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RESEARCH

The long and winding road of climate-resilient development: a case study–driven analysis of shocks, policy strategies, and individual reactions in Austria

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Abstract
Ongoing and future climate change impacts call for climate-resilient development that integrates adaptive and mitigative approaches. Climatic and non-climatic shocks, which are rare and disruptive events, might promote transformative changes and effectively improve climate resilience. Following the IPCC's concept of Climate Resilient Development Pathways (CRDPs), we use document analysis and semi-structured interviews with $n = 41$ stakeholders and $n = 46$ affected individuals to analyse three case studies in Austria: residential relocation after a flood, agricultural water management during a multi-seasonal drought, and tourism investments during the COVID-19 pandemic. The case studies track policy strategies and individual reactions across three distinct phases: strategy development prior to the shock, strategy application during the shock, and strategy impact following the shock. The shocks revealed that the existing policy strategies may fix or at least alleviate the policy problems in the short term but do not catalyse the entry into CRDPs. Several policy strategies were adapted and implemented to support affected individuals but are not transformed by the shocks. The policy strategies mostly fail to promote climate resilience because of disconnected governance levels, fragmented sectoral perspectives, and a lack of horizontal policy coordination. If individuals realise measures that are effective for both climate change adaptation and mitigation, they do so on their own accord and are not triggered by specific policy instruments. Shocks do not emerge as distinct milestones on CRDPs. Future climate-resilient policy strategies should include binding regulations, regional differentiation, and flexibility for individual needs.

Keywords Climate-resilient pathways · Sustainability transformation · Transformational adaptation · Transition · Disturbance

Introduction

Shocks are characterised as rare, harmful, disruptive, and urgent events that either appear suddenly or when accumulated damage becomes unbearable. Shocks often overstretch current coping capacities (Grossman 2015; Dolan 2021). In the recent past, various shocks through natural hazard events around the globe, such as the wildfires and thunderstorms in North America, the severe droughts in South-Western Europe, or the devastating floods in central Europe and the Iberian Peninsula, had heavy impacts on regional economic, social, and ecological systems. In addition to the deplorable human losses, damage to material assets is estimated at US$ 250 billion for 2023 (Munich RE 2024). Losses caused by extreme weather events are likely to increase in the near future as regions continue to experience the ongoing impact of global warming (Dottori et al. 2018; Blöschl et al. 2019; Koks et al. 2019; Raymond et al. 2020; IPCC 2022).

Climate Resilient Development Pathways (CRDPs) are trajectories for integrating climate change adaptation and mitigation within sustainable development (IPCC 2014, 2022). Transformational changes in the pursuit of CRDPs involve interactions between concerned individuals and the systems they live or conduct business in, and often require fundamental changes in values, worldviews, financial and technological partnerships, and policy practice at multiple governance levels (Singh and Chudasama 2021). Transformative action is increasingly urgent across all sectors, systems,

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and scales to prevent the negative effects of climate change and meet the UN Sustainable Development Goals (IPCC 2022); however, climate change adaptation and mitigation, the main components of CRDPs, follow different strategies and implementation actions, causing different aims, competing approaches and even conflicts or discrepancies (Landauer et al. 2019; Kondo et al. 2021). Actions in adaptation may encourage mitigation activities, and vice versa (Langlais 2009). However, prioritising some policy objectives over others may incur maladaptation or rebound effects, that is, implementing short-term fixes that increase vulnerability in the long run, or undermining efficiency gains by increasing overall consumption (Sorrell 2007; Seebauer et al. 2025). Thus, horizontal policy integration that covers both climate change adaptation and mitigation is crucial for more successful outcomes of CRDPs.

Climatic or non-climatic shocks might derail CRDPs. Especially the COVID-19 pandemic revealed the vulnerability of current societal and economic systems to shocks and stresses (Singh and Chudasama 2021; IPCC 2022). Shocks, such as the 2007 Summer Floods in England and Wales (Cabinet Office 2008); Thaler and Priest 2014; Benson & Lorenzoni 2017) or the River Rhine 1995 flood event (Warner & van Buuren 2011; Ritzema and Van Loon-Steensma 2017), can enable substantial reorientation of policy strategies 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. 2014; Bubeck et al. 2017; Rose et al. 2020). Shocks may influence existing strategies or may speed up the development and application of new strategies (Grossman 2015; Dolan 2021). Although the likelihood of developing new strategies is higher than usual, radical and catalytic change rarely happens after a shock (Solecki and Michaels 1994; Kirk et al. 2025). However, new policy strategies, like the Room-for-the-River programme in the Netherlands (Ritzema & Van Loon-Steensma, 2017) or larger political-societal discourses, such as the Big Society and Localism debate in the UK (Thaler & Priest 2014), may take some time to initiate the change of past policy strategies. Research on the disruption of CRDPs addresses gradual socio-political changes in governance regimes (e.g. Herrfahrdt-Pähle et al. 2020) rather than momentary shocks after natural disasters. However, studies on the impacts of droughts (Asfaw et al. 2018; Stringer et al. 2022), floods (Birkmann et al. 2010; Thaler et al. 2020), or hurricanes (Friedman et al. 2019) on climate-resilient development highlight the importance of co-producing the reactions to the shock with stakeholders at all levels.

The aim of this paper is to illustrate the role of shocks on CRDPs by tracing policy strategy development and reactions of affected individuals. We adopt the Strategy Shock Implementation Reaction (SSIR) framework by Seebauer et al. (2025) and apply three phases of (1) *strategy development*, before the shock, (2) *strategy application*, during the shock, and (3) *strategy impact*, after the shock. These three phases mirror the CRDP stages of past conditions, present situation, and development (IPCC 2022) and correspond to the sequence from equilibrium to shock to recovery in Asfaw et al. (2018) or from preparation to navigation to stabilisation in Herrfahrdt-Pähle et al. (2020). In the first phase (*strategy development*), we include the underlying system performance prior to the shock (Farley et al. 2007; O 'Donovan 2017), that is, how various stakeholders at different governance levels had managed previous conditions and had put specific policy strategies and instruments into place to prepare for and anticipate eventual shocks. How these stakeholders assess the policy problem and design policy strategies to deal with it is typically coloured by their predominant (policy) narratives (Sabatier 2007; Zahariadis 2007; Biesbroek 2021; Kammermann and Angst 2021; Zhou et al. 2021) and beliefs (McBeth et al. 2005; Shanahan et al. 2011, 2013; Jones et al. 2014; Crow and Jones 2018). The second phase (*strategy application*) is initiated by a climatic or non-climatic shock, resulting in a realignment of CRDPs that is shaped by strategies that are already implemented and revised if necessary, or by ad hoc emergent instruments that are developed in response to the shock (Seebauer et al. 2025). The third phase shows the actions and outcomes of those affected by the shock (*strategy impact*), including societal as well as individual protective responses or non-protective responses (e.g. denial, fatalism), which are both shaped by the individuals' appraisal of future risk and the costs and efficacy of their coping options (Grothmann and Reusswig 2006; Babcicky and Seebauer 2019; Kuhlicke et al. 2020; Seebauer and Babcicky 2021; Noll et al. 2021).

We use three case studies from different regions and sectors in Austria to analyse the role of shocks on CRDPs, in particular how policy strategies evolve as a consequence of a shock, and how these strategies impact specific reactions chosen by affected individuals. The three case studies are all allocated within the same policy environment of Austrian governance but cover diverse shocks, policy domains, and affected individuals: (a) residential relocation after a flood, (b) agricultural water management after a multi-seasonal drought, and (c) tourism investments during and after the COVID-19 pandemic. In all case studies, the long-term recovery and prevention of future shocks have the potential to advance climate change adaptation as well as mitigation.

The paper is structured as follows: 'Method' section describes the case studies, the document and interview data used, and the analytical approach. The results in the 'Results' section show the trajectory of climate change mitigative and adaptive aspects along the three phases of our analysis, highlighting the lack of policy coordination. The

Table 1 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 km^2; rural; residential sprawl of nearby urban region of Linz in the federal state of Upper Austria	450 km^2; rural area east of Lake Neusiedl in the federal state of Burgenland	12,648 km^2; entire federal state of Tyrol; mostly rural alpine municipalities
Population at risk	About 700 households	About 1,000 farms which cultivate about 33,000 hectares	About 21,800 accommodation providers with about 341,000 tourist 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 and owners, mostly family businesses)

'Discussion' section discusses the role of the shock in each case and conducts a cross-case comparison, pointing out the importance of overarching, binding strategies. The 'Conclusions' section presents the conclusions of the paper.

Method

Description of case studies

When discussing the three case studies (see Table 1 for the case studies' main characteristics), we differentiate between regional and local levels. Thereby, the term regional comprises the federal state level as well as the whole area of Seewinkel and Eferding Basin, whereas the term local refers to municipalities and villages as well as sites of private houses, farms, or tourist accommodation.

The Eferding Basin is located upstream of Linz, the capital of the federal state of Upper Austria. Upper Austria is an economic centre of Austria, including large companies in steel and chemical production and high-tech companies in the ICT sector, as well as an important agricultural sector. The Eferding Basin is characterised by small-scale farming and detached family houses, many of them constructed since the 1970 s when the floodplain was claimed for settlement after the construction of hydropower plants along the River Danube (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 introduced a planned relocation of ca. 180 privately owned buildings in the high-risk area of the floodplain (Land Oberösterreich 2024). The policy problem in the flood case study is that the shock of the 2013 flood showed that unadapted housing in this high-risk area is no longer tenable and that extensive technical flood protection is neither affordable by the public nor feasible. This raised the question of how to set out on a CRDP that modifies existing buildings or constructs new buildings that comply with both flood-proofing and energy efficiency.

The Seewinkel region is located in the Austrian federal state of Burgenland, at the Hungarian border, characterised by a semi-arid Pannonian climate. Important economic sectors are agriculture and summer tourism, concentrating around Lake Neusiedl and the regional vineyards. Draining 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); however, agricultural irrigation relies greatly on groundwater (Mitter and Schmid 2021; Valencia Cotera et al. 2023). Droughts recur repeatedly in the region and their severity has peaked in recent years. Farmers experienced severe droughts in 2003, 2013, 2015, and 2018–2022 with impacts on yield quality and quantity and, thus, farm income. The multi-seasonal drought in 2018–2022 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 in the Seewinkel is defined as the gap between the impacts of drought on farms' economic viability on the one hand and, on the other hand, the current combination of water-demanding land use and insufficient measures to adapt to droughts.

The economy of the federal state of Tyrol is highly dependent on tourism (19.7% of the 2018 gross regional product; Fritz et al. 2021). In 2019, before the COVID-19 pandemic, 12.4 million (mostly foreign) tourists generated 49.6 million overnight stays (Tirol Werbung 2024). The sector is characterised by a high share of small family businesses (Kallmuenzer et al. 2017) and has been developed predominantly by regional entrepreneurs and capital (Bätzing 2015). Climate change poses a grand challenge, as declining snow availability shortens potential ski seasons and requires more technical snowmaking (Steiger and Scott

2020). COVID-19 was also challenging, as travel warnings and strict border controls significantly reduced and in the winter season of 2020/21 even stopped the inflow of foreign tourists (Peters and Steiger 2023). Existing funding schemes for tourism were increased to compensate for the loss of revenue and COVID-19-specific funding was introduced. However, the lockdown situation provided the opportunity for major—also climate-friendly—investments that would normally have a massive impact on ongoing operations. The policy problem of the COVID-19 case study is that, despite ambitious climate resilience goals, national and regional strategies suffer from a lack of binding instruments, practical implementation, interdepartmental coordination, and fragmented sectoral perspectives. This hampers the development of sustainable tourism infrastructure, leaving the region vulnerable to future climate-related challenges.

The three case studies provide a spectrum regarding the onset of the shock, the role of climate change in the policy problem, previous experiences with policy instruments, and the affected individuals. Flood and COVID-19 are transient, stand-alone events, whereas multi-seasonal drought is an incremental, cumulative stressor. Floods and droughts are exacerbated by climate change, whereas COVID-19 had no direct cause in climatic conditions. While there is long-standing experience with water management measures in the case of drought (Iglesias and Garrote 2015), the COVID-19 pandemic was entirely new (Gössling et al. 2020), triggering the transfer of established climate policy instruments (e.g. promoting local renovation). Relocation, on the other hand, is a highly contested adaptation measure that has so far only been implemented as a last resort but will likely gain importance as climate risks increase. Nevertheless, all three shocks provide a window of opportunity for advancing CRDPs that integrate issues of climate change adaptation and mitigation.

Data and analytical approach

We apply a mixed-method approach (Tashakkori et al. 2021) for triangulation and cross-checking from different perspectives, combining document analysis with semi-structured qualitative interviews (for full lists of analysed policy documents and interviewees, see Online Resources 1 and 2). This approach allows comparison and confirmation of the collected data and the interpreted results while avoiding narrow, oversimplifying explanations.

The initial document analysis compiled policy documents published at European, national, and regional levels to reconstruct system performance and policy strategies for the three case studies. 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 reconstruct regional strategy development (flood: $n = 14$; multi-seasonal drought: $n = 15$; 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, which were responsible for disaster aid payments or which 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 (Mitter and Kropf 2025). For the COVID-19 case, key stakeholders in the tourism sector, such as tourism association representatives, marketing representatives, or experts responsible for regional tourism strategies, were approached at regional and local levels. 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 following the recommendations of previous interviewees.

Moreover, 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: $n = 9$). 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 and Winkler 2020a). In the multi-seasonal drought case, farmers were 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 were contacted, as well as farmers recommended by advocacy and advisory representatives. Interviewed farmers were asked to indicate further affected farmsteads they knew in the region. In the COVID-19 case, tourism entrepreneurs that received a subsidy from the federal state of Tyrol (Tiroler Tourismusförderung) were approached. 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 point to further potential interviewees within the region.

All semi-structured interviews were conducted in person between November 2022 and July 2023 and lasted 60–90 min each. Interview audio recordings were transcribed word-for-word for analysis. The interview guidelines translated the SSIR framework elements to the case study–specific contexts, addressing three phases (Seebauer et al. 2025): (1) regarding strategy development, stakeholders and their positions and actions, policy narratives and beliefs, pre-shock policy strategies, and system performance; (2) regarding strategy application, the shock itself and the strategies/instruments implemented post-shock; and (3) regarding strategy impact, risk and coping appraisals, non-protective responses and individual reactions. Interviewees were instructed to refer to the last recent hazard event when describing impacts of and reactions to the shock. See Online Resource 3 for the case study specific interview topics.

We employed qualitative content analysis (Mayring 2010), using MAXQDA and Atlas.ti software for coding the interview transcripts. All three case studies were analysed using the same deductive coding system that reflected the phases and elements of the SSIR framework and was expanded inductively to cover emergent, case study–specific aspects. The results present the central tendencies of the interviews as well as contrary viewpoints of the interviewees. Note that we refrain from reporting any quantitative estimates or absolute frequencies because of the qualitative, non-standardised nature of our data.

Results

Case 1: Flood in the 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 (FS1). Various European directives demand integrated flood risk management and strict reductions in carbon emissions (FS1/FS2). 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 (European Commission 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 2024a). Municipalities at the lowest governance level decide on spatial planning but otherwise have only a consulting role (FS1/FS7/FS12–14). 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 (FS2–6) but are not obligated to do so (BMK 2024b). Insufficient coordination between these strategies leads to inconsistent policy objectives and funding schemes (FS2). For instance, the federal Climate and Energy Strategy of Upper Austria claims to integrate adaptation and mitigation goals but lists housing and flood hazards as separate and unconnected activity areas (Land Oberösterreich 2022). 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 damage and on rebuilding as before the flood (FS1/FS7–9). A national funding 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 (Anderl et al. 2023).

Before the 2013 flood, it was already evident to the regional administration from hydrological modelling that the 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 linear built flood protection (FS12–14). 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 beliefs of do-it-yourself and self-reliance among households with personal or inter-generational flood experience (FI10/FI11/FI13/FI14/FI16/FI17), and a mentality of over-dependency on public protection among those who had recently moved to the region (FI7; Seebauer and Winkler 2020b). Nevertheless, both the adaptation and mitigation policy strategies built on the acceptance and willingness of the homeowners to take action (FS1–6/FS10–14). A small circle of policy entrepreneurs at the federal level pushed regional strategies by means of long-term collaboration (FS4/FS6/FS10/FS11); still, they acted within their respective policy silos and did not consider mitigation benefits from adaptation strategies and vice versa.

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 (FS7–9/FS11–14). These resources were, however, earmarked for restoring the situation prior to the flood. In light of the excessive damage, the public administration finally abandoned its habitual technical-oriented narrative and introduced a planned relocation strategy with the aim of reducing 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 demolished their former home. They then had to acquire building plots or new homes on the open housing market. Households who opted to stay were subjected to a building ban that prohibits extending or modifying their homes (Seebauer and Winkler 2020b). The relocation strategy was designed after a previous application a decade ago in the nearby Machland-Nord area, with the major difference that in Machland-Nord the decision to stay or leave had to be taken jointly by the whole hamlets, whereas in the Eferding Basin, households took this decision individually (Thaler et al. 2020). 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 (FS2–4/FS6/FS10/FS11). Both funding for energy-efficient building renovation and standards for new construction had evolved since the 1990 s, becoming 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 (FI1–4/FI7–9). Nevertheless, these standards only required a specific maximum energy consumption per floor area (in kWh/m^2 per year) and therefore did not preclude rebound effects from rebuilding larger houses than the original ones in the floodplain had been (FS4/FS11). As a further indication of lacking policy coordination resulting in maladaptation, 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 (FS1/FS2/FS4–11/FI4/FI6–7/FI15/FI17). Households who postponed their decision to leave were further confronted with inflation and rising credit interest rates following the Ukraine war and struggled with financing construction beyond the mandatory minimum standards (FS4/FI7). Together, this meant that affected households faced high uncertainty both from the future flood risk in the Eferding Basin and from their housing options and therefore tended to refrain from leaving the floodplain or remodelling their homes.

Phase 3 – Strategy impact

Almost a decade after the flood and the announcement of the relocation strategy, the households acknowledge the persistent flood risk (FI1–17). As the next flood, they picture a large-scale disaster with water at chest level on the ground floor (FI6/FI7/FI11/FI13/FI15–17) but at the same time, they are highly uncertain regarding the return period and damage of a future flood (FI2/FI7/FI8/FI11/FI12/FI16/FI17). Similar to denial as a non-protective response, they shirk from specific considerations of what such a disaster would entail for their livelihood (FI5/FI7/FI13/FI14).

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 (FS7–9). 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 (FI1/FI2/FI4–7/FI9). Their new homes are obviously 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 (FI1–4/FI6–9). 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 (FI1–3/FI5/FI8); thus, as a rebound effect, 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; FI1/FI4/FI9). When planning the new home, they only considered the short-term residential needs of their current family constellation (FI1–3/FI7–9). 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 (FI6/FI7). 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 as 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 rebound in building size (FI2/FI3/FI8/FI9).

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 the flood protection nor energy efficiency of their buildings (FI12/FI13/FI16/FI17). In their coping appraisal, they claim high self-efficacy for tackling emergency and repair measures during an eventual flood (FI10/FI13/FI14/FI16). However, they consider most preventive flood-proofing measures to be futile against the expected inundation level and realise only minor adaptation measures such as flood-resistant floors

and plasterwork or preparing furniture and machinery to be easily broken down and carried upstairs (FI10–FI17). They have insulated their roofs but refrained from wall insulation because they expect that Styrofoam plating will retain humidity from floodwater, leading to mould and damage to wall integrity (FI10–12/FI14/FI16). Few have installed heat pumps; most stick to wood-chip heating instead because they have much wood fuel available from their own forests and therefore have no incentive to switch to more efficient heating. Nevertheless, many plan to invest in photovoltaic panels (FI11–14/FI16). Building modifications are realised in a do-it-yourself manner, typically as part of upkeep and maintenance and unrelated to their flood experience. On a positive note, the building ban of the relocation strategy was effective in preventing living area increases; however, selected shrewd households had quickly obtained construction permits before the building ban entered into force (FI11/FI14). As these permits could not be revoked, these buildings now feature increased living areas and consequently pose higher flood risk and energy demand.

Case 2: Multi-seasonal drought in Seewinkel

Phase 1 – Strategy development

European, national, and regional policy levels affect agricultural water management in the Seewinkel region. At the EU level, the Common Agricultural Policy (CAP) has the aim of furthering contributions of the agricultural sector in line with 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 programme 'ÖPUL' is implemented within the CAP. Designed to support farmers and rural stakeholders in achieving the EU strategies' goals, it specifies operational and administrative requirements. National policy strategies, such as the Austrian National Water Management Plan (implementation in six-year cycles; BMLFUW 2009, 2017; BMLRT 2022), as well as cross-border panels, such as the Austrian-Hungarian Cross-border Water Commission (BGBl. Nr. 225/1959, 1959), affect regional policy strategies. At regional and local levels, the water authorities of the federal state of Burgenland, the Chamber of Agriculture of Burgenland, the authorities of the national park 'Neusiedler See – Seewinkel' and water cooperatives are the main stakeholders who represent and coordinate different interests in land and water use.

Farmers and stakeholders hold different policy narratives and beliefs regarding the policy problem: for farmers, 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, by contrast, 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. Stakeholders primarily promote a technical-oriented narrative, such as the implementation of more efficient irrigation systems (DS1/DS2/DS5/DS12), and only partially mention an eco-oriented narrative, for example, changing to water-saving crops (DS9). Public 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. Nonetheless, sectoral perspectives prevailed in policy design, with limited coordination and integration between the agriculture, water, and nature conservation sectors, leaving the region vulnerable, especially as climate change progresses. The regional government did, however, introduce a task force in 2018 to promote cooperation between the sectors (Kaiser and Böhm-Ritter 2020).

The national strategies referred to water quality and management but only a few directly addressed drought (for example, subsidised drought insurance and the national Special Drought Directive; BMNT 2018). Specific measures of the ÖPUL programme supported greening or reduced soil cultivation and, hence, affected 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 2016, specifying that state aid is not available for losses resulting from an insurable risk such as drought (BGBl. Nr. 201/1996, 1996). The multi-seasonal drought in 2018–2022 stimulated regional stakeholders' discussions about revising existing strategies, as well as about developing new strategies to tackle the policy problem. Applied strategies included the monitoring system of the groundwater level, as well as technical approaches such as backwatering, more efficient irrigation systems, and breeding drought-tolerant crops. In the aftermath of the shock, the monitoring system of the groundwater level was tightened, leading to irrigation restrictions for certain crops and technologies during the daytime (DS11; Rechnungshof Österreich 2020). Backwatering has been implemented as long as financial resources were available (DS11–13).The shock also instigated increased support for water- and energy-efficient irrigation systems on a large scale (e.g. drip irrigation). While already common for vineyards and orchards, consulting initiatives have been extended to also introduce these technologies for field crops. Investment funding for irrigation infrastructure has partially been increased for conventional but also for more sustainable irrigation infrastructure. For extra-regional water

supply, the debate has not yet evolved beyond the conception stage (Sailer 2022). Different options regarding its source (e.g. surface water from the Austrian or Hungarian part of the Danube; DS1/DS3/DS4/DS12) and destination (i.e. to Lake Neusiedl or the groundwater body; DS1/DS3/DS4/DS6/DS10/DS12) were discussed (DS3). Thus, the risk of rebound effects from an extension of irrigated areas currently cannot be assessed (Mitter and Kropf 2025). Though the shock has clearly fuelled discussions, many decisions are still pending, and stakeholders stress the long lead time of large-scale projects (DS1/DS3/DS10–13). Stakeholders also highlight the breeding of drought-tolerant crops as a long-term endeavor; however, the responsibility for providing new breeds is mostly delegated to the private sector (DS3). 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 (DS4/DS6).

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 (DS11; Rechnungshof Österreich 2020). Some farmers understand the need for the ban to preserve groundwater (DI3/DI4/DI10/DI13/DI14/DI20). Others are more critical and worry about more intensive irrigation during nighttime with no ultimate effect on water demand, as well as about being forced to irrigate under adverse—e.g. windy—conditions (DI3/DI6/DI8/DI12/DI15). Similarly, stakeholders warn that incentives for more efficient irrigation systems may lead to rebound effects if the total irrigated area is increased.

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') (DI1–5/DI8/DI10/DI13/DI15/DI20). At the same time, they tend to differentiate between the future of their own farm and the future of agriculture in the region, which they expect to be very challenging, especially for those without sufficient adaptation measures in place (DI3/DI10/DI12/DI15/DI17–20). Farmers voice their concerns from their perspective both as private (attachment, worries, and psychological stress) and as businesspeople (cognitive risk perception focusing on the economic viability of the farms) (DI2–4/DI16/DI19).

Regarding coping appraisal, farmers show a high degree of self-efficacy. Most assess their reactions to drought as sufficient and as the best they can do. No cases of inaction appear among our interviewees, as all farmers emphasise that they realise drought adaptation measures within the range of their possibilities (DI1/DI8/DI9/DI12/DI14/DI15/DI19/DI20).

Funding schemes are adopted if they match the farmers' goals and operational strategy, often as add-on support (i.e. windfall gain) to existing or already planned measures (DI3/DI8/DI13/DI15/DI20). While we do not find any non-protective responses, we observe to some extent fatalism that manifests as perceiving weather and climate as being beyond the influence of regional stakeholders and farmers (DI2/DI4/DI7/DI11/DI12/DI20).

Farmers report regular exchange as well as mutual 'learning by example', 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-riders who copy measures that frontrunners had applied at their own risk and cost, which now even receive funding (DI1/DI3/DI9–12/DI15/DI18/DI20).

The farmers' individual reactions show a pragmatic mix of measures, shaped by factors external and internal to the farm (DI1–20). 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 with transformative potential for climate-resilient reactions include the installation of water-saving irrigation, water-saving soil cultivation, or changing to more drought-tolerant crops. Poor practice examples include high shares of water-demanding crops. However, the farmers' reactions cannot be strictly attributed to the shock, as some measures have already been in place for decades or are the result of other entrepreneurial decisions (e.g. gross margin of crops, challenges in weed control, crop rotation) (DI13/DI19/DI20).

Negative side effects are observed in a few cases: cultivation of crops with higher water consumption, intensified irrigation powered by fossil fuels, or frequent soil cultivation. However, the stakeholders' expectation of rebound effects related to investments in irrigation infrastructure cannot be observed clearly in the farmers' reactions, as some farmers use drip irrigation with low watering doses while others expand the irrigated area.

The agricultural sector has a high potential and needs to contribute to climate change mitigation, yet the measures realised by farmers focus on drought adaptation and hardly leverage benefits for climate change mitigation, such as solar-powered water pumps or greening and reduced soil cultivation for carbon sequestration.

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 national and regional levels, yet not at the EU level. A diverse array of local, regional, and national stakeholders shapes these instruments. At the national level, the masterplan for tourism was introduced in 2019 (BMNT 2019). This national strategy is complemented by the regional tourism strategy (introduced in 1999, being regularly updated before and after the pandemic), which is not legally binding but aims to provide strategic guidelines to partners such as tourism associations and regional tourism organisations (Land Tirol, Tirol Werbung, Wirtschaftskammer Tirol & Verband der Tiroler Tourismusverbände 1991, 2000, 2008, 2015, 2021). In addition, broader strategic frameworks such as the *Tyrolean Sustainability and Climate Strategy* also address tourism as a key sector (Land Tirol 2021). The recent edition of this regional strategy emphasises quality over quantity, advocating 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 strategy have been incorporated into regional acts and legislations (e.g. Tyrolean Tourism Law 2006–2022; Land Tirol 2022a), such as the appointment of sustainability coordinators in all 34 tourism associations (LGBl. Nr.19/2006, 2006). However, the regional tourism strategy lacks binding power, concrete measures, and specific funding information (CS10–12).

Despite ambitious stated 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 (CS3–5/CS7). The narratives and beliefs underpinning these strategies are varied. While eco-oriented narratives, such as those addressing the carrying capacity of Alpine environments, land use conflicts, and resource use, are present (CS3/CS5/CS7), economic narratives dominate the discourse, aiming to safeguard and promote tourism (CS1/CS2/CS8–10/CS12). Market-oriented and liberalism perspectives further emphasise economic incentives, such as funding and individual responsibility. Before the COVID-19 pandemic, it was already evident that Tyrol's tourism sector needed to become more climate resilient in terms of adaptation as well as mitigation, in particular concerning carrying capacity and resource use (CS3/CS5/CS7). Despite their ambitious goals, the strategies often fall short in practical implementation and interdepartmental coordination (CS3/CS5/CS7). The lack of binding measures leaves the region vulnerable to ongoing and future climate resilience-related challenges in tourism.

Phase 2 – Strategy application

Since a situation like COVID-19 had never occurred before, there were no specific instruments in place for supporting affected tourism entrepreneurs. During the pandemic, existing policy instruments were revisited and re-purposed for coping with the pandemic or instruments were newly conceptualised (CS1–3). The funding volume for Tyrolean tourism support increased substantially. While in 2019, funding of €224,597 was approved for investments of €4.1 million, this rose to €1.65 million of funding (+638%) and €36.8 million investments (+793%) in 2020 and €2.9 million of funding (+74%) and €40.1 million investments (+11%) in 2021 (Land Tirol 2022c).

In some of the revisions and in the development of new instruments, there is a noticeable increase in the inclusion of climate change mitigation and adaptation aspects in regional tourism strategies (Land Tirol, Tirol Werbung, Wirtschaftskammer Tirol & Verband der Tiroler Tourismusverbände 2021) and the Tyrolean tourism funding guidelines (Land Tirol 2022b). For instance, the Tyrolean Tourism Law was revised to mandate sustainability coordinators for all 34 destination management organisations, whose task is (among others) to create annual sustainability reports (Land Tirol 2022a). Financial support programmes also put higher emphasis on mitigation aspects, such as the amendment of guidelines to ensure that investment projects focus on energy efficiency and resource conservation, and the integration of ecological criteria, such as the 'ban on fossil fuels' (Land Tirol 2019, 2020).

During the peak of the pandemic, many strategy revisions seem to have happened coincidentally (CS10; Land Tirol 2019, 2020; Land Tirol, Tirol Werbung, Wirtschaftskammer Tirol & Verband der Tiroler Tourismusverbände 2021). The process often began before COVID-19, with prior developments setting the stage. The pandemic created a political window of opportunity, however, that allowed the incorporation of more climate resilience, being driven by various political stakeholders (CS3–5). Tourism stakeholders indicate that the pandemic provided the necessary momentum and political opportunity for strategic changes, heightened awareness, and freed time for strategic work (CS4/CS8). 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 (CS4/CS5).

Additionally, the pandemic brought to the forefront questions about the new strategic positioning and direction of tourism (CS1/CS8/CS9). Certain stakeholders (e.g. the provincial government of Tyrol, Tirol Werbung, destination management organisations) played a significant part in navigating and advocating changes in policy strategies. The current Tyrolean tourism strategy published in 2021 represents a strategic shift in how Tyrol foresees future tourism development (Land Tirol, Tirol Werbung, Wirtschaftskammer Tirol & Verband der Tiroler Tourismusverbände 2021). Discerning the precise role of the pandemic as a shock event in triggering these changes

remains complex, however, especially amidst multiple overlapping crises.

Phase 3 – Strategy impact

In their risk appraisal, tourism entrepreneurs perceive COVID-19 to be a one-off event and consider other risks to be currently more urgent. The pandemic coincided with other issues such as the Ukraine war, energy supply challenges, inflation, and the lack of staff availability in the tourism sector (CI2–4/CS4). This overlapping of crises introduces ambiguity 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 the perceived good preparation of the sector (CI2/CI5/CI9). On the contrary, Tyrol is perceived as a net winner of climate change as the Alps are seen as a recreational area to which tourists may retreat from serious climate impacts elsewhere (e.g. heat waves, droughts) (CI4/CI5/CI7).

The coping appraisal of tourism entrepreneurs shows a very diverse degree of self-efficacy: Some stress the manageable individual scope of action to contribute to climate change mitigation (CI2/CI3/CI5); others do not see any opportunity for them to take action (CI1/CI7/CI8).

The phases of the pandemic lockdown were used by many businesses to realise outstanding projects; however, many of these plans were already on the drawing board, which suggests that the crisis was not necessarily a driver for profound changes but rather an accelerator of already ongoing processes (CI3–5). Mitigation measures include improving energy efficiency in hotels (e.g. switching to renewable energies, improving thermal insulation) (CI5/CI6) or the connection to sustainable mobility services (CI1). The results on the effect of funding measures were ambiguous: while representatives of the administration are very much of the opinion that funding leads to investments in climate protection measures (CS3–5/CS9–11), the statements of the hotel operators tend to indicate that the decision to invest was made independently of possible funding (CI4/CI5). Tourism as a cross-sectional topic has access to diverse funding schemes; however, the sector suffers from considerable confusion about the availability and criteria of existing schemes (CI1/CI2/CI6). Because of this information overload, many tourism entrepreneurs approach funding agencies as late as when construction projects have already begun or other investments have been made, which limits their access to funding (CI1/CI2/CI6).

Good practices for tourism entrepreneurs include a repositioning of the tourism offer while creating climate-friendly products (e.g. renovation of existing infrastructure) (CI1/CI2/CI5–7). Poor practices include the creation of new offers that are energy intensive (e.g. thermal spas, indoor and outdoor pools) (CI3/CI4/CI6/CI7) implying rebound or even backfire effects of policy instruments regarding the total energy demand.

Discussion

The article presents the role of shocks as potential turning points for Climate Resilient Development Pathways (CRDPs) that integrate climate change adaptation and mitigation to realise the overall societal goal of sustainable development. We next discuss the interrelations between policy strategy, shock, and individual reactions within and across our three case studies.

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 own 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.

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 rebound 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 broader policy coordination between climate adaptation

and mitigation policies by the national and regional governments.

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

The dominant narratives of economically viable farms and problem solving via technical measures promote an irrigation focus that had already been present before and was maintained in revised form after the multi-seasonal drought in 2018–2022. The regional water management strategy that is currently in effect limits 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 account neither for regional climate conditions nor for drought impacts. Consequently, farmers typically apply only for those funding schemes that conform to 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 extra-regional 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 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 lifetimes of irrigation tubes from damage by ultraviolet radiation and rodents resulting in plastic residues remaining in the soil. Investment funding often has an add-on effect because it supports adaptation measures that farmers would adopt anyway. Rebound effects of water-saving irrigation technology, as mentioned by Pérez-Blanco et al. (2021), are not clear-cut; this may be related to the absence of irrigation-intensive farms in our sample.

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 instruments was adopted to support the sector. Subsidies, which were both increased and expanded, were a crucial element of this package. The guidelines were revised to incorporate ecological criteria; however, most of the measures would have been adopted anyway, which indicates an add-on effect.

The COVID-19 pandemic was not the decisive but a supporting driver for changes in the tourism sector (e.g. legally prescribed sustainability coordinators in destination management organisations). The initiatives for transforming the sector can be attributed to an ongoing process of change that had already started before the shock. COVID-19 opened a window of opportunity to bring climate change mitigation and adaptation 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 stakeholders from federal state policy and destination management organisations.

Cross-case discussion

In **phase 1**, across all three case studies, system performance was impaired by prevailing conflicts of interest, fragmented sectoral perspectives, and disconnection between governance levels, especially between the national and regional levels (Table 2). 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 levels pursue a long-term planning perspective, whereas the local level considers mainly short-term impacts and needs. If superordinate policy strategies are non-binding, they tend to be not (sufficiently) recognised and implemented at the regional and local level: binding EU directives, as in the flood and the multi-annual drought cases, lead to the implementation of national and regional strategies and instruments. In the absence of EU-level requirements, however, as in the COVID-19 tourism case, national and regional strategies and instruments tend to be inadequately implemented. At the same time, overarching EU-level strategies are hardly tailored to regional or local particularities.

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 (Table 2). In the flood case, the planned relocation strategy was modelled on a previous application in a neighbouring area; in the multi-annual drought case, 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 were not coordinated with other instruments that were already in place and therefore did not deploy to their full effect: in the flood case, the policy strategy overlooked the need

Table 2 Communalities and differences between the three cases

	Case study 1: Flood	Case study 2: Multi-seasonal drought	Case study 3: COVID-19
Phase 1 – Strategy development	- Conflicts of interest, fragmented sectoral perspectives - Disconnection between governance levels (esp. between national and regional level)		
	- Binding EU directives lead to implementation of national/regional strategies and instruments		- Lack of binding strategies at national/regional level
Phase 2 – Strategy application	- Lack of pre-shock policy coordination: no accounting for climate resilience - Shocks lead to no development of new policy instruments but to application of existing/planned instruments - Lack of coordination of emergent instruments with already established instruments		
	- Lack of combined advancement of adaptation and mitigation - No differentiation between individual/regional needs		- Overall confusing funding landscape
Phase 3 – Strategy impact	- No triggering of joint realisation of mitigative and adaptive measures - Preference of funding schemes to regulations		
	- Regulations present and serving as trigger for individuals' re-appraisal of risk		- No regulations are present
	- Reactions as private individuals	- Reactions are also driven by business developments parallel to the shock	

to advance adaptation and mitigation among the households who stay on the floodplain; in the drought case, farmers lacked sufficient funding and support to adopt water-saving irrigation or other drought management options; in the COVID-19 case, the financial support dedicated to climate-resilient tourism was hardly visible within an overall confusing funding landscape. Moreover, policy strategies were applied in a uniform manner and did 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 (Table 2). Especially in the multi-annual drought case, the focus is on adaptation with little mitigation happening at all. Mitigative measures are mostly realised as a side benefit to adaptive measures (e.g. greening of cropland); 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 rebound effect from oversized floor areas that partially offsets the efficiency gains. The policy strategies of all three case studies prefer funding schemes to regulations. If regulations are present, such as the building ban on the floodplain or the temporary irrigation ban, they serve as a trigger for individuals to reflect on how they plan to prepare for future risk. In order to direct these plans to climate-resilient development, the policy strategies rely on voluntary funding schemes, which mostly provide add-on incentives for individual intentions that would be realised anyway.

However, the effect of the shock as a distinct milestone on a Climate Resilient Development Pathway does not emerge as clear-cut from the empirical data, as might be expected from the transformation literature. In the multi-annual drought case and the COVID-19 case, the reactions of farmers and tourism entrepreneurs are also driven by parallel developments such as long-term business outlook, staff availability, and energy costs, which makes it hard to disentangle the unique effect of the shock. As all three case studies rely on qualitative interviews, we cannot exclude the possibility that the observed reactions to the shock could be coloured by the selection of interviewees. For instance, in the multi-annual drought case, we could not recruit farmers with large-scale water-intensive crops who solely rely on irrigation. Moreover, the high self-efficacy of the interviewed farmers could also indicate a certain sampling bias because less confident farmers who struggle with drought risk might be less willing to agree to an interview. Notwithstanding their respective regional characteristics, we consider the findings for our three Austrian case studies to be transferable to other countries with similar challenges, climatic conditions, and political frameworks—especially within the European Union legislative framework.

Across all three case studies, policy coordination and stakeholder interaction emerge as critical issues. Previous research similarly points to the significance of including stakeholders at all levels (Asfaw et al. 2018; Thaler et al. 2020; Friedman et al. 2019). Stringer et al. (2022) highlight engagement and partnerships to gain diverse knowledge for CRDPs, emphasising equity, justice, and assessment of trade-offs in CRDP actions. Sparks and Werners (2023) stress co-creation, understanding governance impacts and power dynamics, and informed decisions by actors with varied knowledge and power to ensure equity. Taylor et al.

(2023) highlight building networks of intermediaries across groups, sectors, disciplines, and scales to foster trust and enable transformative, equitable CRDPs.

Conclusions

Following the Climate Resilient Development Pathways (CRDPs) concept (IPCC 2022) and the Strategy Shock Implementation Reaction (SSIR) framework (Seebauer et al. 2025), we illustrate for three case studies the impacts of climatic and non-climatic shocks, tracing policy strategies and reactions of affected individuals as they develop before, during, and after the shock; in other words, over the phases of strategy development, application, and impact. While existing strategies were adapted and implemented to support affected individuals to cope with the shock, profound change in policy strategies towards climate resilience did not happen. Thus, within the Austrian policy environment of our three case studies, we cannot confirm that climatic and non-climatic shocks have substantial transformative power (Moore et al. 2014; Grossman 2015). Instead, shocks should not be overrated in their relevance for initiating radical change (Solecki and Michaels 1994). However, turning points in CRDPs need not be restricted to momentary shocks from natural hazards. CRDPs may also reorient 'due to the exceedance of a performance threshold, an opportunity arising, or as a result of moving targets' (Langendijk et al. 2024:5). Thus, if the multi-annual drought case and the COVID-19 case continue to degrade from ongoing developments in agriculture and tourism, it might take longer than the observation period of the present study until thresholds or targets are reached, and policy strategies are profoundly revised (Seebauer et al. 2025).

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 set out on 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. Transformational change in CRDPs would require fundamental change in the worldviews and partnerships of the involved stakeholders (Singh and Chudasama 2021). The policy strategies in the drought and the COVID-19 case were developed by a circle of regional partners; however, this circle reproduced previous stakeholder constellations and hardly included new perspectives or actors.

Unless driven by EU-level requirements and goals, the national and regional strategies in the three case studies fall short of a concise, targeted 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 foresighted manner, future shocks, which will most likely occur more frequently and more severely than in the past, could be used as an opportunity to enter and pursue CRDPs.

The present study demonstrates how CRDPs and their underlying policy strategies may be operationalised in empirical research by adopting the SSIR framework. No established procedure for pathways appraisal exists yet (Werners et al. 2021; Langendijk et al. 2024). SSIR framework elements are confirmed in all three case studies, such as policy narratives that shaped the original strategies, strategy revision during implementation, and individual risk and coping appraisals that are directed by the revised strategies. However, tracing specific elements over the sequence of strategy development, application, and impact would require further longitudinal data. Still, the SSIR framework seems a useful structure for reconstructing why individual reactions to shocks occur against the background of prevalent policy strategies within CRDPs.

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Declarations

Conflict of interest The authors declare no competing interests.

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