Exploring recovery complexity in the context of consecutive disasters

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Abstract. Abstract. Consecutive disasters, where two or more disasters occur in close succession, can interrupt ongoing recovery processes and create additional layers of complexity compared to isolated events. While research has increasingly examined interactions between multiple hazards, recovery processes in the context of consecutive disasters remain comparatively understudied. In this perspective paper, we draw on empirical examples and insights from scientific literature to explore how consecutive disasters can affect recovery across four interconnected societal domains representing a cross-section of society: human settlements, human health, the economic domain, and socio-political domain. Through these examples, we illustrate how incomplete recovery can alter vulnerability and exposure conditions, creating feedbacks that shape recovery trajectories within and across societal domains, as well as across spatial and temporal scales. Reflecting on these examples, we discuss the implications of disrupted recovery for long-term societal resilience, including the potential for reinforcing feedbacks associated with negative tipping and the role of consecutiveness as an inhibiting factor for positive transitions. We further highlight how interpretations of recovery and consecutiveness depend on system definitions, including the indicators, scales, and interconnections considered, and discuss the conceptual ambiguities surrounding the distinction between disasters, impacts, vulnerability, and exposure. Together, these reflections demonstrate that recovery under consecutive disasters cannot be understood independently from the systems, scales, and conceptual framings through which it is assessed. Ultimately, a better understanding of the complexities of recovery in a consecutive disaster context, both conceptually and in practice, is essential for developing more nuanced approaches to disaster risk assessment and to support long-term resilience building in a future characterised by increasingly frequent and intense hazards.

1 Introduction

Recovery after a disaster is often a long-term process that involves the “restoration or improvement of livelihoods and health, as well as economic, physical, social, cultural, and environmental assets, systems and activities, of a disaster-affected community or society, aligning with the principles of sustainable development and ‘Building Back Better’, to avoid or reduce future disaster risk” (UNDRR, 2016). As recovery can take months, years, or even decades, societies may experience additional disasters while still recovering from previous events. Such events, where two or more disasters occur in close succession, while recovery of the first event has not yet been completed, are defined as consecutive disasters (de Ruiter et al., 2020). When recovery between disasters is incomplete, impacts and recovery demands can overlap and interact, creating challenges that differ substantially from those associated with isolated disaster events (Kappes et al., 2012; Marzocchi et al., 2012; Mohammadi et al., 2024).

Global assessments have provided insights into the occurrence of events where multiple disasters occur simultaneously or consecutively (Claassen et al., 2023; Ridder et al., 2020). As a result of climate change, the frequency and intensity of many climate-related hazards are projected to increase, subsequently altering the likelihood of experiencing successive disaster events with limited recovery time (IPCC, 2023). For example, hurricane seasons similar to the 2017 Atlantic season, which featured 17 named storms and 10 hurricanes, with six escalating to major status, are expected to become more frequent as a result of climate change (NOAA National Centers for Environmental Information, 2025). Xi et al. (2023) project that, by the end of the century, the recurrence interval between consecutive tropical cyclones affecting the U.S. coast will decrease from approximately 10–92 years at present to only 1–3 years. This shift, driven by rising sea surface temperatures, sea-level rise, and changing storm dynamics, may increase the risk of insufficient recovery time between events. Additionally, population growth and economic expansion will increase exposure, placing more people and assets at risk (Tellman et al., 2021).

Recovery is often represented as a distinct phase within the disaster risk management (DRM) cycle, following response and predating prevention, mitigation, and preparedness. In practice, however, the boundaries between these DRM phases are often blurred. This is reflected in recent alternative conceptualisations of DRM, such as the recovery continuum used by Federal Emergency Management Agency (2024) or the DRM Helix as defined by Bosher et al. (2021), which recognise that recovery may commence alongside immediate response and relief activities, while preparedness and risk reduction measures can be implemented during the reconstruction phase. This is also emphasised by the “Building Back Better” principles of disaster recovery (UNDRR, 2016). The occurrence of consecutive disasters can further complicate this distinction, as recovery efforts associated with one disaster may overlap with response activities for a subsequent event. As a result, different phases of the DRM cycle may occur simultaneously across multiple events, creating competing demands for resources, attention, and decision-making (Mohammadi et al., 2024). Moreover, recovery processes are closely linked to long-term resilience of a society, as resilient societies are characterised by their ability to resist, absorb, accommodate, adapt to, transform, and recover from the effects of hazards in a timely and efficient manner (UNDRR, 2022; Zobel and Khansa, 2014). Understanding how recovery unfolds under consecutive disasters is therefore essential not only for disaster recovery itself, but also for understanding how resilience evolves over time.

While it is evident that recovery plays a role in shaping the impacts of consecutive disasters, recovery processes in the context of such events remain one of the least-explored areas in disaster science (Drakes and Tate, 2022). Considerable progress has been made in improving our understanding of how multiple hazards interact when they coincide or occur in short succession (Gill and Malamud, 2016; Tilloy et al., 2019), but the socio-economic impacts of consecutive disasters remain comparatively understudied (Drakes and Tate, 2022; Jäger et al., 2024; Lee et al., 2024). Recent studies have also underscored that dynamic exposure and vulnerability conditions following a first disaster can significantly influence people's ability to respond to and recover from subsequent events (de Ruiter et al., 2020; **?**). This highlights the importance of better understanding recovery processes in the context of consecutive disasters.

Here, we explore the complexity of recovery under consecutive disasters through illustrative empirical examples and insights from the scientific literature across four selected interrelated societal domains: human settlements, human health, the economic domain, and the socio-political domain (Fig. 1). We use the term societal recovery throughout this paper to clarify that we focus on recovery processes within human systems. The domains represent a cross-section through which different dimensions of recovery complexity can be illustrated, rather than providing an exhaustive representation of society. Together, they encompass a range of critical systems and services on which societies depend, such as housing, healthcare, governance structures, infrastructure, and food systems. We note that the distinction between societal domains is not always clear-cut, as many critical systems and services are interconnected and support multiple societal domains simultaneously. For example, access to water, sanitation, and hygiene (WASH) is discussed primarily within the human health domain, but is closely linked to the living conditions, housing quality, and displacement dynamics considered in relation to human settlements. Additionally, the examples of affected recovery processes are discussed through the lens of the societal domain in which they are presented, rather than assigned exclusively to it.

Recovery from disasters resulting from natural hazards may also overlap with other disruptive events, such as health crises, conflicts, and economic shocks, that may constitute disasters in their own right. Such events can generate impacts and recovery demands overlapping with those of natural hazards, affecting recovery trajectories (Thalheimer et al., 2022; WHO, 2019). Therefore, within the scope of this perspective, we adopt a broad interpretation of consecutive disasters, also encompassing sequences involving other disruptive events as they interact with, occur alongside, or influence recovery from natural-hazard disasters. This all-hazard perspective is consistent with the UNDRR Hazard Information Profiles, which recognise biological and societal hazards alongside natural hazards (UNDRR, 2021). Nevertheless, for conceptual clarity, we use the term disaster as a standalone term throughout this paper to refer to disasters resulting from natural hazards. Health crises, conflicts, and economic shocks are therefore discussed only in relation to their interactions with natural-hazard disasters and their influence on recovery processes under consecutive disasters.

The pathways discussed throughout this paper were developed through an iterative expert-driven and literature-informed process. Initial examples and pathways identified through interdisciplinary discussions among the authors were subsequently refined, expanded, and grouped through targeted literature searches and repeated rounds of collective discussion. This process was repeated as new examples and insights emerged from the literature, resulting in the final set of illustrative pathways and examples presented in this paper.

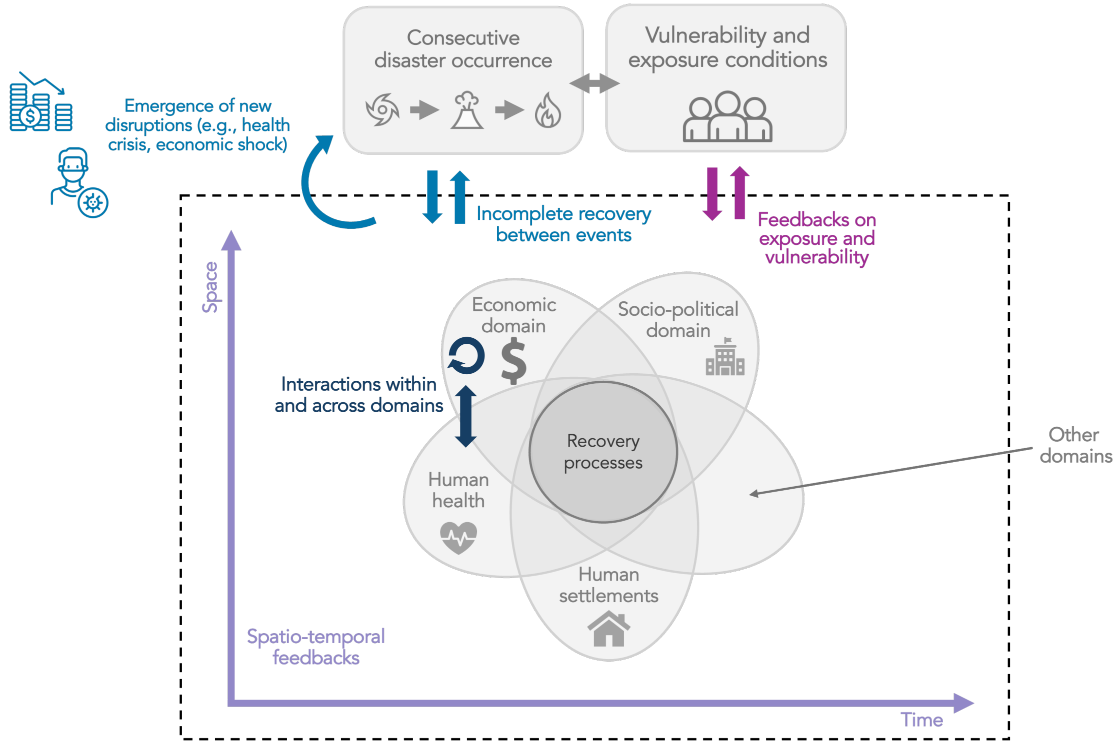

Figure 1. Conceptual illustration of the scope of this perspective (dotted box). The perspective considers recovery processes within the interconnected societal domains in the context of consecutive disasters, including their connection with exposure and vulnerability conditions, subsequent and newly emerging societal disruptions, and feedbacks across domains, space, and time.

Sections 2–5 discuss pathways through which recovery may be affected under consecutive-disaster conditions within one of the four societal domains: human settlements (Sect. 2), human health (Sect. 3), the economic domain (Sect. 4), and the socio-political domain (Sect. 5), while highlighting interactions across domains. Building on these examples, the final section reflects on broader conceptual challenges related to recovery complexity under consecutive disasters, including the implications of disrupted recovery for long-term resilience (Sect. 6.1), the role of system definitions in shaping interpretations of recovery and consecutiveness (Sect. 6.2), and the conceptual boundaries between disasters, impacts, vulnerability, and exposure conditions in a consecutive disaster context (Sect. 6.3).

2 Impacts within human settlements

Human settlements refer to the places where people live, and the critical systems they depend on, such as housing, healthcare, education, public transport, and food (Newman et al., 1996). Disasters can repeatedly disrupt the structural functionality of human settlements, causing cumulative damage to buildings, infrastructure, and ecosystems, as well as prolonged displacement and loss of life (IPCC, 2023). This section explores recovery within human settlements, which may involve, for instance, the restoration of housing, critical infrastructure, access to essential services, and safe living conditions. Within this context, we discuss different pathways through which inadequate or incomplete recovery can increase vulnerability and exposure to future risks (Fig. 2).

Pathway	Empirical examples
Exposure and vulnerability increases through displacement and relocation	• Displaced populations from the 2010 earthquake, still living in camps, were affected by the 2021 Nippes earthquake and cyclone Grace (Haiti, 2010/2021); • Earthquake-displaced individuals faced harsh winter conditions in temporary shelters (Syria and Turkey, 2023);
Structural weakening and compounding damages under consecutive events	• Monsoon rains after the Ghorka earthquake compounded road damages, slowing recovery (Nepal, 2015); • Buildings affected by the 2015 Ghorka earthquake were significantly more vulnerable during flash flooding in 2017 (Nepal, 2015/2017).
Disruptions and redundancy loss in critical systems	• Storm-related flooding from tropical cyclone Grace obstructed access roads to earthquake-affected communities (Haiti, 2021); • Drought from the 2015-2016 El Niño compounded crop damage from Typhoon Haiyan (2013), worsening food insecurity (Philippines, 2013/2016).
Hindered response and recovery due to ongoing or consecutive hazardous conditions	• Landfall of cyclone Grace shortly after the Nippes earthquake forced a halt in search and rescue operations (Haiti, 2021).

Figure 2. Summary of the main recovery pathways and illustrative examples discussed in Sect. 2 (human settlements).

2.1 Exposure and vulnerability increase through displacement and relocation

Each year, over 20 million people are displaced by disasters, forcing them into temporary shelters or informal settlements. Displaced individuals are often more exposed to subsequent disasters, particularly in hazard-prone areas (IDMC, 2021). Following the 2010 earthquake (7.0 Mw) in Haiti, displaced residents migrated across the country, away from affected urban areas into flood- and landslide-prone areas with high seismic risk. Camps were established based on NGOs' presence in the area, with minimal consideration of geographic appropriateness or disaster risk. Over a decade later, 33,000 victims of the 2010 earthquake were still living in camps, making them vulnerable to the major 2021 Nippes earthquake (7.2 Mw), followed just days later by tropical cyclone Grace (Cabas et al., 2023). While displacement could theoretically also reduce exposure if communities relocate to safer areas, empirical evidence remains lacking (Stalhandske et al., 2024).

Displacement also heightens vulnerability. People staying in poorly constructed temporary shelters, or on the streets without any shelter at all, can become more susceptible to impacts from severe weather. After the severe earthquakes (7.8/7.6 Mw) in Syria and Turkey (2023), displaced individuals were, for example, living in tents when they were confronted with harsh winter weather, making earthquake victims vulnerable to medical issues such as hypothermia (Bayram et al., 2023; Orak, 2024). Moreover, people staying in displacement camps and temporary shelters often lack adequate access to critical services, such as water, sanitation, and hygiene (WASH) infrastructure. This increases their susceptibility to biological hazards, which may result in the subsequent emergence of new health crises (further discussed in Sect. 3.1 on emerging and aggravated health risks in post-disaster contexts) (IDMC, 2021). Although intended as a short-term solution, shelters often unintentionally become permanent or semi-permanent over time, resulting in long-term vulnerabilities (Askar et al., 2019). Regaining stable housing can take years, or even decades, even in high-income countries such as the United States and Japan (Action Aid, 2010; Merdjanoff et al., 2022).

2.2 Structural weakening and compounding damages under consecutive disasters

Even when disasters do not fully destroy houses and structures, they can leave these structures and the overall system significantly more vulnerable to subsequent disasters. Consecutive disasters compound earlier impacts, amplifying existing damage and undermining reconstruction efforts (Kim and Choi, 2013; Puri et al., 2024). After the 2015 Gorkha earthquake (7.8 Mw) in Nepal, monsoon rains further degraded the road network, slowing the delivery of materials and aid, and forcing communities to divert efforts from rebuilding homes to address the new infrastructure impacts (Twigg et al., 2017).

When structures have not been able to fully recover from a preceding event, they can also become more vulnerable to later impacts, with increased risk of collapse or sustaining disproportionately large impacts from subsequent events (Gautam and Dong, 2018; Korswagen et al., 2019). Empirically estimated damage functions from the Gorkha earthquake illustrate this, showing that buildings affected by the earthquake in 2015 were significantly more vulnerable to subsequent flash flooding in 2017. In some cases, damage was aggravated by up to 300% when buildings had suffered earthquake damage prior to the flood (Gautam and Dong, 2018).

2.3 Disruptions and redundancy loss in critical systems

The critical systems that human settlements rely on, such as energy, water, healthcare, transport, and food, also become increasingly affected when impacts accumulate. Access to facilities providing critical services, such as shelters and hospitals, after a disaster plays a key role in accelerating recovery, while lack thereof can significantly slow down the overall recovery process (Alam et al., 2024; Ade Bilau et al., 2018; Sospeter et al., 2020; Suppasri et al., 2024). For example, in Haiti (2021), storm-related flooding obstructed access to earthquake-affected communities, making it difficult for humanitarian workers to reach those in need of assistance (OCHA, 2021b).

To maintain functionality under shocks, critical systems are typically designed with redundancy of critical components and functions, meaning that multiple components perform similar functions and thereby serve as a safety net if part of the system fails (Nowell et al., 2017; Urlainis et al., 2022). However, when redundant system components are reduced, for instance when two of three major roads leading to a city are disrupted, the transport system becomes more vulnerable to subsequent events through a reduction in redundancy (Argyroudis et al., 2020; Fereshtehnejad and Shafieezadeh, 2018). Recovery time depends on initial damage, system interdependencies, and the spatial distribution of critical components (Der Sarkissian et al., 2022; Jeddi et al., 2022). Effective preparedness, recovery planning, and prioritisation can, however, help accelerate restoration (Koks et al., 2022; Urlainis et al., 2022).

Food system redundancy is also threatened under consecutive disasters. In the Philippines, drought-related crop failures caused by prolonged dry spells and reduced rainfall during the strong 2015–2016 El Niño event compounded earlier damage from typhoon Haiyan (2013) to coconut and banana trees, which require approximately 1–2 years to fully recover (Sargeant et al., 2020). Similarly, Mozambique faced widespread food shortages after cyclones Idai and Kenneth (2019), worsened by prior droughts (IFRC, 2019; UNICEF, 2019). Crop diversification can improve resilience, but its effectiveness is limited when multiple hazards affect different food sources simultaneously (Bacon et al., 2017).

2.4 Hindered response and recovery due to ongoing or consecutive hazardous conditions

Response and recovery can be slowed or hindered by physical hazard conditions that create unsafe, inaccessible, or unworkable environments. After the 2021 Haiti earthquake, tropical storm Grace halted efforts to search for survivors for several critical hours (Cavallo et al., 2021). Similarly, the harsh winter weather following the 2023 Syria and Turkey earthquakes, accompanied by ongoing aftershocks, not only worsened the suffering of displaced and injured individuals, but also created a difficult working environment for emergency personnel (Aljazeera, 2023; Mavrouli et al., 2023). In New Mexico (2024), wildfires were immediately followed by flash floods, forcing firefighting crews to temporarily evacuate (Anguiano, 2024). Ongoing hazardous conditions can also affect reconstruction, for instance when labour efficiency is significantly reduced under extreme heat conditions (Alshebani and Wedawatta, 2014). Labour and other resource constraints are discussed more comprehensively in Sect. 4.3.

3 Impacts on human health

The relationship between climatic disasters and health crises is mutually reinforcing: extreme weather exacerbates existing health burdens and can create new ones, while ongoing health crises can weaken the ability of a society to respond to and recover from disaster impacts (Hariri-Ardebili et al., 2022; WHO, 2019). When health crises arise from the convergence of a biological hazard, such as cholera or other infectious diseases, with an exposed and vulnerable population, they may themselves constitute consecutive disasters (UNDRR, 2021). At the same time, recovery within the human health domain can also be affected more broadly through processes that do not necessarily constitute separate disasters. Recovery in the human health domain can, for instance, encompass the reconstruction of health-related critical systems and the restoration of access to health-related critical services, such as water, sanitation, and hygiene (WASH) and healthcare, as well as broader health outcomes, including physical and mental health (WHO, 2019). In this section, we discuss different pathways through which consecutive disaster dynamics can affect recovery in the human health domain, summarised in Fig. 3.

Pathway	Empirical examples
Emerging and aggravated health risks in post-disaster contexts	• Overcrowding in shelters after typhoon Goni led to a surge in COVID-19 cases (Philippines, 2022); • Tuberculosis outbreak among evacuees after the Great East Japan earthquake (Japan, 2011); • Ebola transmission worsened by displacement following floods (Sierra Leone, 2015); • Emergency personnel brought COVID-19 to Tonga after volcanic eruption and tsunami (Tonga, 2022); • COVID-19 and flood-related disruptions of vaccination programmes led to measles and polio outbreaks (Pakistan, 2022); • Poor WASH conditions after cyclones Idai and Kenneth resulted in cholera outbreak (Mozambique, 2019).
Challenges in disaster-health crises coordination	• Response and recovery after disaster events (e.g., cyclone Amphan in India, wildfires in the U.S., and earthquakes in Greece) were incompatible with COVID-19 pandemic-related restrictions (India, 2020 / U.S., 2020 / Greece 2020-2021). • COVID-19 restrictions interrupted ongoing reconstruction after the 2015 Gorkha earthquake in Nepal through labour and material shortages, illustrating how health crises can delay disaster recovery.
Mental health implications of repeated disaster exposure	• People affected by hurricane Harvey in 2017 experienced more anxiety during the COVID-19 pandemic (U.S., 2017/2022).

Figure 3. Summary of the main recovery pathways and illustrative examples discussed in Sect. 3 (human health).

3.1 Emerging and aggravated health risks in post-disaster contexts

One of the most immediate ways in which disasters and health crises interact is through the increased susceptibility to biological hazards in the aftermath of a disaster. Post-disaster conditions can foster the spread of communicable diseases, for example due to overcrowding of displaced people in emergency shelters or when mass evacuations are required (Hariri-Ardebili, 2020). This was seen after typhoon Goni in the Philippines in 2022 with a surge in COVID-19 cases (Rocha et al., 2022), Japan's 2011 earthquake with a tuberculosis outbreak (Kanamori et al., 2013), and Sierra Leone's 2015 floods, which worsened Ebola transmission due to strained resources in overcrowded shelters (Ratto et al., 2016). Natural hazards can also contribute to the spread of vector-borne diseases such as dengue and malaria, for example when long-standing water after a flood creates breeding grounds for mosquitoes (Coalson et al., 2021). Moreover, the spread of diseases can occur through disaster-related movement, such as evacuations and humanitarian deployments. This was exemplified during the COVID-19 pandemic after the 2022 Tonga volcanic eruption and tsunami, when emergency personnel entering the affected area inadvertently brought the virus to the island, resulting in a major outbreak (IFRC, 2022).

Related to the disruptions to critical systems discussed in Sect. 2.3, disasters can increase health risks by limiting the availability and accessibility of health-related critical systems and services. This may, for instance, result from direct damage to healthcare infrastructure, increased pressure on healthcare systems, or disruptions to interconnected systems, such as transport networks and supply chains that support access to healthcare and the delivery of medical supplies. For example, through damaged hospitals or hospital access roads, and the disruption of vaccination programmes (Ali and Hamid, 2022; Hariri-Ardebili, 2020; Salam et al., 2023). In Pakistan, disruptions to vaccination programmes initially caused by the COVID-19 pandemic and later compounded by the 2022 "super floods" led to outbreaks of diseases such as polio and measles (Ali and Hamid, 2022). Similarly, the availability and accessibility of adequate water, sanitation, and hygiene (WASH) infrastructure can play an important role in post-disaster health outcomes. Following cyclone Kenneth in Mozambique in early April 2019, less than six weeks after cyclone Idai, poor WASH conditions contributed to a cholera outbreak with over 6,700 deaths (Lequechane et al., 2020). Healthcare systems can also experience additional pressure in a post-disaster context due to increasing demand for medical services and occupying hospital capacity (Hariri-Ardebili, 2020). Hassan and Mahmoud (2021) evaluated different patient demand management strategies under the combined impact of a wildfire and pandemic and found that losing access to medical care is a direct function of the relative occurrence time between the two events.

There are also indirect health effects that can arise, for example when disasters affect food security by disrupting agriculture and supply chains. As discussed in Sect. 2.3, food system resilience is vulnerable under consecutive disasters. The repeated destruction of cropland, loss of livestock, and ongoing displacement leave communities with little time to recover, gradually exacerbating food insecurity, particularly among vulnerable populations, as food scarcity drives up prices and limits access to essential nutrition (FAO, 2023). Especially for children, this can have significant health implications. Hossain et al. (2020) found that children exposed to multi-hazard risks were significantly more likely to be stunted and underweight than those in low-risk districts.

3.2 Challenges in disaster-health crises coordination

Governments and responding agencies face the difficult task of balancing multiple, often conflicting priorities, such as preventing disease transmission while coordinating disaster relief efforts (Quigley et al., 2020). The co-occurrence of disasters during a health crisis, or vice versa, can further strain already limited financial and humanitarian resources, particularly in vulnerable, low-income communities that are disproportionately affected by climate change, or create physical and organisational barriers (Hochrainer-Stigler, 2021). In addition, authorities must safeguard emergency personnel and military workers from health risks during ongoing crises while ensuring effective disaster response and recovery operations (Hadeed et al., 2023).

These coordination challenges became particularly apparent during the COVID-19 pandemic. Various studies examined disaster events that occurred at the height of the pandemic, such as earthquakes in Greece (2021–2022), wildfires in the United States (2020), and cyclone Amphan in India (2020) (Izumi and Shaw, 2022; Mavrouli et al., 2023). They found that response and recovery actions were often constrained by pandemic-related restrictions, such as quarantine and social-distancing measures, resulting in restricted humanitarian aid delivery, reduced capacity for safe evacuations and sheltering, and a decline in volunteer numbers. The effects of the pandemic also extended into longer-term disaster recovery. Following the 2015 Gorkha earthquake in Nepal, for example, ongoing housing reconstruction was brought to a standstill during the COVID-19 lockdown due to labour shortages, disrupted material supply chains, travel restrictions, and concerns over virus transmission, delaying recovery of earthquake-affected communities (Neupane and Mishra, 2020). These challenges illustrate the broader issue of increased disaster risk management complexity under consecutive disasters, which will be further explored in Sect. 5.2.

3.3 Mental health implications of repeated disaster exposure

Disasters are known to have adverse effects on mental health and wellbeing, with impacts such as post-traumatic stress disorder (PTSD), anxiety, depression, and increased health risk behaviours (Keya et al., 2023; Zenker et al., 2024). When people experience repeated exposure to disasters, mental health issues such as PTSD, acute stress disorder (ASD), and depression are exacerbated. This has been found for different hazard types and in a wide range of regions and socio-economic contexts, including exposure to multiple hurricanes in the United States (Garfin et al., 2022), repeated earthquakes in China (Geng et al., 2018), and multiple weather-related disasters in Australia (Mitchell et al., 2024). Similar findings emerge when examining the intersection of the COVID-19 pandemic with natural hazards. Callender et al. (2022) reported that, during the COVID-19 pandemic, people who had been significantly impacted by Hurricane Harvey (2017) had higher odds of experiencing severe anxiety. Children are particularly vulnerable to mental health impacts from disasters, as early disaster exposure increases the risk of mental health and substance abuse issues later in life (Maclean et al., 2016). Particularly when children are repeatedly exposed to disasters, these mental health impacts can be long-lasting, persisting for months or even years (Save the Children, 2023).

4 Impacts within the economic domain

The economic domain encompasses the structures, institutions, and decision-making processes involved in the production, allocation, and distribution of goods, services, and capital within and across communities. Like human settlements and health systems, the economy is increasingly subject to multiple stressors, including extreme weather events, pandemics, and economic conflicts, which collectively create compounding challenges for recovery and growth (Middelanis et al., 2023; Townend et al., 2023). Similar to biological hazards that may give rise to health crises in the human health domain, the UNDRR Hazard Information Profiles also recognise financial shocks as hazards that may result in societal disasters (UNDRR, 2021). At the same time, disasters can also affect economic recovery through broader economic processes that do not necessarily constitute separate disasters.

Defining recovery in the context of the economic domain strongly depends on the scale and the variables considered. It may be reflected through indicators such as household finances and debt levels, business revenue, government budgets, and gross domestic product (GDP). The interconnected nature of economic systems means that disaster disruptions and associated recovery processes can affect sectors, regions, and spatial scales extending well beyond the directly affected area. In this section we explore how the recovery and long-term resilience of the economic domain are affected by consecutive disasters, as overlapping shocks gradually deplete financial resources, shift investment behaviours and risks, and trigger cascading effects within a highly interconnected global system. A summary of the pathways discussed in this section can be found in Fig. 4.

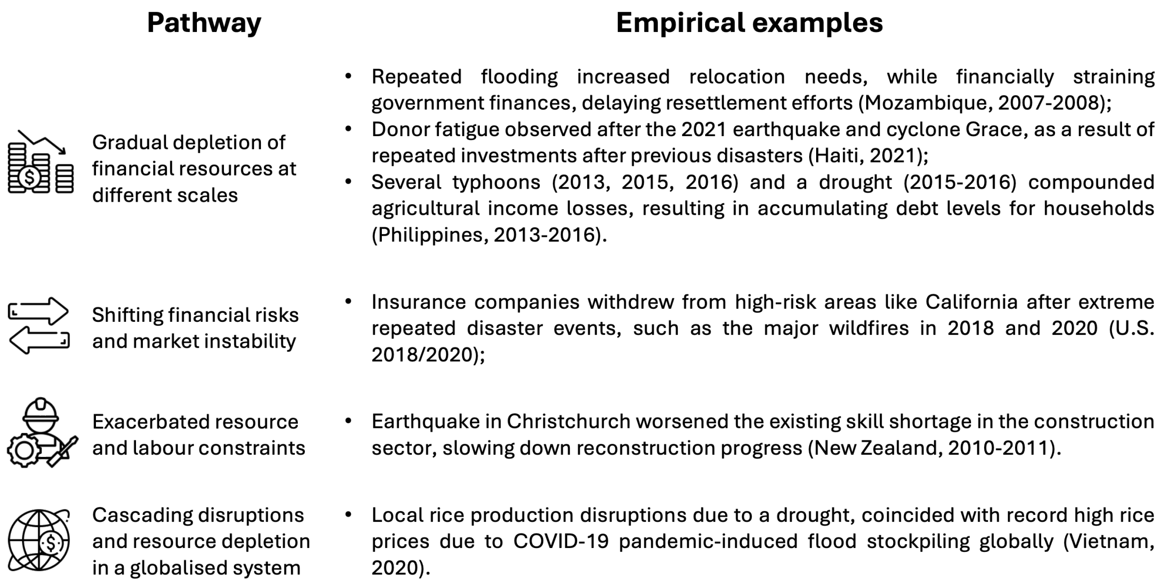

Figure 4. Summary of the main recovery pathways and illustrative examples discussed in Sect. 4 (economic domain).

4.1 Gradual depletion of financial resources at different scales

Financial resources are a core element of healthy economies that can become increasingly constrained because of consecutive disasters. This affects recovery and eventually long-term financial resilience at different scales, from large-scale impacts at supra- and (inter)national levels down to individual households.

At the national level, recurrent disasters create compounding costs that deplete government funds to financially support their economies and fund disaster recovery (Miao et al., 2019; Skertich et al., 2012). In Mozambique, for instance, a resettlement programme to relocate 30,000 families to higher ground after the 2007 floods was disrupted by recurrent flooding in 2008. The additional costs of relocating 21,000 more displaced families further strained financial resources, delaying the project's completion for several years (Ferris, 2011). Internationally, repeated disasters stretch donor resources, potentially leading to so-called donor fatigue (Maçon and Alexander, 2022; OCHA, 2021a). Signs of donor fatigue were observed after the 2021 consecutive earthquake and hurricane event in Haiti, where the lack of disaster risk reduction improvements and the additional social conflicts discouraged donors from continuing to invest (Maçon and Alexander, 2022). Similar dynamics can take place on a supranational scale. A counterfactual storyline study covering 2002–2018 demonstrated that the succession of tropical cyclones in the Caribbean territories of European Union countries, combined with earthquakes in Italy, could deplete the European Union Solidarity Fund, leaving insufficient funds for recovery from other extreme weather events (Ciullo et al., 2021). This illustrates how the recovery capacity of one country can also be shaped by disaster events occurring in other regions, effectively raising the likelihood that disaster impacts and recovery needs will overlap in time, thus increasing the chance of experiencing consecutive disaster impacts.

At the household level, financial resilience similarly erodes under recurrent shocks. Those who take on debt to recover from an initial disaster, or who lose their income, face increased hardship under additional shocks, making it increasingly difficult to fund recovery from subsequent events and to repay loans (Bacon et al., 2017; Sargeant et al., 2020). In the Philippines, the compounding agricultural losses from the consecutive typhoon Haiyan (2013) and El Niño-induced drought (2015–2016) not only threatened food security (as discussed in Sect. 2.3) but also severely reduced agricultural income, forcing many households to take on loans (Sargeant et al., 2020; Twigg et al., 2017). These impacts were compounded by typhoons Koppu (2015) and Haima (2016), which forced households that were still struggling after the previous disasters to take on additional loans, deepening their pre-existing debts (Sargeant et al., 2020). Simulations of household recovery after recurrent shocks show that even middle-income households, which are likely to recover quickly from an individual shock, risk falling into poverty when exposed to successive disasters (Sauer et al., 2025).

4.2 Shifting financial risks and market instability

Repeated disasters can also place growing pressure on financial markets and risk-sharing mechanisms such as insurance and banking. Insurance is thought to improve disaster resilience by promoting and supporting fast recovery and by providing incentives for "Building Back Better" (Eriksen et al., 2020; Kousky, 2019). Especially under consecutive disasters, increases in economic growth losses could be effectively mitigated by adequate insurance coverage, while recovery outcomes are significantly improved because insurance speeds up recovery (Cookson et al., 2025; Kousky, 2019; Otto et al., 2023). In contrast, evidence for the role of insurance in promoting precautionary measures and long-term resilience is more limited (Kousky, 2019).

Insuring disaster damages with fat-tailed risks is challenging, as these involve a relatively high likelihood of rare but extremely large losses that often exceed annual revenues in disaster-prone years. Consequently, insurance companies need access to sufficient capital, which must be built up as reserves during years with lower claims or through reinsurance solutions. Consecutive disasters can deplete available funds in private insurance and reinsurance markets and drive risks beyond what is commonly insurable, resulting in elevated premiums or even the complete withdrawal of insurance providers from high-risk regions (Sastry et al., 2024). This has already been observed in the United States, where repeated extreme events, including major wildfires in 2018 and 2020, contributed to insurance companies withdrawing from California (Brenna, 2024; Clark et al., 2024). Higher premiums may further marginalise vulnerable low-income groups. Cookson et al. (2025), for instance, found that after the 2021 Marshall Fire in the United States, lower-income households were less likely to be insured than higher-income households.

Erosion of financial resources (Sect. 4.1) at the household level can also affect banking stability through deterioration of outstanding loans. A study of rural credit cooperatives in China showed that borrowers' ability to repay declined after repeated disaster events, increasing credit risks for banks (Deng et al., 2025). Similar patterns have been observed across parts of Europe, where extreme weather has contributed to higher insolvency rates in France, Italy, Portugal, and Spain (Pastor-Sanz et al., 2025). As these financial pressures accumulate, they may surpass the shock-absorbing capacity of financial systems, contributing to broader market instability (Mahalingam et al., 2018).

4.3 Exacerbated resource and labour constraints

Beyond financial constraints, consecutive disasters can create bottlenecks in the availability of resources required for recovery. Scarcity of construction materials and skilled labour can delay reconstruction and escalate costs when demand accumulates, especially in regions already facing structural shortages (Acharya et al., 2022; Ade Bilau et al., 2018; Sospeter et al., 2020). Chang-Richards et al. (2017), for instance, found that the 2010/2011 earthquakes in Christchurch exacerbated the existing skill shortage in the construction sector, creating significant obstacles to resourcing disaster recovery projects. General resource constraints in materials, equipment, and labour are among the most frequently reported challenges in post-disaster recovery (Puri et al., 2024). These limitations become more pronounced when disasters occur consecutively, as resources are further strained and recovery is prolonged due to competing demands for limited resources (Puri et al., 2024; Sargeant et al., 2020).

4.4 Cascading disruptions and resource depletion in a globalised system

The impacts of extreme events on recovery are not limited to the directly affected areas (Hallegatte, 2014; Mühlhofer et al., 2023; Otto et al., 2017). In a globally interconnected economy, disruptions in one region can ripple through supply chains, affecting the availability and cost of critical resources, such as construction materials, fuel, and food, in other parts of the world (Middelanis et al., 2023). A modelling study of Hurricane Sandy in the United States (2012) showed that longer recovery times in the directly affected area significantly increased economic losses across other economically interconnected countries. Countries already incurring losses under short recovery periods would have faced substantially greater losses with prolonged recovery (Middelanis et al., 2021). Modelling exercises further show that socio-economic ripple effects from disasters in trade-connected regions can result in substantial consumption losses, even in countries where direct losses are minimal (Kuhla et al., 2021; Middelanis et al., 2023).

These global interconnections are also evident in the food system. As discussed in Sect. 2.3, consecutive disasters can erode the redundancy of local and regional food systems, temporarily making communities more reliant on international food trade while they are still recovering. However, the increasingly centralised nature of the global food market makes it particularly vulnerable to systemic shocks (Clapp, 2023). In the same way that recurrent disasters can overwhelm local food production, consecutive disasters in geographically distant but interconnected regions can affect food system redundancy on a global scale, as their impacts propagate through interconnected systems. In Vietnam in 2020, for instance, local rice production was affected by a severe drought, while global rice prices sharply increased because of COVID-19-related food stockpiling (Fox et al., 2020). The risk of simultaneous decreases in maize, wheat, and soybean yields across major food-producing regions (breadbasket failures) has increased over recent decades because of the growing frequency of climate extremes in major crop-producing areas (Gaupp et al., 2020) and is projected to increase further under future global warming, putting food security at risk (Hunt et al., 2021; Kornhuber et al., 2023). Countries highly dependent on imports are particularly vulnerable to supply shocks and price changes induced by crop failures in distant regions, with severe implications for poverty (Bren DAmour et al., 2016).

5 Impacts within the socio-political domain

The socio-political domain, comprising the institutions, governance structures, and societal dynamics that influence decision making, plays a central role in how societies prepare for, respond to, and recover from disasters. Within this domain, recovery may, for instance, involve the restoration of institutional capacity, societal equality, security, and political stability. Disaster impacts are shaped not only by physical hazard characteristics but also by underlying socio-political structures and pre-existing vulnerabilities (UNDRR, 2024). When political crises and natural hazards co-occur, they can be consecutive disasters because of their overlapping impacts and increased recovery complexity (Hariri-Ardebili et al., 2022). Reflecting this recognition, various societal hazards, such as civil unrest, armed conflict, and violence, have been included in the UNDRR Hazard Information Profiles alongside environmental and technological threats (UNDRR, 2021). The simultaneous occurrence of conflicts and disasters can hinder both immediate response and long-term recovery, creating cycles of instability and heightened vulnerability. The relationship is mutually reinforcing: while disasters can contribute to political crises, political instability can also exacerbate disaster impacts (Rosvold, 2023). In this section we explore how the socio-political domain both shapes and is reshaped by repeated disaster impacts, and how underlying vulnerabilities and governance structures affect recovery trajectories and long-term resilience under consecutive disasters. A summary of the pathways discussed in this section can be found in Fig. 5.

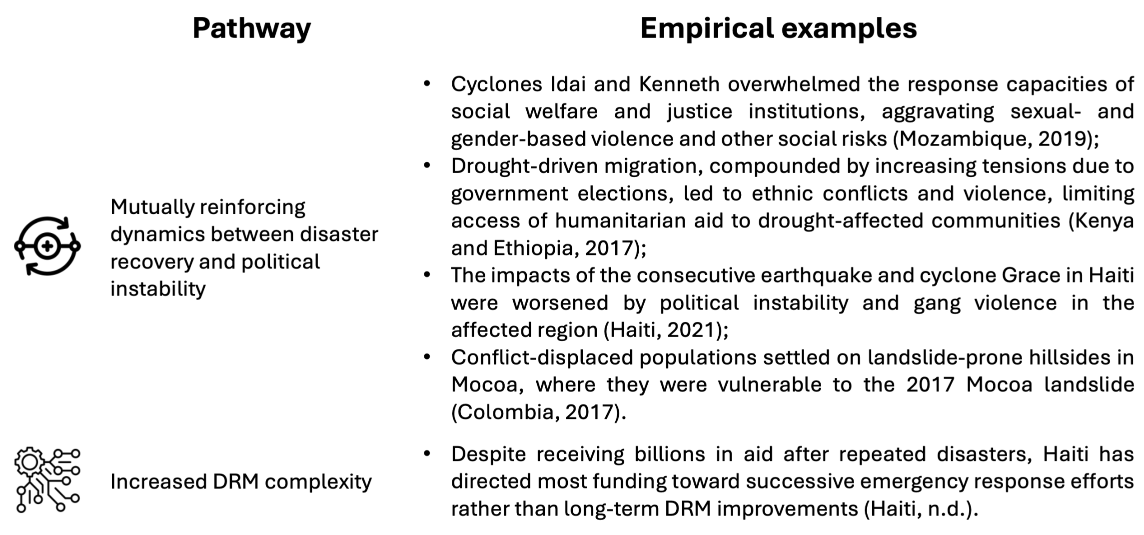

Figure 5. Summary of the main recovery pathways and illustrative examples discussed in Sect. 5 (socio-political domain).

5.1 Mutually reinforcing dynamics between disaster recovery and political instability

Disasters can further destabilise already fragile socio-political systems, for instance by overwhelming the capacity of state institutions. After cyclones Idai and Kenneth struck Mozambique six weeks apart in 2019, the response capacities of social welfare and justice institutions were significantly weakened. This aggravated risks related to child safety, loss of personal documentation and property rights, and sexual and gender-based violence (UNICEF, 2019). Social disorder following disasters is also linked to large-scale displacement, particularly in low-income countries lacking resources to manage sudden population shifts (Castells-Quintana et al., 2022). In Kenya and Ethiopia, for example, a drought in 2017 affected pastoralist migration, causing resource conflicts and ethnic tensions that were further worsened by election-related violence and unrest in Kenya (Matanó et al., 2022). Moreover, recurrent disasters can contribute to existing inequalities, as the poorest and most vulnerable populations sustain disproportionate disaster impacts and have the greatest difficulty fully recovering between events (Sauer et al., 2025). Particularly in countries with weak institutions and high levels of inequality, the risk of conflict increases in post-disaster settings (Ide et al., 2020).

Political conflict before or during disasters also increases vulnerability and hinders effective disaster response and recovery (Matanó et al., 2022; Rosvold, 2023). Ethnic conflicts and violence following drought-driven migration in Kenya and Ethiopia (2017), for instance, significantly hindered humanitarian access to drought-affected communities (Matanó et al., 2022). Similar access limitations arose in Haiti (2021), where the impacts of an earthquake and tropical storm were exacerbated by a highly unstable political situation, creating additional challenges for disaster response and recovery. Accessibility to affected areas was already limited due to road damage caused by landslides and rockfalls and was further restricted by escalating gang violence, which obstructed aid delivery and movement along key transport routes (Cabas et al., 2023).

Volatile political circumstances can also drive displacement, which can, similarly to disaster-driven displacement (Sect. 2.1), force vulnerable people into high-risk environments. In Colombia, for instance, people displaced by conflict in Bajo Putumayo settled on landslide-prone hillsides in Mocoa, leaving them exposed to the deadly 2017 Mocoa landslide (Siddiqi et al., 2019). Similarly to repeated disasters, political crises can reinforce inequalities. Displaced populations, for example, often face marginalisation and are systematically excluded from formal disaster preparedness and recovery efforts (Few et al., 2021). In the case of the 2017 Mocoa landslide, internally displaced people and Indigenous groups living in Mocoa were largely excluded from disaster preparedness activities and rehabilitation planning (Siddiqi et al., 2019). It was estimated that 80% of the landslide victims had also been victims of prior conflict. Social inequalities can also shape access to support provided through response and recovery programmes (Emrich et al., 2022).

5.2 Trade-offs between immediate response and long-term recovery

After a disaster, even without a political crisis, decision-makers must balance trade-offs between immediate response and recovery and long-term planning. While investing in disaster risk reduction provides substantial benefits in terms of avoided losses (Hugenbusch and Neumann, 2019), consecutive disasters often divert resources to immediate response and relief efforts, limiting the capacity for long-term planning and preparedness (Finucane et al., 2020). Additionally, there is a tension between rapid recovery, focused on quickly replacing losses, and adopting a deliberate recovery approach that aligns with the "Build Back Better" principles (Olhansky, 2018). Haiti, hit by frequent disasters, has received billions in international aid, amounting to approximately 20% of its annual government budget. Most of these funds have been directed towards immediate humanitarian response, with comparatively little investment in reconstruction and long-term development (Cabas et al., 2023; Fischer and Levy, 2012). Prioritising short-term needs over long-term preparedness can ultimately trap disaster-affected communities in cycles of loss and dependence on external aid (Norton et al., 2023). Long-term reliance on international aid may also discourage local governments from taking ownership of disaster risk management and sideline local initiatives (Hendriks and Boersma, 2019). Furthermore, poorly planned recovery without adequate integration of long-term and multi-hazard considerations can lead to maladaptation and risk trade-offs, as discussed in Sect. 2.6.

6 Reflecting on the complexity of recovery under consecutive disasters

The examples discussed throughout the previous sections illustrate a wide range of processes through which recovery can be affected under consecutive-disaster conditions. Collectively, they demonstrate that the complexity of recovery increases when new disasters interact with ongoing recovery processes across different societal domains and at different spatial and temporal scales.

In the following sections, we reflect on three dimensions of recovery complexity in the context of consecutive disasters. First, we reflect on how repeatedly interrupted recovery processes can have implications for long-term societal resilience. Second, we discuss how system definitions, indicators, and analytical boundaries shape our understanding of recovery and consecutiveness. Third, we consider conceptual challenges related to distinguishing disasters, impacts, and underlying vulnerability and exposure conditions within a consecutive-disaster context, particularly when recovery from disasters interacts with other disruptive events, such as health crises, conflicts, and economic shocks. Together, these reflections illustrate that interpretations of recovery, especially in the context of consecutive disasters, as well as the interpretation of consecutiveness itself, depend not only on the recovery processes themselves, but also on the analytical choices through which they are examined. As synthesised in Fig. 6, clearly defining the system of interest, recovery definition, indicators, spatial and temporal scales, and conceptual boundaries is therefore essential for interpreting recovery under consecutive disasters.

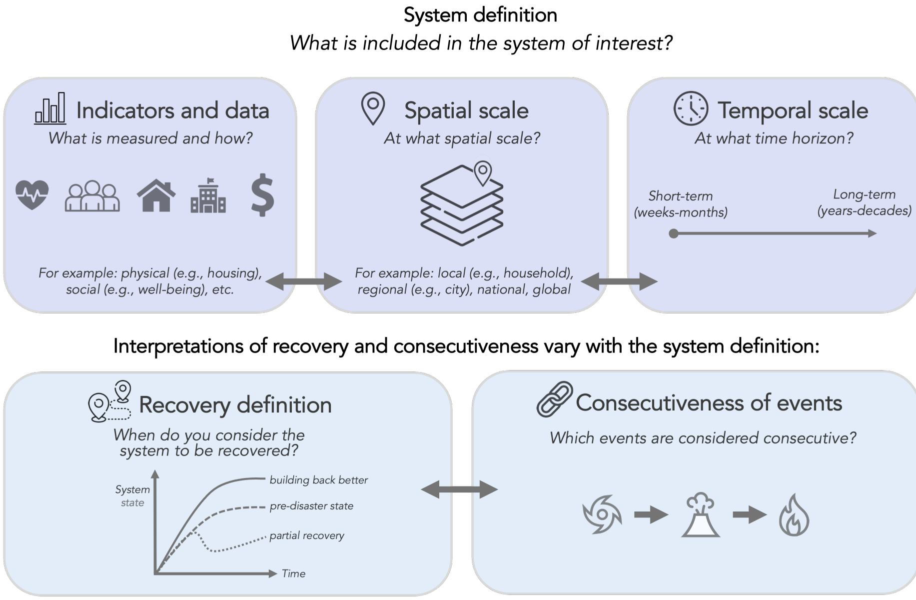

Figure 6. Conceptual synthesis illustrating how interpretations of recovery and consecutiveness are interconnected and dependent on analytical choices regarding the system of interest, recovery definitions, indicators, and spatial and temporal scales.

The examples discussed throughout this paper show that when consecutive disasters repeatedly disrupt recovery, this may gradually erode a society's capacity to prepare for, respond to, and recover from new disasters, for instance by depleting financial resources, weakening institutional capacities, and reinforcing pre-existing vulnerabilities. Over time, this can push societal systems towards critical thresholds where relatively small additional disturbances can trigger abrupt, disproportional, and difficult-to-reverse changes in the system.

6.1 Recovery does not necessarily imply a return to the pre-disaster state

One way of conceptualising these dynamics is through the lens of social tipping processes, where such critical thresholds are defined as tipping points (Milkoreit et al., 2018; Spaiser et al., 2024; Winkelmann et al., 2022). While often discussed in the context of climate change, this framing can also be used to conceptualise the effects of consecutive disasters on recovery pathways. Tipping processes are generally driven by self-reinforcing feedback loops, where a small change in the system triggers further reinforcing changes. Once the tipping threshold is crossed, the shift in the system can be difficult to reverse, even if the original stressors are removed (Spaiser et al., 2024; Winkelmann et al., 2022).

Several examples discussed throughout this paper illustrate how consecutive disasters may give rise to reinforcing feedbacks that shape long-term recovery trajectories. Accumulating debt burdens and depleted financial buffers, for instance, can gradually erode the capacity to respond to and recover from subsequent events, thereby increasing vulnerability to future disasters (Sect. 4.1). Spaiser et al. (2024) describe similar reinforcing dynamics in displacement-related tipping processes, where feedback mechanisms such as disrupted livelihoods, cultural heritage loss, and weakened social networks can contribute to prolonged displacement and eventually outmigration after disasters. Under consecutive disasters, such dynamics may be further amplified, as repeated disruptions can prolong displacement, and displaced populations often face increased vulnerability (Sect. 2.1) and reduced access to disaster preparedness and recovery efforts (Sect. 5.1). While migration can also function as an adaptive strategy under changing risk conditions, outmigration may also be forced by a situation in which recovery is no longer feasible or desirable in the original location (Thorn et al., 2023; Wiederkehr et al., 2018).

Importantly, these dynamics rarely occur in isolation. Our examples illustrated the interconnectedness of recovery processes in different societal domains. In such cases, prolonged recovery in the economic domain directly undermines progress in others, amplifying systemic risk. This can not only accelerate the movement of one of the societal domains towards a tipping point, but could also trigger so-called tipping cascades, where destabilisation in one system cascades into others (Klose et al., 2021; Liu et al., 2023). A clear example of such interdependencies emerged in the discussion of supply chain and breadbasket failures, where disruptions in geographically distant but interconnected regions propagate through global food systems and supply chains, affecting the availability and affordability of essential resources far beyond the directly affected areas (Sect. 4.4). Breadbasket failures, in particular, pose a risk, as they may escalate into severe humanitarian crises such as famine, with ripple effects on social and political stability (Gaupp et al., 2020; Janetos et al., 2017).

While the previous examples illustrate how reinforcing feedbacks may erode resilience and contribute to negative tipping processes, recovery may also create opportunities for positive transformation. The inclusion of "Building Back Better" in the UNDRR (2016) definition of recovery, for instance, explicitly recognises that disaster exposure may also trigger social learning and adaptation, contributing to a positive transformation of society towards a more resilient stable system state (Di Baldassarre et al., 2018; Kreibich et al., 2022). However, the literature suggests that successful policy learning mainly occurs under moderate disaster conditions. Velev and Hochrainer-Stigler (2025) note that moderate, manageable floods can encourage learning, while extreme or chronic exposure stalls progress. This is related to the availability of the human capital necessary to accelerate change, as large shocks can drain financial and institutional resources, limiting the ability to invest in forward-looking disaster risk management. Additionally, Kreibich et al. (2022) show that for recurrent hazards, positive effects are most pronounced for events of the same type with a similar or lower intensity than previously experienced events. This is consistent with patterns observed in floodplain settlements, where societies adapt to frequent low-intensity floods but remain vulnerable to rare, high-intensity events (Devitt et al., 2023; Moftakhari et al., 2018). This suggests that the conditions required for transformative adaptation are undermined when disasters become too intense, too frequent, or too closely spaced in time.

A consecutive-disaster perspective therefore highlights a potential tension between transformative change and repeated disruption of recovery processes. Many forms of adaptation, institutional learning, and vulnerability reduction require time to become embedded within society. While recovery may create opportunities for positive transformation, repeated disasters may constrain the ability to realise such opportunities by continually redirecting attention, resources, and governance capacity towards immediate response and short-term recovery needs (Sect. 5.2). Consequently, the consecutiveness of disasters acts as an inhibitor of positive transformation and vulnerability reduction.

6.2 Recovery, consecutiveness, and system definitions

The second reflection point concerns the interrelated nature of recovery and consecutiveness, and how interpretations of these concepts are highly dependent on the definition of the system. The apparent recovery speed or recovery outcomes that are observed, for instance, can vary greatly depending on the chosen proxy. While indicators such as electricity outages, housing reconstruction, and business reopening rates can provide valuable insights, these indicators might fail to capture dimensions such as political stability, inequality, and psychological well-being. Consequently, as the consecutiveness of disasters is typically defined as the occurrence of a subsequent event before recovery from a previous disaster has been completed, these ambiguities directly translate into the interpretation of consecutiveness. Events separated by several years may, for instance, appear independent when considering rapidly recovering systems, while consecutiveness might become more apparent when longer-term recovery processes are considered.

Extended recovery times present further challenges for analysing and defining recovery under consecutive events. In some cases, recovery may remain incomplete for such long periods that the distinction between individual recovery phases and broader trajectories of societal change becomes increasingly difficult to maintain. The prolonged recovery following the 2010 Haiti earthquake illustrated this challenge, as people were still displaced when subsequent disasters affected the region more than a decade later (Sect. 2.1).

The examples also highlight the importance of considering interactions across systems and spatial scales. Many recovery dynamics become visible only when broader spatial, sectoral, or functional interconnections are taken into account. Disaster effects can, for instance, propagate through globalised systems, resulting in impacts originating in one region influencing recovery trajectories in geographically distant locations through food systems and trade networks (Sect. 4.4). Assessments that focus on individual systems or regions in isolation may therefore overlook instances of consecutiveness that emerge through these interconnections.

This raises important questions regarding the definition of recovery timescales and event boundaries. If recovery remains incomplete for decades, should all subsequent disasters be considered consecutive? And if impacts propagate across systems and scales, which consequences do we still consider? Existing definitions provide limited guidance for answering such questions. Rather than prescribing single definitions for recovery or consecutiveness, we highlight the need to define recovery and consecutiveness in relation to the specific system and research question under consideration.

6.3 What constitutes a disaster in a consecutive-disaster context?

The third reflection point addresses conceptual ambiguities surrounding the distinction between disasters, impacts, and underlying exposure or vulnerability factors. While these concepts might be relatively straightforward to disentangle when adopting a single-hazard perspective, where the focus is on a particular disaster and its immediate causes and consequences, they become more intertwined when adopting a broader all-hazard and consecutive-disaster perspective.

In single-hazard analyses, disasters are often conceptualised as events that produce impacts to which societies subsequently respond and recover. From this perspective, phenomena such as displacement, food insecurity, or political instability that emerge following a disaster may be viewed as consequences of the event, whereas they can be conceptualised as factors driving vulnerability and exposure if already present prior to the disaster. Adopting an all-hazard, consecutive-disaster perspective complicates these distinctions because the same phenomenon may be interpreted as a disaster impact, a factor influencing vulnerability and exposure conditions, or a disaster in its own right. Health crises, conflicts, political instability, displacement, and economic shocks may, for instance, arise as negative consequences resulting from preceding disasters, while they simultaneously influence recovery trajectories, generate new impacts, and increase vulnerability or exposure to new disasters.

For example, a cholera outbreak following a flood may be interpreted as an impact of the flood resulting from disruptions to WASH services (Sect. 3.1). However, when considering the outbreak itself as the event of interest, the flood-induced WASH disruptions may instead be viewed as factors increasing vulnerability and exposure to the biological hazard, while the outbreak itself can be conceptualised as a disruptive event with its own impacts, response, and recovery process. Similar ambiguities arise for other societal disruptions. We have shown how a prolonged drought can contribute to social unrest through the disruption of pastoralist migration patterns, but the conflict may subsequently create a negative feedback loop through displacement and disruption of livelihoods (Sect. 5.1), blurring the distinction between disasters, impacts, and underlying exposure and vulnerability conditions.

Similarly to how interpretations of recovery and consecutiveness depend on the temporal and spatial scales considered, the indicators selected, and the interconnections included in the analysis (Sect. 6.2), they also depend on this conceptual framing of disasters, impacts, and underlying vulnerability and exposure factors. These choices ultimately affect how impacts are attributed, how recovery processes are interpreted, and consequently how disaster impacts are attributed and reported.

7 Conclusion

This perspective paper highlighted the practical and conceptual complexities of recovery in a consecutive-disaster context. Using a broad all-hazard perspective, we explored the myriad of ways through which consecutive disasters can disrupt, delay, and reshape recovery processes within and across societal domains, including human settlements, human health, the economic domain, and the socio-political domain.

Building on these observations, we reflected on the increased complexity of recovery under consecutive-disaster conditions and its implications for how recovery can be conceptualised. Specifically, we highlighted:

i) The implications of disrupted recovery for long-term societal resilience, discussing how this can be conceptualised through a tipping-point lens, as consecutive disasters can contribute to reinforcing feedbacks associated with negative tipping while simultaneously acting as an inhibiting factor for positive transformation.

ii) The implications of system definitions, showing how choices regarding recovery indicators, societal domains, spatial and temporal scales, and system interconnections directly shape interpretations of recovery and, subsequently, consecutiveness.

iii) The conceptual ambiguities surrounding the distinction between disasters, impacts, and underlying vulnerability and exposure conditions, highlighting how the same phenomenon might be conceptualised in multiple ways depending on the system boundaries and analytical perspective adopted, particularly when adopting an all-hazard consecutive-disaster perspective.

Together, these reflections demonstrate that recovery under consecutive-disaster conditions cannot be understood independently from the systems, scales, indicators, and conceptual framings through which it is assessed. Moreover, we have illustrated how recovery trajectories, and particularly the extent to which they remain incomplete between events, shape vulnerability and exposure over time. These evolving conditions, in turn, influence disaster risk and the impacts of subsequent disasters. Yet, disaster risk assessments often continue to rely on simplified assumptions in which damages are either fully repaired or permanently unresolved, overlooking how vulnerability and exposure may evolve throughout the recovery process and how residual impacts can shape risk in subsequent events (De Angeli et al., 2022; Spaiser et al., 2024; Winkelmann et al., 2022).

Moving forward, a key challenge is to develop approaches to disaster risk assessment and management that explicitly account for these complex and dynamic recovery trajectories and their implications for future risk. This aligns with recent calls for more dynamic approaches towards assessing vulnerability and exposure (De Ruiter and van Loon, 2022; Ward et al., 2026). At the same time, translating these more dynamic risk assessments into practice requires disaster risk management and financing mechanisms to evolve as well, in order to better balance immediate response needs with investments in long-term resilience building and risk reduction under increasingly frequent and interconnected disasters.

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