period could not be maintained in the Eferding Basin within the dominant technical-oriented narrative of public flood protection through linear built infrastructure. Thus, the market-oriented narrative of providing awareness building and economic incentives for households to adapt their buildings on their own accord, which had already been common in mitigation policy, gradually gained traction in adaptation policy as well. These policy narratives met a mentality of do-it-yourself and self-reliance among households with personal or inter-generational flood experience, and a mindset of over-dependency on public protection among those who had recently moved to the region (Seebauer & Winkler 2020b). Nevertheless, both the adaptation and mitigation policy strategies are built on the acceptance and willingness of the homeowners to take action.

Phase 2 – Strategy application

In the days and weeks immediately after the shock, flood-affected residents received substantial resource inflow in terms of volunteer workforce for cleanup and repair, as well as monetary support from disaster aid payments (which is provided by the regional authority) and charity donations. These resources were, however, directed (directly and indirectly) at restoring the situation prior to the flood. In light of the excessive damages, the public administration finally abandoned its habitual technical-oriented narrative and introduced a planned relocation strategy to minimise the level of exposure in the Eferding Basin. Households were compensated for 80% of their building's value if they volunteered to move away from the floodplain and demolish their former home. Households who opted to stay were subjected to a building ban that prohibits extending or modifying their homes.

The policy instruments for climate change mitigation in the private housing sector had already been implemented pre-shock and were not changed by the shock of the 2013 flood. Both funding for energy-efficient building renovation and standards for new construction had evolved since the 1990s, turning stricter in parallel to increasingly stringent national carbon emission reduction targets. Those

households who relocated and rebuilt in a flood-safe location had to comply with strict energy efficiency regulations for their new homes. However, these standards only required a specific maximum energy consumption per floor area (in kWh/m2 per year) and therefore did not preclude backfire effects from rebuilding larger than the original houses in the floodplain had been. As a further indication of lacking policy coordination, the disaster aid, donations, and relocation compensation were paid out to remunerate lost assets and did not prescribe or incentivise any building improvements regarding flood-proofing or energy efficiency. However, this bundle of adaptation and mitigation policy strategies met a constrained housing market with increasing price levels for properties and real estate. Latecomer households were further confronted with inflation and rising credit interest rates following the Ukraine war. Together, this meant that affected households faced high uncertainty both from the future flood risk in the Eferding Basin and from their housing options.

Phase 3 – Strategy impact

Almost a decade after the flood and the announcement of the relocation strategy, all interviewed households acknowledge the persistent flood risk. As the next flood, they picture a large-scale disaster with water at chest level on the ground floor but at the same time, they are highly uncertain regarding the return period and damages of a future flood.

Among those households who left the floodplain, the policy strategy led to two-sided reactions. Public disaster aid, insurance, and donations were paid out to refund the costs of restoring damaged private assets. Households spent these payments for quick recovery and for re-establishing their damaged homes to have a place to live. However, when they eventually moved out and demolished their former home these interim investments turned out to be wasted. Their new homes are no longer exposed to flooding, as they had to move out of the floodplain, and are highly energy efficient because of mandatory building codes for new construction and because heat pumps are now (compared to the construction period of their former homes) a common heating technology. Thus, in principle, the shock of the flood and the related policy strategy incurred substantial gains regarding climate change adaptation and mitigation. However, most households built their new homes with a larger living area; thus, part of the efficiency gain was offset by increased energy demand. These households compensated for the emotional loss of their previous residence by aiming for a ‘perfect home’ with more space and extended facilities (such as air conditioning). When planning the new home, they only considered the short-term residential needs of their current family constellation. Now, a few years later, they realise that their new homes are oversized as their children have moved out or their grandparents have passed away. Only a few households deliberately downshifted to smaller housing because their children had already left the parental home, because they prepared for barrier-free living in older age, or because of financial restrictions. Farmer households are entitled by Austrian law to build anywhere on their cropland regardless of zoning specifications but local authorities must approve whether the

building construction plan qualifies for a farm and not just a residential building. Thus, some farmers who relocated were obliged to oversize barns and garages but were restricted in their residential areas which partially buffered their overall backfire in the size of their living area.

Among those households who rejected the relocation offer and decided to stay in the floodplain, the policy strategy mostly failed as these households improved neither flood protection nor the energy efficiency of their buildings. In their coping appraisal, they claim high self-efficacy for tackling emergency and repair measures during an eventual flood. However, they consider most preventive flood-proofing measures as futile against an overwhelming flood risk and implement only minor adaptation measures such as flood-resistant floors and plasterwork or preparing furniture and machinery to be easily broken down and carried to a higher level. They have insulated their roofs, but refrain from wall insulation because they expect that Styrofoam plating will retain humidity from floodwater, leading to mold and damages to wall integrity. Few have installed heat pumps; most stick to wood-chip heating instead because they have excessive wood fuel available from their forests and therefore have no incentive to switch to more efficient heating. Piecemeal building modifications are not notified to the authorities and therefore do not show up in building registers. On a positive note, the building ban of the relocation strategy was effective in preventing living area increases. However, selected savvy households had quickly obtained construction permits before the building ban entered into force. As these permits could not be revoked, these buildings now feature increased living areas and consequently pose higher flood risk and energy demand.

4.3 Case 2: Multi-seasonal drought in Seewinkel

Phase 1 – Strategy development

EU, national, and regional policy levels affect agricultural water management in the Seewinkel region. At the EU level, the Common Agricultural Policy (CAP) intends to shape the agricultural sector. Currently, it is designed to contribute to the adaptive and mitigative ambitions of the European Green Deal, including the Farm to Fork Strategy and the EU Biodiversity Strategy. Austria's agri-environmental program 'ÖPUL' is implemented within the CAP. Designed to support farmers and rural stakeholders to secure the achievement of the EU strategies' goals, it specifies operational and bureaucratic requirements. National policy strategies, such as the Austrian National Water Management Plan (implementation in six-year cycles, started in 2009), as well as cross-border panels, such as the Austrian-Hungarian Cross-border Water Commission, affect regional policy strategies. At the regional and local level, water authorities of the federal state of Burgenland, the Chamber of Agriculture Burgenland, the authorities of the national park "Neusiedler See – Seewinkel" and water cooperatives are mentioned as main stakeholders representing and coordinating different interests in land and water use.

The predominant policy narratives and beliefs regarding the policy problem are twofold: For farmers, on the one hand, the economic aspects are prevalent, as their main goal is to make a decent living from their farm and to preserve the (family) business. Stakeholders, on the other hand, also stress the status of the groundwater body, the preservation of unique ecosystems, national food security, the value of regionally produced food and the preservation of regional tourism as main policy goals. In comparison, the stakeholders primarily promote a technical-oriented narrative, such as the funding of more efficient irrigation measures which is more strongly propagated than, for example, changing to water-saving crops. Irrigation management and the discussion of an irrigation ban show a rules-oriented spin of narratives.

The evolution of the policy problem was already evident before the shock, due to previous droughts. However, sectoral perspectives prevailed in policy design, with limited coordination and integration between the crucial agriculture, water, and nature conservation sectors, leaving the region vulnerable, especially as climate change progresses.

The national strategies were connected to water quality and management but only a few directly addressed drought (for example subsidized drought insurance). Specific measures of the ÖPUL programme supported greening or reduced soil cultivation and, hence, affect agricultural water management directly and indirectly. This pattern continued after the shock.

Phase 2 – Strategy application

The national government opted not to provide any compensation for farmers after the shock. This decision was taken because of a regulatory amendment in 2018, specifying that state aid is not available for losses resulting from insurable risks (such as drought risk). The multi-seasonal drought 2018-2022 stimulated regional stakeholders' discussions about revising or refining existing strategies, as well as about developing new strategies to tackle the policy problem. Existing strategies included the monitoring system of the groundwater level as well as technical approaches such as backwatering, more efficient irrigation systems, external water supply from other water bodies, and breeding drought-tolerant crops. In the aftermath of the shock, the monitoring system of the groundwater level was tightened with stricter warning levels, leading to irrigation restrictions for certain crops and technologies during the daytime. Backwatering has been implemented only locally but could be extended in the short term, given, for instance, the provision of financial resources.

The shock has also increased the pressure for supporting water and energy-efficient irrigation systems at the large scale (e.g. drip irrigation). While already common for vineyards and orchards, consulting initiatives have been extended to introduce such technologies also for field crops. Subsidies for investments in irrigation infrastructure have partially been increased for conventional but also for more sustainable irrigation infrastructure. For external water supply, different options regarding its source (e.g., surface water from Austrian or Hungarian part

of Danube) and destination (i.e., to Lake Neusiedl or the groundwater body) were discussed. Though the shock has fueled discussions, many decisions are still pending and stakeholders stress the long lead time of large-scale projects. Stakeholders also highlight the breeding of drought-tolerant crops as a long-term endeavor. A new strategy that has been addressed very cautiously is the introduction of groundwater pricing, as a control mechanism for groundwater use and an incentive for the selection of less irrigation-intensive species and varieties.

The shock led to a change in narratives and as such in policy strategies: Before the shock, irrigation bans were already part of the policy strategy, but not yet in force. With a rule-oriented policy narrative becoming more important after the shock, a local irrigation ban during the daytime was executed in the most affected municipalities. Some of the interviewed farmers understand the need for the ban to preserve groundwater. Others are more critically and worry about more intensive irrigation during the nighttime with no ultimate effect on water demand, as well as about being forced to irrigate under adverse – e.g. windy – conditions. Similarly, stakeholders warn that incentives for more efficient irrigation systems may lead to an increase in the total irrigated area.

Phase 3 – Strategy impact

Farmers show high awareness of climate change and droughts, yet risk perception varies widely ('all is getting worse' vs. 'changing weather is normal'). At the same time, they tend to differentiate between the future of their farm and the future of the sector in the region, which they expect to be very challenging, especially for those without sufficient measures in place. The findings illustrate the background of farms being residencies of private people (attachment, worries, and psychological stress) and simultaneously business locations (cognitive risk perception focusing on the economic viability of the farms).

Regarding coping appraisal, farmers show a high degree of self-efficacy. Most assess their implemented measures against drought as sufficient and as the best they can do. No cases of inaction appear in our sample, as all farmers emphasize that they realize drought adaptation measures within the range of their possibilities.

Funding measures are implemented if they match the farmers' goals and operational strategy, often as add-on support (i.e. windfall benefit) to existing or already planned measures. While we do not find any non-protective responses regarding drought-related measures, we find to some degree fatalism, in the sense that weather and climate are conceived as beyond the influence of regional stakeholders and farmers.

In general, regular exchange among farmers as well as mutual 'learning by example' is reported, leading to a high degree of response efficacy. Additionally, many see themselves as frontrunners and leading examples for others. However, there are also complaints about free-riding 'copycats' who even receive funding for adopting measures that frontrunners had applied at their own risk and cost.

Besides the fact that we have not found inaction, the farmers' reactions show a pragmatic mix of measures, shaped by factors external and internal to the farm. External factors include available strategies and accessible funding instruments, as well as contracts regarding varieties and commodity prices. Internal factors include the farm's economic situation and technical infrastructure. Good practice examples for farmers' climate-resilient individual reactions include the implementation of water-saving irrigation, water-saving soil cultivation, or changing to more drought-tolerant crops. Poor practice examples include a high share of water-demanding crops. However, the farmers' reactions cannot be strictly attributed to the shock, as some measures are already in place for decades or the result of other entrepreneurial decisions (e.g. gross margin of crops, challenges in weed control, crop rotation).

4.4 Case 3: COVID-19 in Tyrol

Phase 1 – Strategy development

The tourism sector in Tyrol is governed by a variety of political instruments, including strategies, laws, and subsidies at both the national and federal levels. A diverse array of local, regional, and national stakeholders is shaping these instruments. At the national level, the main tourism strategy is formulated through "Plan T - Masterplan for Tourism" (introduced in 2019). The national strategy is complemented by regional efforts, particularly the Tyrolean tourism strategy "Tiroler Weg" (introduced in 1999 being regularly updated before and after the pandemic), which is not legally binding but aims to provide strategic guidelines to partners, particularly tourism associations and regional tourism organizations. The recent edition of Tyrol's regional tourism strategy emphasizes quality over quantity, advocating for a reduction in the number of touristic beds and the integration of ecological, economic, and social sustainability into tourism practices. Some aspects of the regional tourism strategy have been incorporated into regional acts and legislations (e.g., Tyrolean Tourism Law 2006-2022), such as the implementation of sustainability managers in all 34 tourism associations. However, the regional tourism strategy lacks binding power, concrete implementation measures, and specific funding information.

Despite ambitious sustainability goals, the strategies at both national and regional levels suffer from a lack of cohesion and coordination with similar strategies from other departments and fragmented sectoral perspectives. The narratives and beliefs underpinning these strategies are varied. While eco-oriented narratives, such as those addressing carrying capacity, land use conflicts, and resource use, are present, economic narratives dominate the discourse, aiming to safeguard and promote tourism. Market-oriented, liberalism, and individualistic perspectives further emphasize economic incentives, such as subsidies, and individual responsibility. Before the COVID-19 pandemic, it was already evident that Tyrol's tourism sector needed to become more sustainable in terms of adaptation as well as mitigation, particularly concerning carrying capacity and resource use. The

fragmented perspectives and lack of binding measures leave the region vulnerable to ongoing and future challenges in tourism sustainability.

Phase 2 – Strategy application

Since a situation like COVID-19 had never occurred before, there were no instruments in place that could be used to support affected tourism entrepreneurs. During the pandemic, existing policy instruments were revisited and re-purposed for coping with the pandemic, or instruments were newly conceptualized. The funding volume for Tyrolean tourism support increased substantially. While in 2019, subsidies of € 224,597 were approved for investments of € 4.1 million, this multiplied to € 1.65 million subsidies (+638%) and € 36.8 million investments (+793%) in 2020 and € 2.9 million subsidies (+74%) and € 40.1 million investments (+11%) in 2021.

In some of the revisions and the development of new instruments, there is a noticeable increase in the inclusion of climate protection and sustainability aspects in regional tourism strategies and the Tyrolean tourism funding guidelines. For instance, the Tyrolean Tourism Law was revised to legally incorporate sustainability coordinators for destination management organizations. Financial support programs also saw a stronger integration of climate aspects, such as the amendment of guidelines to ensure that investment projects focus on energy efficiency and resource conservation and integrate ecological criteria.

During the peak of the pandemic, many strategy revisions appeared to have happened 'coincidentally'. The process often began before COVID-19, with prior developments setting the stage. However, the pandemic created a political window of opportunity that allowed for changes towards the incorporation of more sustainability, being driven by various political stakeholders and especially the Green party. Interviews with tourism stakeholders indicate that the pandemic provided the necessary momentum and political opportunity for strategic changes, heightened awareness, and allowed time for strategic work. Thus, the pandemic was not the initiator but rather the final impetus for changes in laws, subsidies, and strategies that had already been circulating or were on the back burner.

Additionally, the pandemic brought to the forefront questions about the new strategic positioning and direction of tourism. In the process of strategy changes, the role of certain stakeholders in the tourism system is highlighted, who play a significant part in navigating and advocating changes in policy strategies. The Tyrolean tourism strategy "Tiroler Weg", published in 2021 in its current version, was mentioned by several interviewees from tourism associations and public administration as representing a strategic shift of how tourism development in Tyrol is desired for the future. However, it remains complex to discern the precise role of the pandemic as a shock event in triggering these changes, especially amidst multiple overlapping crises.

Phase 3 – Strategy impact

Interviewed tourism entrepreneurs' risk appraisal shows that COVID-19 is perceived as a one-off event and that other risks are currently more urgent. The pandemic coincided with other urgent issues such as the Ukraine war, energy supply challenges, inflation, and the lack of staff availability in the tourism sector. This overlapping of crises introduces a fuzziness regarding which reactions of tourism entrepreneurs were specifically triggered by the pandemic versus other parallel developments or factors.

Climate risks for tourism are acknowledged but not experienced as an immediate threat, also due to well preparation of the sector. On the contrary, Tyrol is perceived as a net winner of climate change as the Alps are seen as a refuge from serious climate impacts elsewhere (e.g. heat waves, droughts).

The coping appraisal of interviewed tourism entrepreneurs shows a very diverse degree of self-efficacy. While some interviewees stress that it is within the scope of action of each individual to contribute to climate change mitigation, others would like to act but do not see how they could do so.

Interviewees' individual reactions show that the phases of the lock-down were used by many businesses to implement projects which often have already been in the drawer, which suggests that the crisis was not necessarily a driver for profound changes but rather an accelerator of already ongoing processes. Mitigation measures include improving energy efficiency in hotels (e.g. switching to renewable energies, improving thermal insulation) or the connection to sustainable mobility services. Investments go hand in hand with financial incentives. Tourism as a cross-sectional topic has access to diverse opportunities for funding. However, the industry suffers from considerable confusion regarding the available information, often perceived as a 'funding jungle'.

Good practices for tourism entrepreneurs include a repositioning of the tourism offer while creating climate-friendly products (e.g. renovation of existing infrastructure). Poor practices includes the creation of new offers that are energy intensive (e.g. thermal spas, indoor and outdoor pools).

4.5 Recognition justice in flood risk management

We use the analytical lens of implementation gaps and legitimacy gaps to assess how these mentions enter actual flood risk management (FRM) practice. An implementation gap refers to the discrepancy between the way social vulnerability is acknowledged and prescribed in policy goals and how it is implemented in FRM rules and instruments. An implementation gap emerges, for instance, if social justice is just a pretext or if vulnerable groups are described in vague and ambiguous terms. A legitimacy gap refers to actors who enact distributional, procedural, or recognition justice but do not have the statutory power or community standing to do so. A legitimacy gap emerges, for instance, if actors make decisions of public interest who are not democratically elected

representatives, or if they do not transparently disclose their decision and are held accountable by said representatives.

The main source of the observed implementation gap in the Upper Austrian flood risk management (FRM) is the strict application of the equality principle. The equality principle manifests in uniform rules, for instance in identical cost contributions and design levels for all flood alleviation schemes. When applied by the letter, the equality principle undermines the notion of differentiated vulnerability, as poorer households receive the same support and risk reduction as richer households (Ciullo et al. 2020). Possibly, resorting to the equality principle is used as an excuse for circumventing difficult debates on who needs which risk reduction strategy and how much public support.

The main source of the legitimacy gap in the Upper Austrian FRM is the strong role of civil servants in the public administration. The asymmetric distribution of knowledge and power between the public administration and citizens as well as the lack of transparency on FRM processes allows civil servants to implement FRM policies with little accountability. It seems that, to some degree, this ambiguity is intended by policy-makers in order to maintain political room for maneuver or to avoid legally enforceable claims. This leads to the conundrum that those who are legitimized to set rules for recognition of justice do not legitimate the current ambiguous rules.

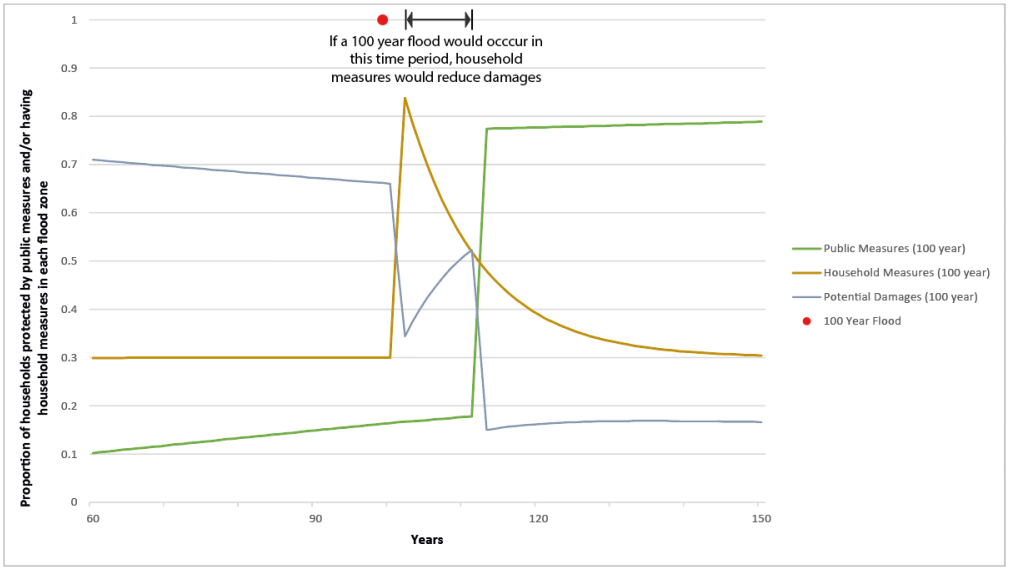
4.6 Long-term interactions in public and private flood adaptation

There is a critical need to better grasp the longer-term interactions between flood events, public measures that reduce exposure, and private measures that reduce vulnerability. Dynamic models, that can simulate flood risk change through time would enable the long-term trajectories of the existing system to be analysed and improvements, or optimisation strategies to be explored. The concept of socio-hydrology was proposed by Sivapalan et al (2012) following the premise that human behaviour drives changes in hydrology (for example through actions that modify the path and flow rate of water) and that humans respond to the resulting changes in hydrology (for example, by utilising land from which water flow has been diverted). The interactions between the modified hydrological system and human responses drives a co-evolutionary process, leading to emergent, and sometimes unexpected, behaviour, such as increased flood risk (Di Baldassarre et al., 2013).

As an exemplary result, the socio-hydrological model illustrates that household preparedness measures are implemented rapidly in all flood zones immediately after flooding, which reduce the vulnerability to subsequent flood events in the aftermath of a flood. For the 100 year flood zone, the reduction in vulnerability due to the implementation of household measures could play an important role in minimising loss and damages should a flood occur in the period of time during which public measures are in progress but not yet implemented. This could be

considered an adaptation effect, whereby damages are observed to be lower in subsequent floods. In this simulation, based on an empirical data set, the capacity of household measures to reduce flood damages has a significant, but short lived, impact on reducing vulnerability and potential flood damages due to the relatively rapid decay rate of household measures.

Figure 2. Potential damages, household, and public protection measures in the 100-year flood risk zone for the "baseline" scenario, showing how household measures go up directly after a flood event and reduce the potential damages in the event of a subsequent flood in the time before public measures are implemented.



The main strength of the socio-hydrological modelling process is the structured abstraction of the complex interactions between flood damages, public measures and private measures. Many different analytical approaches can be taken to examine process interactions, but the numerically based, systems-dynamics approach demands the researcher to split the complex system into components and make explicit the relationships and feedbacks by identifying parameters and assigning them values. By specifically examining the coupling between floods and human responses, the work highlights that while the experience of flood damage does drive the implementation of household and public measures, the perceived threat of flooding plays a limited role in stimulating private protection measures at the household level. Instead, external public support increases household coping appraisal, which is subsequently translated into an increased uptake of household measures.

4.7 Climate resilience in building reconstruction after a flood

In the flood case study, data from the streetside observation allow to describe the climate resilience of the current building stock on the floodplain both regarding the flood protection and energy efficiency of single buildings. The current level of flood protection seems fairly low considering that all observed buildings are located on the floodplain, that most of them had been damaged by the 2013 flood, and that implementing flood protection would substantially reduce their vulnerability. The majority of observed buildings have a mid to low energy efficiency level. This supports the conclusion that the post-flood repairs were not used as an opportunity to improve the overall building quality.

Figure 3. Flood case study map.

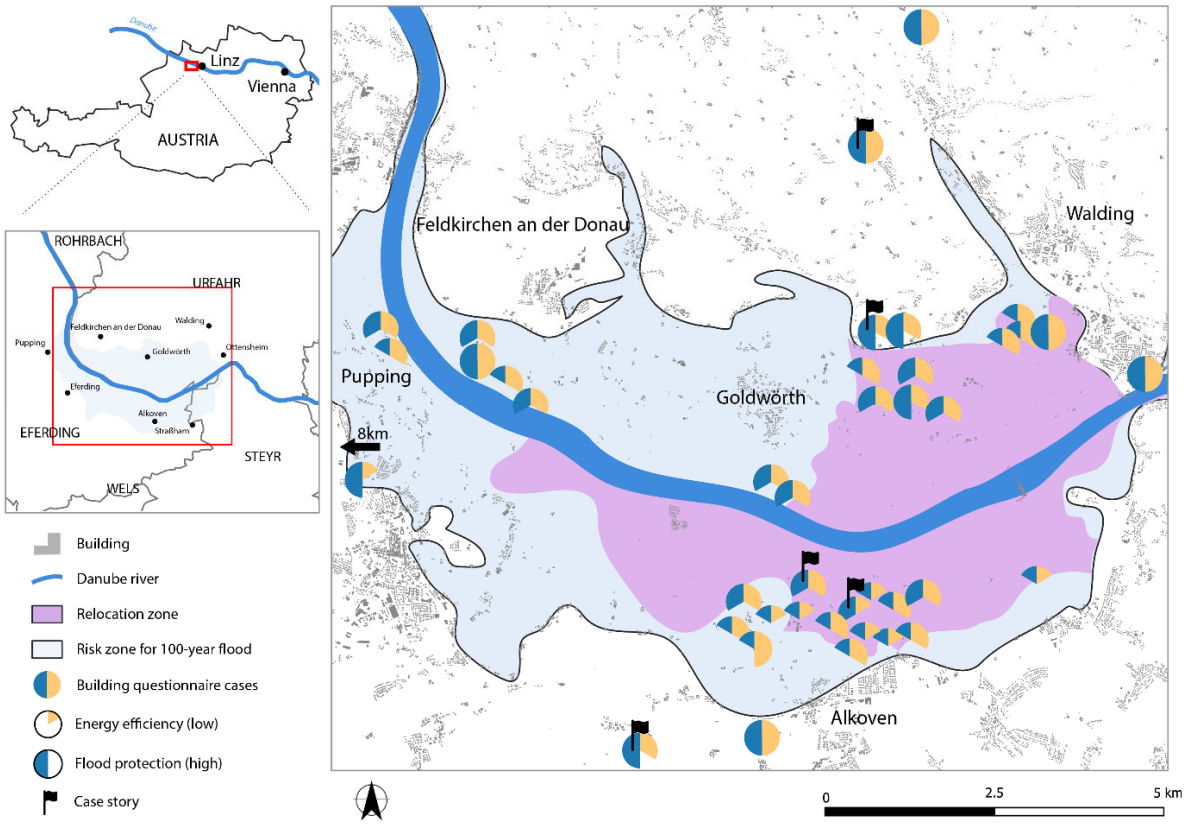


Table 1. Current level of flood protection and energy efficiency in the municipalities in the Eferding Basin.

Municipality	Flood protection			Energy efficiency		
	High	Mid	Low	High	Mid	Low
Alkoven	4%	27%	69%	4%	49%	47%
Feldkirchen	9%	26%	65%	13%	57%	30%
Goldwörth	20%	47%	33%	7%	47%	47%
Pupping	0%	40%	60%	0%	60%	40%
Walding	15%	26%	59%	3%	65%	32%

Table gives relative frequencies. N=126 based on streetside observation (Alkoven n=49, Feldkirchen n=23, Goldwörth n=15, Pupping n=5, Walding n=34). Table does not include households who accepted the relocation offer, as these households moved away from these municipalities.

4.8 Farmer reactions to policy instruments for drought adaptation

In the drought case study, we find a substantial mismatch between farmers' capacities and the current policy instruments fails to encourage climate-resilient development pathways (CRDPs). The interviewed farmers voice strong discontent with the current strategies and criticise the lack of an overarching strategy and of differentiated regional approaches that would allow them to develop a mid-term planning perspective. Furthermore, we observed a distinct discrepancy between the call for a top-down solution versus the desire for less intervention of policy instruments or actors and more individual responsibility and autonomy of farmers.

Farmers state a high risk awareness and self-efficacy. Social factors are limited to informal peer learning on drought adaptation. Economically, farmers struggle to balance the demands of a competitive market situation with the costs and effort of technical irrigation or the cultivation of drought-adapted crops. Agronomic considerations such as production practices, the timing of management steps, pest control, and fertilising, play a central role. Since they consider agronomic flexibility as essential, farmers take out subsidies only if they are compatible with their production strategy. For example, subsidies for greening measures are foregone due to restrictive requirements, even though these measures are nevertheless implemented to some extent. Thus, current policy instruments have only marginal effects on local drought adaptation; they provide add-on funding but have hardly any incentivising effect. Revised policy instruments should include seasonal and regional gradations, simplification, and flexibilisation, as well as incentives for regional transformative adaptation towards CRDPs.

5 Conclusions and recommendations

5.1 Applying the SSIR framework

As the SSIR framework tracks policy strategies over the three phases of development, application, and impact, it raises research questions about how policy strategies evolve and function over time. First, the framework proposes that policy narratives persist throughout the process of deploying policy strategies and that these narratives continue to shape a strategy once it has been implemented. Research in this direction could retrace which narratives come to the fore at which critical points in a strategy's evolution (intended, emergent, unchanged, revised), why some narratives prevail over others, whether the predominant narratives affect the governance level responsible for the strategy, and whether traces of narratives are still recognizable once a strategy has been implemented and its activities and instruments have been adopted by households and businesses.

Second, the framework points to shocks as moments of change that convert intended strategies into implemented strategies, instigate revision, or introduce emergent aspects to the strategy. Shocks can affect intended strategies substantially, especially if the activities and instruments originally envisaged in the strategy cannot deliver an effective response, even instigate maladaptive individual reactions, and have to be amended on the fly. Research in this direction could disassemble policy strategies and analyze which of their functional parts are reframed and reoriented when they meet the harsh reality of managing the consequences of a shock. This research could detail whether the scope of a shock determines the governance level at which a strategy is implemented; for instance, lower governance levels could be expected to react faster because of lower coordination efforts.

Third, the framework depicts individual reactions as the endpoint of the strategy process. How households or businesses cope with current and prepare for future shocks depends, inter alia, on the policy environment they live in. Policy strategies trickle down to individual reactions, past the filters of shock and implementation. Research in this direction could reconstruct how early policy beliefs and narratives remain as residue in implemented strategies and eventually guide individual reactions to a shock.

The SSIR framework may be used for empirical research on cross-cutting policy problems, such as climate resilience at local to international levels, that require more coordination and integration, but the policy strategies to be integrated need not move in a concerted manner but may develop at different paces or even in opposite directions (Candel & Biesbroek 2016). (Un)successful strategies could be assessed with regards to their degree of coordination – vertically by facilitating interactions between higher and lower governance levels (e.g., information flows, resource allocation), horizontally by producing agreements between actors at the same governance level who deal with specific aspects of the policy problem or are differently affected by the shock.

5.2 The role of shocks in Case 1: Flood in Eferding Basin

After the 2013 flood and the announcement of the planned relocation strategy, most households focused on a fast-recovery process with minor adaptation and mitigation efforts. This was mainly driven by the fact that they had marginal contact with governance actors, even at the municipal level, and hardly adopted the available policy instruments. They relied on their technical expertise and did not access consulting apart from architects, construction engineers, and informal contacts with neighbours or family. Nevertheless, the combination of policy instruments was partially successful by decreasing the number of exposed households in the floodplain and achieving energy savings at the newly constructed buildings because of building regulations at the national and regional levels.

Both the policy strategy and the households frame choices on building modification within a market-oriented narrative. The policy strategy has a narrow scope on voluntary funding schemes and forgoes other instruments such as consulting, regulations (apart from building codes and the building ban), or taxes. Households describe their building decisions in monetary terms as balancing costs and effort with the expected benefits. Thus, the degree of adaptation or mitigation mainly depends on the willingness and financial capabilities of households, and backfire seems logical if households are able and willing to pay for larger living areas. Furthermore, households often describe the funding schemes (except the relocation compensation payment) as an add-on windfall profit to choices they would have taken anyway. Overall, the results show that a broader societal transformation process was not reached even after a radical risk management strategy such as planned relocation. One core reason is the lack of a broader policy coordination between climate adaptation and mitigation policies by the national and regional governments.

Governance actors show practically no awareness for the integration of climate change adaptation and mitigation. In consequence, policy instruments are uncoordinated, neither vertically between governance levels nor horizontally between water, housing, and energy authorities. Presumably, this diminishes the effect of the policy instruments. Affected households show widespread inertia in their reactions to the shock of the flood. Changes to existing buildings are minimal. By contrast, all new homes of relocating households are climate resilient. However, the policy instruments are not designed to preclude backfire from increased floor areas in new homes. Households tend to focus on a quick return to normal life instead of taking a long-term perspective on their future housing needs, energy costs, and flood risk. Transformation to climate resilience is limited to new construction.

However, our results also indicate how policy instruments could be revised to achieve more climate resilience. Regulatory restrictions, such as the construction standards for new buildings and the building ban seem more effective than economic instruments, such as relocation compensation or renovation subsidies, which depend on voluntary acceptance by citizens. Funding requirements could be

adapted across policy domains; for instance, households could be offered higher disaster aid if they restore the damaged building with better flood protection and in a more energy-efficient manner.

One key barrier to encouraging climate resilience in the flood case is the lack of political interest. The current policy actors show practically no awareness of a common strategy and integrated instruments that address both climate change adaptation and mitigation. In consequence, policy instruments are uncoordinated, both vertically between governance levels and horizontally between water, housing and energy authorities. In particular, economic policy instruments (e.g. disaster aid payments, planned relocation programmes, renovation subsidies) pose funding requirements only within their own policy domain and do not provide incentives for improving building quality in relation to other domains.

5.3 The role of shocks in Case 2: Multi-seasonal drought in Seewinkel

The dominant narratives of economically viable farms and problem solution via technical measures promote an irrigation focus that had already been present before and was maintained in revised form after the multi-seasonal drought 2018-2022. The regional water management strategy that is currently in effect limits total groundwater withdrawal to preserve the regional groundwater body and includes the option of imposing an agricultural irrigation ban. European policy strategies, such as the CAP, are transposed into national funding schemes, but these nationally uniform schemes neither account for regional climate conditions nor drought impacts. Consequently, farmers typically apply only for those funding schemes that conform with their own farms' goals and are not encouraged by the schemes to reorient their goals. The shock invigorated an ongoing debate on alternative strategies including external water supply, breeding drought-tolerant crops, and tighter restrictions on groundwater use. However, this debate has not yet resulted in the implementation of new policy instruments and has not yet instigated new farmer reactions.

Irrigation is a contested issue where farmers' appraisals only partially align with the current policy instruments. When a local daytime irrigation ban was executed for the first time in 2022, some farmers reacted by investing in water-saving drip irrigation systems which are exempt from the ban. However, due to its technical setup drip irrigation is better suited for permanent crops than for arable farming, thus excluding a sizeable agricultural segment. Other farmers postpone irrigation investments as they face uncertainty and concerns regarding the future frequency of irrigation bans, insufficient grid connections to operate electrical water pumps in the open field, high work effort during installation or short device lifetimes from damage by ultraviolet radiation and rodents resulting in plastic residues from the irrigation tubes remaining in the soil. Investment funding often has an add-on effect because they support adaptation measures that farmers would adopt anyway.

If the observed mismatch between farmers' capacities and the current policy instruments were reduced, public budgets could be deployed more effectively to reach policy goals. To achieve this, the design of policy instruments should take better account of the perspective, the different prerequisites and the existing approaches of the farms. We mainly find add-on effects of existing funding for irrigation infrastructure; moreover, these instruments do not address the structural or technical challenges in connection with using renewable energy sources for powering irrigation machinery. Hence, funding for irrigation technologies should offer higher funding rates for water-saving or electrically powered installations. The current policy instruments are insufficient to initiate a shift towards transformative capacity. Incentives for comprehensive climate change adaptation and mitigation should include flexibility in legal frameworks or funding requirements and funding for new production systems, for example, agroforestry systems.

5.4 The role of shocks in Case 3: COVID-19 in Tyrol

When the tourism sector in Tyrol was hit by the COVID-19 pandemic, a range of measures was implemented to support the sector. Subsidies were a crucial element of this package, which were both increased and expanded. The guidelines were revised to incorporate ecological criteria. However, the interviewees mentioned that most of the measures would have been implemented anyway, which indicates an add-on effect.

The COVID-19 pandemic was not the decisive, but a supporting driver for profound changes in the tourism sector. The initiatives for transforming the sector can be attributed to an ongoing process of change that had already begun before the shock. COVID-19 opened a window of opportunity to bring sustainability aspects into practice that had already been considered for some time, both in revising strategies and in realising hotel renovation and construction projects. These processes were driven by various political stakeholders, with the Green party playing a particularly significant role at both the state and federal levels.

5.5 Cross-case findings on the role of shocks

All three case studies are characterised by a policy problem that had been present and (to some degree) acknowledged by policy actors and affected individuals long before the shock. The shock revealed that the existing policy strategies may fix or at least alleviate the policy problem in the short term, but are insufficient to enter CRDPs. This is mainly because of a lack of policy coordination. The policy strategies are designed and implemented within their respective policy silos and do not leverage synergies for advancing climate change adaptation in concert with mitigation. Unless driven by EU-level requirements and goals, national and regional strategies fall short of a concise, target-oriented development. Besides a cross-sectoral perspective, climate-resilient policy strategies should include binding regulations, regional differentiation, and flexibility for individual needs. If

such policy strategies were implemented in a foresightful manner, future shocks, which will most likely occur more frequently and more severely than in the past, could be used to facilitate CRDPs.

In phase 1, across all three case studies, system performance was impaired by prevailing conflicts of interests, fragmented sectoral perspectives and disconnection between governance levels, especially between the national and regional level. If non-binding, national policy strategies are not (sufficiently) recognised and transposed at the regional and local levels. By contrast, EU directives as in the flood and the multi-annual drought cases lead to the implementation of national and regional strategies and measures. At the same time, overarching strategies hardly account for regional or local particularities. In the absence of EU-level pressure, as in the COVID-19 tourism case, national and regional strategies and measures tend to be inadequately implemented. Administrative departments act within their narrow area of responsibility and are not encouraged or obliged to coordinate with other departments in neighbouring fields. Additionally, the national and regional level pursue a long-term planning perspective, whereas the local level considers mainly short-term impacts and needs.

The lack of pre-shock policy coordination spills over to phase 2 in that the policy instruments which are implemented to deal with the shock have a narrow scope that does not account for climate resilience. The respective shocks did not induce entirely new policy instruments but brought options to the table that had been debated but not realised before the shock: In the flood case, the planned relocation strategy was introduced which was modelled after a previous application in a neighbouring area; in the multi-annual drought case, the threat of the irrigation ban was carried out for the first time; in the COVID-19 case, additional funding for tourism support was made available. However, these emergent instruments are not coordinated with other instruments that are already in place and therefore do not deploy to their full effect: In the flood case, the policy strategy overlooks the need to advance adaptation and mitigation among the households who stay on the floodplain; in the drought case, farmers lack funding and support to adopt water-saving irrigation or other drought management options; in the COVID-19 case, the financial support dedicated to sustainable tourism was hardly visible within an overall confusing funding landscape. Moreover, the policy strategy is applied in a uniform manner and does not differentiate between individual needs (in the flood case) or between different regions and hence climatic conditions (in the drought case).

Phase 3 shows that the policy strategies do not trigger joint realisation of mitigative and adaptive measures. Especially in the multi-annual drought case the focus is on adaptation with little mitigation happening at all. Mitigative measures are mostly implemented as a side benefit to adaptive measures (e.g. greening); only rarely do they have the dedicated purpose of reducing carbon emission (e.g. electric instead of fossil fuel-powered irrigation pumps). Households who relocated from the floodplain and rebuilt in a flood-safe and energy-efficient manner are

prone to a backfire effect from oversized floor areas that partially offsets the efficiency gains. The policy strategies of all three case studies prefer funding schemes over regulations. If regulations are present, as the building ban on the floodplain or the temporary irrigation ban, they serve as trigger for individuals to reflect on how they plan to prepare for future risk. To direct these plans to climate-resilient development, the policy strategies rely on voluntary funding schemes, which do not have a steering effect but rather provide add-on incentives for individual intentions that would be realised anyway.

5.6 Outlook for future research

The flood case study applies streetside observation of building features to compensate for the lack of a continuously updated building register. Such a register would allow tracking of how buildings are remodelled and constructed over time and could be used to evaluate the impacts of shocks and policy instruments. Streetside observation is an empirical option to close this data gap for a defined area. However, even in the open landscape and settlement structure of the Eferding Basin, the streetside observer did not have an unrestricted view of all external building features; in urban settings, it might be even more difficult to discern all relevant features. Nevertheless, as main advantage in representativeness, streetside observation allows building classification even when the building inhabitants cannot be reached.

Systems-dynamics based models can convert a narrative on human-flood interactions into a time series that illustrates the possible evolution of interacting social and hydrological flood processes. We developed a socio-hydrological model based on a large data set of 3700 household surveys on flood risk perceptions and management from various locations in Austria. By further developing the model to a dynamic model it would become possible to explore how the system may change through time. However, this process requires explicit assumptions about public-private flood interactions to be stated and generalisations to be made.

C) Project details

6 Methods and concepts

6.1 Description of the case study regions

The case studies provide a spectrum regarding the onset of the shock, the role of climate change in the policy problem, and the affected individuals. Flood and COVID-19 are momentary, stand-alone events, whereas multi-seasonal drought is an incremental, cumulative stressor. Flood and droughts are exacerbated by climate change, whereas COVID-19 had no direct cause in climatic conditions. However, all three shocks provide a window of opportunity for advancing CRDPs that integrate issues of climate change adaptation and mitigation.

Table 2. Main characteristics of case studies

	Case Study 1: Flood	**Case Study 2: Multi-seasonal drought**	**Case Study 3: COVID-19**
Region	Eferding Basin, Northern Austria	Seewinkel, Eastern Austria	Tyrol, Western Austria
Area	60 km²; rural; residential sprawl of nearby urban region of Linz in federal state of Upper Austria	450 km²; rural area east of Lake Neusiedl in the federal state of Burgenland	12,648 km²; federal state; mostly rural; many tourism municipalities; located in the Alps
Population at risk	About 700 households	About 1,000 farms cultivate about 33,000 hectare	About 21,800 accommodation providers with about 341,000 touristic beds
Shock (most recent hazard event)	Danube flood 2013	Multi-seasonal drought 2018-2022	COVID-19 pandemic 2020-2022
Individuals affected (unit of analysis)	Residents (private households)	Farmers (family businesses)	Tourism entrepreneurs (hospitality managers/owners, mostly family businesses)

The Eferding Basin is located at the Danube river upstream of the City of Linz, the capital of the federal state of Upper Austria. The Eferding Basin is characterized by small-scale farming and single-detached family buildings, many of them constructed since the 1970s when the floodplain was claimed for settlement after the construction of hydropower plants along the Danube river (Dolejs et al. 2022). Many inhabitants of the region commute to the nearby city of Linz. The region is

highly prone to flood events, experiencing floods in 1954, 1967, 2002, and most recently in 2013 (Blöschl et al. 2013). After the 2013 flood, the public administration foresaw the realization of the planned relocation of more than 180 private-owned buildings complemented by technical mitigation measures with total costs of € 96 million (Land Oberösterreich 2024). The policy problem in the flood case study is that the shock of the 2013 flood showed that unadapted housing on the floodplain is no longer tenable and that extensive public flood protection is neither affordable nor feasible. This raised the question how to enter a CRDP that modifies existing buildings or constructs new buildings that comply with both floodproofing and energy efficiency.

The Seewinkel region is located in the Austrian federal state of Burgenland, at the Hungarian border, characterized by a semi-arid pannonian climate. Important economic sectors are agriculture and summer tourism, concentrating around Lake Neusiedl and the regional vineyards. Drainaging regional wetlands started in 1945 to gain more land for agriculture, which led to low groundwater levels in periods of low precipitation (Blaschke and Gschöpf, 2011). Droughts are recurring in the region and their severity peaked in the last years. In particular, farmers experienced severe droughts in 2003, 2013, 2015 and in the 2018-2022multi-seasonal drought which represents the starting point of this case study. Facing the challenge of groundwater shortages (due to changing precipitation patterns, higher average temperatures, etc.), the policy problem is defined as the gap between the impacts of drought on farms' economic viability on the one side, and the current combination of water-demanding land use and insufficient measures to adapt to droughts on the other side.

In Tyrol in 2019, before the COVID-19 pandemic, 12,4 million tourists generated 49,6 million overnight stays, whereof 92% were attributed to foreign tourists (Tirol Werbung 2024). The tourism industry in Tyrol is characterized by a high share of SMEs, especially family businesses (Kallmünzer et al. 2017). Even before COVID-19, climate change was considered a mid-term but grand challenge for Tyrolian tourism. Climate change will shorten potential ski seasons and declining snow availability will require more intense technical snowmaking (Steiger & Scott 2020). However, COVID-19 turned out to be one of the greatest challenges for tourism, as travel warnings and strict border controls significantly reduced the flow of foreign tourists (Peters & Steiger 2023). To reduce the loss of revenue existing funding programs for tourism were increased and new COVID-specific funds were introduced. The lockdown situation also provided the opportunity for major conversion work that would normally have a massive impact on ongoing operations. The policy problem consists of the fact, that despite ambitious sustainability goals, the strategies at both national and regional levels suffer from a lack of binding measures, practical implementation, interdepartmental coordination, and fragmented sectoral perspectives. This hampers the development of sustainable hotel and mobility infrastructure, leaving the region vulnerable to ongoing and future challenges in tourism sustainability.

6.2 Interviews with stakeholders

In each case study, semi-structured interviews were conducted with key stakeholders to complement the document analysis, select the most relevant instruments within the policy strategies, and to get deeper insights into regional strategy development (flood: n=14; multi-seasonal drought: n=14; COVID-19: n=12). In the flood case, the interviewed stakeholders represented regional associations and governmental agencies for water engineering, spatial planning, disaster aid, or climate coordination, which had been involved in the planning and implementation of the planned relocation process, were responsible for disaster aid payments or designed policy strategies and funding instruments for climate adaptation or mitigation at the national and federal state level. To cover the local authorities, all mayors from the Eferding Basin were interviewed. For the multi-seasonal drought case agricultural interest groups, regional water authorities, water cooperatives, regional associations, and mayors were interviewed, who had extensive experience in the planning and implementation of water management strategies in the region and represented the agriculture, water, and nature conservation sectors. For the COVID-19 case, key stakeholders in the tourism sector were approached at the regional and local level, according to whether they influence or participate in the decision-making process (e.g., tourism association representatives, marketing representatives, experts responsible for tourism strategies at the regional level). In all case studies, stakeholder interviewees were recruited based on their mention in the analysed documents, previous research activities of the authors and website portals; subsequently, sampling was expanded by the snowball-technique.

We addressed the question of how vulnerable population groups are recognized in flood risk management (FRM). Qualitative semi-structured interviews were conducted with 32 experts and policy-makers who are responsible for FRM policy at the national, regional, and local governance levels. Interviewees were selected based on their mention in policy documents as responsible for the design or implementation of FRM strategies; subsequent snowball sampling ensured coverage of relevant actors without formal or expert roles. The interviews were conducted in German between 2016 and 2023, face-to-face, over the telephone or online, lasting between 25-60 minutes each. The interviews were conducted as part of various research activities in Upper Austria; as the relevant actors and the main strategies and instruments remained unchanged over the last decade, the present paper collates interview transcripts that had been published in our earlier works, for re-analysis and extends them by more recent interviews.

6.3 Interviews with affected individuals

In each case study, semi-structured interviews were conducted with affected individuals to understand their perception of as well as their reactions to implemented strategies and instruments (flood: n=17; multi-seasonal drought: n=20; COVID-19: n=18). In the flood case, households were recruited from the

address lists of previous research activities, aiming for balanced representation by relocation decision (stay/leave: n=8/9), biographical stage (aged younger/older than 50 years: n=8/9) and coping outcomes (Seebauer & Winkler 2020a).

In the multi-seasonal drought case, farmers were purposefully selected to cover a broad scope of agricultural activities, focusing on arable farming and viticulture (conventional/organic: n=7/13; main crops permanent/arable: n=6/14; with/without irrigation: n=17/3). To approach potential interviewees, farmers already known from previous research activities, as well as farmers recommended by advocacy and advisory representatives were contacted. Interviewed farmers were asked to recommend further affected farmsteads they knew in the region.

In the COVID-19 case, three different groups of tourism stakeholders were approached: 1) representatives of the administration, who are responsible for applying for and approving subsidies and/or disseminating the relevant information, to gain insights into the processing of subsidies; 2) tourism interest groups, for industry perspectives on the pandemic; 3) managing directors and/or owners of accommodation establishments in Tyrol , to inquire about the relevance of subsidies during and after the pandemic, in particular for climate protection. For the selection of interview partners from group 3, hotel owners who have received funding from the province of Tyrol (Tyrolean tourism subsidy) were approached in order to identify exemplary cases that illustrate prototypical individual reactions of hotel owners. Efforts were made to include a diverse range of accommodation categories. Initial contacts were made with tourism entrepreneurs known from previous projects and those recommended by tourism association representatives. Additionally, interviewed tourism entrepreneurs were asked to recommend further potential interviewees within the region.

All semi-structured interviews were conducted face-to-face between November 2022 and July 2023 and lasted 60-90 minutes each. Interview audio recordings were transcribed word-for-word for analysis.

6.4 Socio-hydrological modelling

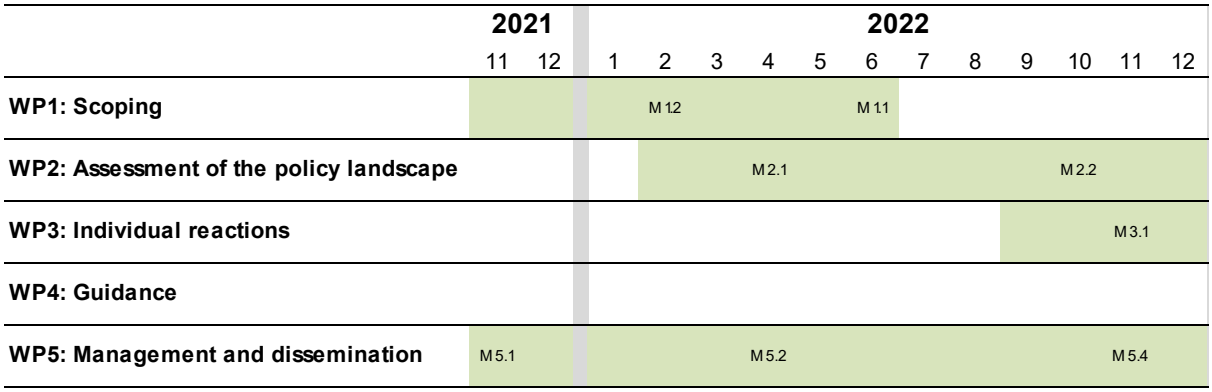
We first conceptualise (based on theory) and identify (based on data) the interactions between flood risk and the implementation of public and private measures. Secondly, a socio-hydrological, systems dynamics-based model is developed and parameters are estimated to describe the rates of change in the observed interrelationships. Thirdly, the model is used to explore the implications (in terms of flood exposure, vulnerability, and damages) of social and hydrological changes. The data set used in this study consists of 3770 household responses from flood-prone municipalities in Austria, taken during four different survey campaigns between 2014 and 2020 in a series of earlier ACRP projects.

6.5 Streetside observation of building features

In the flood case study, to compensate for a lack public statistics on the building stock, we observed buildings on the Eferding Basin floodplain from the streetside. A trained observer recorded external building features that could be detected despite fences, hedges, plot boundaries, or surrounding buildings, using a structured coding sheet, and then approached the residents (by asking over the fence, ringing the doorbell, via neighbours) whether they would be willing to complete a more detailed building questionnaire that validated external building features, assessed internal features and also covered the building status before the 2013 flood. Streetside observation was conducted in July and August 2022. In all, 126 buildings were observed, of which 41 completed the building questionnaire. Each building was classified into a high, mid or low level of flood protection and energy efficiency, respectively.

7 Work and time schedule

Build Back Better was conducted from Nov 2021 to Apr 2024, over a total duration of 30 months. It comprised of five interlocking work packages, each structured by tasks and methodological steps.



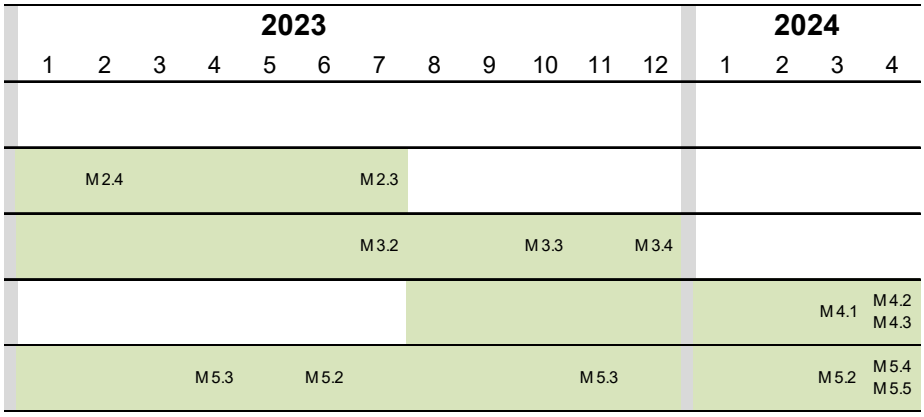
MILESTONES

WP1
M1.1: Conceptual framework completed
M1.2: Report on international best-practices

WP2
M2.1: Mapping of actors and institutions completed
M2.2: Used and non-used strategies identified
M2.3: Stakeholder interviews completed
M2.4: Policy integration compiled

WP3
M3.1: Semi-structured interview guidelines designed
M3.2: Interviews completed and transcribed
M3.3: Secondary data compiled
M3.4: Reactions maps completed

WP4
M4.1: Policy briefs completed
M4.2: Stakeholder workshops completed and policy briefs revised
M4.3: General summary for broader audience completed



WP5
M5.1: Kick-off meeting of project partners
M5.2: Progress meetings
M5.3: Participation at ACRP activities
M5.4: Reporting to the fund provider
M5.5: Academic papers submitted

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9 Publications and dissemination activities

All publications are linked and available at https://buildbackbetter.joanneum.at/.

Scientific publications	
Authors, title	*Available at*
Kropf, B., Achs, T., Schmid, E., Mitter, H. (2022). A Qualitative Behavioral Systems Map for Analyzing Farmers' Intended and Actual Drought Adaptation.	Schriften der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaues e.V., Bd. 58.
Seebauer, S., Posch, E., Thaler, T., Winkler, C., Mitter, H. (2022). Under which conditions can shocks stimulate transformative recovery: The Strategy Shock Implementation Reaction (SSIR) framework.	Build Back Better Working Paper No. 1
Thaler, T., Seebauer, S. (2023). Realizing recognition justice in flood risk management policy: A case study on implementation gaps and legitimacy gaps in Austria.	Build Back Better Working Paper No. 2
Dreisiebner-Lanz, S., Winkler, C., Seebauer, S. (2024). Agronomy is paramount: A case study on the mismatch between farm-scale measures and policy instruments for drought adaptation in Seewinkel, Austria.	Build Back Better Working Paper No. 3
Winkler, C., Seebauer, S., Dreisiebner-Lanz, S., Thaler, T., Mitter, H., Posch, E., Gorbach, T., Steiger, R., Kropf, B. (2024). The long and winding road of climate-resilient development: A case study-driven analysis of shocks, policy strategies and individual reactions in Austria.	Build Back Better Working Paper No. 4
Seebauer, S., Ellmer, H.P., Thaler, T. (2024). Ambition and reality in the climate resilience of residential buildings: A case study on flood reconstruction in Austria.	Build Back Better Working Paper No. 5
Carr, G., Lun, D., Seebauer, S. (2024). Interactions between public and private flood adaptation: insights from a socio-hydrological model.	Build Back Better Working Paper No. 6
Steiger, R., Posch, E., Gorbach, T. (2024). Sustainable Recovery: Analyzing Pandemic Subsidies and Their Role in Promoting Climate-Friendly Investments in Tyrolean Hotels.	Build Back Better Working Paper No. 7
Mitter, H., Kropf, B. (2025). Strategies for combating climate extremes in a semi-arid region in Austria.	Build Back Better Working Paper No. 8.

Scientific conferences	
Authors, title	*Presented at*
Thaler, T., Posch, E., Seebauer, S., Winkler, C. (2022). Leveraging the transformative potential of shocks: a conceptual framework to reach the adaptigation goal.	Geophysical Research Abstracts, EGU22-11380. European Geosciences Union General Assembly, 23-27 May 2022, Vienna.
Kropf, B. (2022). Motive österreichischer Landwirt*innen für und gegen die Umsetzung von Anpassungsmaßnahmen an Dürre.	20. QIA Workshop, 1-3 July 2022, Velden.
Kropf, B., Achs, T., Schmid, E., Mitter, H. (2022). A Qualitative Behavioral Systems Map for Analyzing Farmers' Drought Adaptation.	62. Jahrestagung der Gesellschaft für Wirtschafts- und Sozialwissenschaften des Landbaus, 7-9 September 2022, Hohenheim.
Kropf, B., Schmid, E., Mitter, H. (2022). Exploring farmers' reasons for drought adaptation.	32nd annual conference of the Austrian Society of Agricultural Economics, 22-23 September 2022, Ljubljana.
Seebauer, S., Thaler, T., Mitter, H., Steiger, R., Dreisiebner-Lanz, S., Ellmer, H.P., Winkler, C., Friesenecker, M., Kropf, B., Gorbach, T., Posch, E. (2023). Designing policies for transformative recovery and adaptigation after systemic shocks.	23rd Austrian Climate Day, 11-13 April, Leoben.
Gorbach, T., Posch, E., Steiger, R. (2023). Shocks as opportunity for transformation in tourism?	Consumer Behaviour in Tourism Symposium, 31 May – 2 June 2023, Breda.
Kropf, B., Larcher, M., Vogel, S., Seebauer, S., Mitter, H. (2023). Empirically-based farmer types of drought adaptation in Austria.	17th Congress of the European Association of Agricultural Economics, Aug 29 – Sept 1, 2023, Rennes.
Posch, E., Gorbach, T., Steiger, R. (2023). Die Pandemie als Chance zur Transformation im Tourismus? Eine Fallstudie aus Österreich.	Deutscher Kongress für Geographie 2023. 20 – 22 September 2023, Frankfurt.
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Seebauer, S., Ellmer, H.P., Thaler, T. (2024). It ain't over 'til it's over: Long-term implementation and coping processes in a voluntary relocation scheme in Austria.	32nd Conference of the Society for Risk Analysis Europe, 2-5 June 2024, Athens.

Materials for professional and non-academic audiences	
Mitter, H., Kropf, B., Dreisiebner-Lanz, S., Winkler, C. (2024). Umgang mit mehrjährigen Dürreereignissen in der Landwirtschaft mit Fokus auf den Osten Österreichs.	Build Back Better Policy Brief
Thaler, T. (2024). Climate-resilient pathways: interconnect climate adaptation and mitigation strategies	Policy brief at weADAPT.org
Anna Pribil (2022). Der Wald im Klimawandel. Unterschiedliche Betroffenheiten und Umgang mit Borkenkäferkalamitäten in der Obersteiermark.	Master thesis in Global Studies, University of Graz.

Stakeholder involvement and outreach	
Ellmer, H.P. (2022). Leveraging systemic shocks for integrated climate change adaptation and mitigation.	Joanneum Research Zukunftskonferenz, 20 Sept 2022, Graz.
Seebauer, S. (2023). Pfadabhängigkeiten in der Klimawandelanpassung erkennen und managen.	5. ACRP Dialog, 23 Nov 2023, Vienna.
Seebauer, S., Dreisiebner-Lanz, S., Steiger, R., Ellmer, H.P. (2024). Strategien für mehr Klimaresilienz von Betrieben und Privathaushalten nach Schockereignissen.	Policy workshop, 19 Jun 2024, online.
Thaler, T. (2024). Ermöglicher & Hindernisse im Mainstreaming von Klimawandelanpassung.	6. ACRP Dialog, 21 Nov 2024, Vienna.
Seebauer, S. (2025). Ambition and reality in the climate resilience of residential buildings.	EU Mission Adaptation Event "Building Back Better", 11 Feb 2025, online.

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