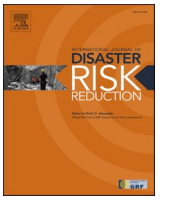
International Journal of Disaster Risk Reduction 127 (2025) 105670

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr



The mixed blessing of shifting responsibilities: Challenges for introducing compulsory elemental insurance in Germany

Julia Plass [a,*], Jens O. Zinn [b]

[a] Chair for Cultural Geography, University of Bayreuth, Universitätsstraße 30, Bayreuth, 95440, Germany
[b] School of Social and Political Sciences, University of Melbourne, Parkville, VIC, 3010, Australia

ARTICLE INFO

Keywords:
Climate change
Extreme weather
Flooding
Germany
Insurance
Responsibility

ABSTRACT

For a long time, Germany was largely spared from extreme weather events such as flooding. Severe flooding occurred only sporadically and at extended intervals. However, due to climate change, adjustments to more severe and frequent flooding are necessary. This was demonstrated by the Ahr Valley floods in 2021 and the southern German floods in 2024. In response, the introduction of compulsory elemental insurance has been repeatedly discussed to strengthen household resilience. However, the perspective of the (re-)insurance industry on necessary responses to extreme weather events is still underresearched. This study contributes to overcoming this deficit through an interview study with 27 (re-)insurance experts from Germany, exploring their views on the challenges associated with implementing mandatory elemental insurance. According to the experts, three central factors – risk awareness, accessing and understanding data and information, and adaptation measures – shape household resilience and, at the same time, challenge current responsibility distributions. However, shifting responsibility to the insurance industry and households can entail counterproductive effects on household resilience. Instead, more complex approaches involving different stakeholders could be more effective.

1. Introduction

In July 2021, Germany, particularly its federal states of Rhineland-Palatinate and North Rhine-Westphalia, experienced one of its worst floods in the past 60 years, resulting in more than 180 deaths and an insured loss of approximately € 8.2 billion [1,2]. For most people, the floods came unexpectedly. Thus, a large proportion of households were unprepared for the extent of the flooding or lacked the knowledge of how to respond to flood warnings [3]. As Fekete and Sandholz [4] suggested, a possible reason could have been the lack of experience, making it more difficult for households to understand the danger and prepare accordingly. As Thieken et al. [3] argued, this problem was exacerbated by experts underestimating the flood's magnitude and the insufficient warning infrastructure. They showed that during the 2021 floods, "around one-third of residents at risk of pluvial or flash floods [were] not reached by severe weather and flood warnings" [3]. Still, people who received warnings underestimated the floods and did not evacuate or take any other safety measures. That individuals tend to underestimate the risks posed by extreme weather events is reflected in the flood protection gap - defined as "the difference between the amount of insurance that is economically beneficial, and the amount of coverage actually purchased" [5] - which is, according to the European Insurance and Occupational Pensions Authority (EIOPIA) [6], moderate to high. One possible explanation, as proposed by Gross et al. [7], is that extreme weather events have been comparatively rare in Germany,

* Corresponding author.
E-mail addresses: julia.plass@uni-bayreuth.de (J. Plass), jzinn@unimelb.edu.au (J.O. Zinn).

https://doi.org/10.1016/j.ijdrr.2025.105670
Received 29 March 2025; Received in revised form 25 June 2025; Accepted 26 June 2025
Available online 27 June 2025

which may prevent the development of broader public awareness and concern about hazards such as flooding.

Inadequate insurance coverage and limited mitigation measures, combined with the increasing frequency and intensity of extreme weather events, heighten household vulnerability and hinder the recovery process [8,9]. In this situation, the state can come under political pressure to step in as the *last insurer* to cover the losses of the uninsured [10]. To free the state from the role of insurer of last resort, the implementation of compulsory elemental insurance has repeatedly been discussed in German politics, especially after severe floods such as the Elbe flood in 2002 [11,12] or the Ahr Valley flood in 2021 [1]. A heavy reliance on insurance, paired with increasing climate change, however, challenges current responsibility structures and indicates a shift of responsibility away from the state to the insurance industry and private households [13], resulting in new complexities and calls for new practices in governing extreme weather events. Increasing reliance on insurance markets requires a deeper understanding of the insurance industry's perspective and how its experts frame and respond to key challenges. However, the view of experts regarding insurance and extreme weather events has so far gained little attention in the scholarly debates in Germany and internationally [see 14, 15, 16]. To overcome this deficit, this article draws on a qualitative study with (re-)insurance experts from Germany in 2022/23, which identified several concerns and shortcomings associated with relying solely on compulsory insurance as a regulative mechanism. Thus, the article contributes to the ongoing debate about the introduction of compulsory elemental insurance in Germany [10,12,17,18] with a specific focus on the influence of insurance on household vulnerability and resilience to extreme weather events. A critical element are the changing responsibilities accompanying such a shift in the governing of extreme weather events.

The following section (2) provides a theoretical overview of the central concepts of *insurance*, *risk*, and *resilience* and how they relate. Based on existing literature and official documents, the subsequent section introduces flood risk management in Germany, highlighting the current distribution of responsibilities among the various stakeholders (3). Following the outline of the methodology (4), section 5 identifies central issues in flood risk management and its likely challenges for current responsibility distributions. On this basis, section 6 discusses what introducing compulsory elemental insurance would mean for the distribution of responsibilities and household responses. The article concludes that compulsory elemental insurance, which is associated with a shift in responsibility towards insurers and households, is insufficient to meet the long-term challenges of increasingly occurring extreme weather events or might even trigger reverse effects. Therefore, efficient future-oriented resilience measures involving various actors (e.g., federal states, the government, insurers, and households) would be required based on a more clearly defined division of responsibility (7).

2. Resilience and the role of insurance

Since the 1990s, the concept of *resilience* has begun to enter disaster discourse. It has become increasingly influential, surpassing older approaches that focused on risk assessment, hazard mapping, and emergency response, followed by the growing recognition of the social roots of vulnerability to disasters [19,20]. Influenced by (ecological) systems thinking, debates increasingly addressed the connection between social resilience and ecological resilience [21,22]. These early concerns did not disappear. However, there is a shift away from the idea of 'bouncing back' and a narrow focus on the adaptive capacity of systems and communities, which were central to the original understanding of the concept. Instead, more complex approaches gained ground, partly mixed up with trends towards neoliberal governance and a shift away from state intervention to local and community self-reliance. This is not only about the stronger emphasis on local knowledge, networks, and social capital, but also involves questions of inequality and justice [23,24]. As *resilience* has become a central concept in disaster risk reduction — e.g., the UN's Sendai Framework for Disaster Risk Reduction 2015–2030 [25] —, its usage has broadened and grown more complex. This expansion, however, has come at the expense of conceptual clarity, as resilience increasingly overlaps with related concepts such as coping, adaptation, and vulnerability [26]. *Resilience* in disaster studies is increasingly understood as a cyclical process that integrates preparedness, prevention, protection, response, and recovery, and has become a key issue in promoting positive social change [27]. With a stronger focus on change and transformation (e.g. Refs. [23,28,29], *resilience* tends to consider aspects of inequality, equity, power, and justice, while there is no one-fits-all approach. Instead, resilience emerges as a context-dependent concept shaped by cultural and political factors. Overall, *resilience* captures complex social changes and transformation, which address the flexibility and capacity to prevent, adapt to, and respond to hazards. Insurance is part of this mix of institutional strategies to manage the financial impact of disasters [30].

There is a tension between the foreseen and calculated risks and the uncertain and unforeseen catastrophes people have to deal with, which relates to resilience and the allocation of responsibility. The need to prepare for an undesired event puts responsibility on agents in the present. As Francois Ewald [31] once argued in the context of the development of social insurance in France, when accidents are no longer considered as a failure of a person, but happen even when everyone behaves reasonably, the bearer of harm has no responsibility for the undesired outcomes and requires compensation (i.e. by the state or compulsory insurance) [31]. Ewald's hypothesis of spreading costs amongst the insured has long been complemented by differentiating different risks groups within a population rewarding low risk groups and low risk behavior. Thereby relative and absolute insurance costs affect the vulnerable groups more contributing to heighten socio-structural (risk-) inequalities [32].

Insurance entails another downside — moral hazards — when people no longer engage in precautions and prevention but feel sufficiently financially protected [33,34]. In this way, there is a shift in the understanding of *resilience* from an ability to 'bounce back' to the general attitudes and resources that shape the future [23], including hazards and risks. This may include both the desire and active preparation, as well as the generalized ability to manage the unforeseen.

Therefore, the insurance industry has introduced strategies to reduce the costs and likelihood of *moral hazards* by shaping people's practices and subjectivities. For example, fire insurance has set standards for fire protection as a prerequisite for providing insurance coverage (e.g., Ref. [35]). Similarly, it can be argued that any compulsory elemental insurance must address potential *moral hazards*. This requires different forms of incentives or mindsets that support reducing both the impact of flooding and the costs to be covered by

the insurance industry.

As with other insurances, protection against flooding is not only an issue for individual households. The state must also provide reasonable infrastructure to ensure that individualized protection is efficient. For example, to protect a house with waterproof windows and cellars is inefficient when the house is swept away by the force of a flood caused by negligent infrastructural provision, which is the responsibility of local governments. Therefore, state and private actors must collaborate to enhance the resilience of communities and households. Even when the state hands over responsibility to households for preparatory flood measures, decision-making power for households can only unfold on a solid base of state provision and requires a network of information exchange, as well as precautionary and preventive measures [13]. Households then still have the freedom to exercise choice based on available resources and to judge and take risks.

These choices to a large degree reflect inequality patterns expressed in the risk-taking of households. Typically, households with fewer resources compensate for their lack of resources by taking higher risks [36,37]. Thereby the measures that follow neoliberal policy styles when relying on market mechanisms invisibilize social inequalities by individualizing flood risk management. As a result, these tend to intensify deeply rooted socio-structural differences. Indeed, such a policy has the advantage of reducing the political explosiveness of inequality patterns by shifting responsibility to the households and are therefore politically attractive.

3. Flood risk management and responsibilities in Germany

Germany has experienced severe flooding in recent decades (e.g., 2002, 2006, and 2013) [38]. In particular, the 2002 Elbe flooding led to various regulatory changes in flood risk management (for a detailed overview, see German Committee for Disaster Risk Reduction, DKKV [39]), including the Water Resource Act (*Wasserhaushaltsgesetz*). In response to flooding events, the federal and state governments regularly questioned the current elemental insurance scheme and considered implementing compulsory insurance [12, 39–41]. However, such flooding events also showed that understanding and clear attribution of responsibilities are key issues when managing flood risks. Thieken et al. [38] concluded in their study on flood risk management in Germany that "unclear and disjointed responsibilities between the federal, the state, and the municipal level" [38] were a significant issue during the flood risk management in 2002. This also included households. Their contribution remained unclear, whether for implementing adaptation measures (i.e., building improvements) or taking out elemental insurance [38,42]. In response, various official documents now contain a comprehensive account of stakeholder responsibilities aimed at improving the situation [39,43–45].

In 2022, the German Federal Government released a general strategy to enhance resilience to various risks, drawing on the

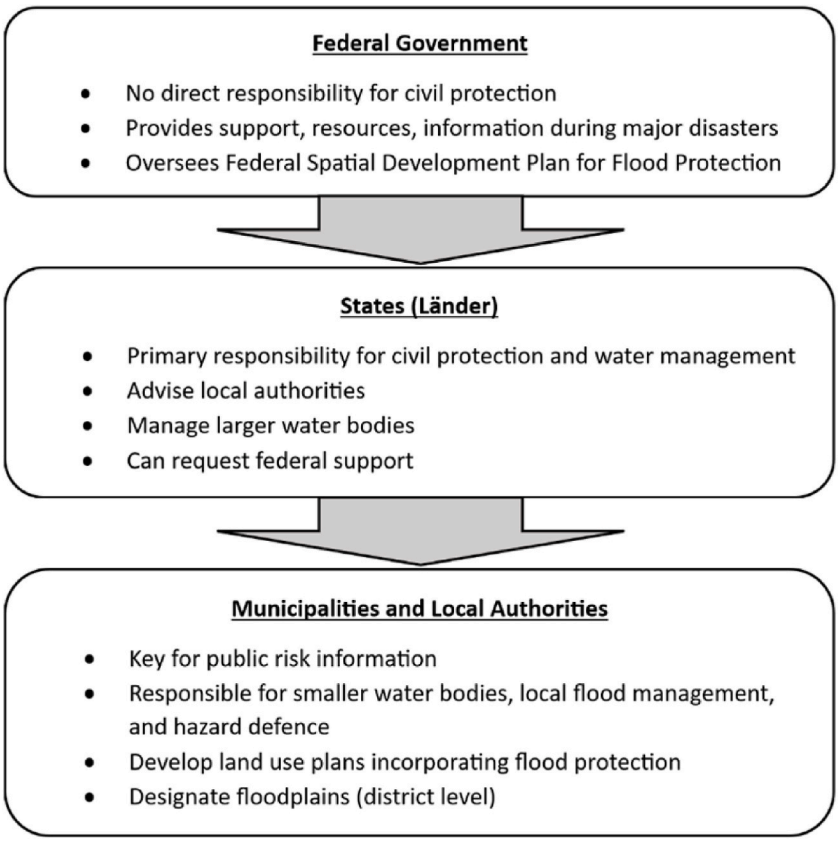


Fig. 1. Administrative responsibilities for flood risk management

principles of the Sendai Framework for Disaster Risk Reduction [43]. In addition to nuclear and chemical risks, the strategy also addresses extreme weather events, such as floods. It identifies various stakeholders, including federal, state, and local governments, businesses, civil society, and the media, who are considered essential for households' resilience to diverse hazards. Their identification highlights the aim of increasing resilience through stronger cooperation and shared responsibility, for example, by developing a knowledge exchange platform [43].

Nevertheless, the federal structure of the German state comes with a complex allocation of responsibilities, which makes collaborative efforts difficult (compare Fig. 1):

In Germany, civil protection, as well as water resources management, are primarily the responsibilities of the states (*Länder*) [38]. For the people, however, the main information source for risks is the level of districts, cities, and municipalities. The federal government, in contrast, has no direct responsibilities for civil protection. When significant events occur, the government can support the states, i.e., providing advice, resources, and information. The federal states can also request support (e.g., police or the federal Agency for Technical Relief – *THW*) from other states [46].

Regarding specific prevention measures, the responsibilities also differ. A central aspect of flood prevention and flood protection implementation is urban planning [45]. Mainly three instances are legally responsible — cities, municipalities, and the water management administration. Cities and municipalities are responsible for the hazard defense as well as the development and implementation of flood management strategies for smaller bodies of water (e.g., in Bavaria). Additionally, municipal urban land-use planning requires considering flood protection measures [45,47]. When designating new development areas, municipal and urban authorities are obliged to align with the Federal Spatial Development Plan for Flood Protection (*Bundesraumordnungsplan für den Hochwasserschutz*). This development plan complements and optimizes the transnational flood protection measures [48]. The district authorities are responsible for designating floodplains and approving flood protection measures. These are based on the advice of the water management authority, which oversees the management of larger water bodies and advises local authorities as well as municipalities on matters of water management [45,47].

In addition to the government, states, cities, and local councils, the insurance industry is also explicitly mentioned in different official documents, such as the German strategy for increasing resilience to catastrophes (*Deutsche Strategie zur Stärkung der Resilienz gegenüber Katastrophen*). In this document, insurers are considered a central actor for increasing resilience to extreme weather events such as flooding [43].

Insurance, understood as a mechanism that transfers "risk from one party to another for the payment of a premium" [16], has its instruments for assessing risks and hazards. Insurance risk communication is considered essential for creating incentives to take preventive measures, such as installing backflow prevention systems or relocating the heating system to upper floors [39,45]. As insurance plays an important role in prevention, it can also serve as a risk indicator to households since insurers price the risk according to its probability of occurrence and the severity of the threat measured monetarily [49].

In Germany, elemental insurance covers the costs of flood damage. Until 1993, elemental insurance was compulsory in Baden-Württemberg, which still influences insurance coverage in the state [50], which remains high at 94 %. However, insurance coverage varies within the country, with Lower Saxony and Mecklenburg-Western Pomerania having the lowest coverage at 35 % [51]. According to the German Insurance Association (GDV), [52], the overall elemental insurance coverage is considered insufficient at 54 % in comparison to the insurance coverage for hail and storms (96 %). Due to the low average insurance coverage (2002: 19 % or 2013: 35 %), the German state has often stepped in and provided financial assistance for affected households after major flood events [39,52]. In response, nationwide compulsory elemental insurance has been discussed throughout the years [1,12]. Notably, the 2002 Elbe floods not only sparked a lengthy discussion about the implementation of mandatory insurance [12]. It also triggered several changes within the flood risk management and the insurance system in Germany, such as the development of flood risk maps and concepts for flood risk management [44,53,54]. Additionally, a fourth risk category was introduced in the so-called ZÜRS (Zoning system for flooding, backwater and heavy rain), which divides the country into different flood hazard zones. The initial class 1 – flooding frequency of less than once per 50 years – was divided into two classes: Class 1 – flooding frequency less than once per 200 years and Class 2 – flooding frequency less than once per 50–200 years [55].

Despite all these changes and the past and current debates about compulsory insurance, no legislative response has been decided yet. As reported by the GDV one of the major reasons were legal challenges [17]. Some critics suggested that implementing compulsory elemental insurance "would be constitutionally impermissible as an excessive state intervention into the general freedom of action" [56]. There are concerns that if insurance becomes a substitute for prevention, this will negatively affect government and state efforts to increase flood adaptation measures [17,57]. Subsequently, a mandatory insurance could increase the responsibilities of households and insurers in flood risk management.

The shift of responsibilities is already observable for households: Until the 2002 floods, the responsibilities of households for flood risk response, adaptation strategies, and insurance were unclear [38]. Nevertheless, throughout the years, especially after the 2002 floods, the legal responsibilities of households increased, for example, through the implementation of the *Water Resource Act* in 2005 [58]. Besides the different governmental levels, the primary responsibility for implementing flood adaptation measures is now with the households [59]. According to the Water Resource Act, every person who is likely to be affected by flooding is obliged to take precautionary measures to protect themselves against the adverse consequences [58]. Still, as suggested by Thieken et al. [38], "the implementation thereof remains unclear." The growing role of households in implementing adaptation measures indicates an individualization of risk that comes with an increasing attribution of responsibilities to individual households and their members. This includes, for example, that households must inform themselves about flood risks in the region where they live or plan to move to. They are also responsible for implementing structural adaptation measures, such as installing waterproof windows or backwater protection, while elemental insurance take-up is recommended [58,60]. However, the provision of information to households for well-informed

decision-making remains limited. The EU Flood Directive makes the development of flood maps mandatory for all EU member states [61]. This information is available for most rivers in Germany [60,62]. Nevertheless, the availability of maps for pluvial flood risks and hazards varies and is significantly lower due to the difficulties of modelling with little historical flooding data [62] and the lack of legal regulations for the publication of pluvial flood risk and hazard maps [63]. Additionally, various river and pluvial maps have been produced by private and public sectors, including local water authorities, local governments, and insurers [64]. The large variety, on the one hand, and the lack of publicly available maps in some regions, on the other, make it difficult for households to find and access the information they need [65].

The lack of adequate and accessible flood risk information challenges the responsibilities of households. At the same time, past flood events showed that households lack risk awareness and knowledge about flood adaptation measures [42]. This pattern is confirmed by the study of Fekete and Sandholz [4] who focused on the 2021 Ahr Valley flood. They argue that Germany's limited exposure to extreme weather events, combined with a tendency among households to attribute responsibility to other institutions, contributes to a lack of risk awareness and knowledge about flood adaptation [4]. Thus, households often lack an understanding of their own and others' responsibilities, which can negatively impact their risk-minimizing behavior [66]. Conversely, Dillenardt et al. [67] have found that people affected by floods have shown their responsibility and motivation for flood protection. There are considerable concerns that the increasing dependence of households on insurers might even increase the risk of maladaptation of households [34]. Therefore, it was essential to assess how a compulsory elemental insurance might affect current and future responsibilities from an insurance perspective and how insurance experts perceive their role and the role of others in increasing household resilience to extreme weather events.

In contrast, existing research that focuses on the impact of extreme weather events on household vulnerability or resilience is mainly based on existing quantitative data, standardized surveys, or qualitative household interviews (see, for example, [68–70]. Insurance gains attention when it comes to creating resilience against extreme weather events on a global level [71]. However, to date, the perspectives of insurance and reinsurance experts have received little attention in both national and international research [14–16]. For example, the DKKV [39] conducted qualitative and quantitative surveys with insurers on topics such as insurance products, insurance coverage, or the role of insurers. However, the role of households and other actors from an insurer's perspective has not been addressed. Hudson and Thieken [72] drew on interview data to examine *moral hazard* in the context of German private businesses. Still, their study does not explore how floods impact existing structures of responsibility. The following study addresses the identified research gaps by assessing, from the perspective of (re-)insurance experts, the potential challenges and shifts in responsibilities when implementing a compulsory elemental insurance in Germany.

4. Methodology and methods

The original study underpinning this article aimed to assess the future of elemental insurance in the face of the increasing frequency and intensity of extreme weather events. Between December 2022 and May of the following year, the first author conducted 27 qualitative online and in-person interviews with insurance and reinsurance experts in Germany. The experts were selected based on their experience and (former) position within their companies [73]. To enhance the value and credibility of results, a variety of specialists with different areas of expertise have been selected who are currently or have been working in overall 47 different (re-) insurance companies [74]. These areas of expertise included climate and risk modelling, elemental insurance products, agricultural insurance, regulations of the general global reinsurance market, as well as climate risks and reinsurance. Since the contact details of several experts have not been openly available, most interviewees were contacted through the company's media team or other experts using snowball sampling [75].

As the interview partners were based in various German cities and often on business trips, interviews were mainly undertaken online to increase flexibility. This allowed for relatively spontaneous interviews between work meetings, which may have also positively influenced the number of participants [76].

Overall, 68 experts have been contacted. 27 experts from 20 different companies agreed to participate in interviews of varying durations, ranging from 30 to 90 min (see Table 2). The other experts contacted either did not reply or declined due to confidentiality concerns or lack of time. According to Malsch and Salterio [77], the number of interviews should be sufficient to reach saturation. Since the sample comprises a diverse range of experts from various companies, positions, and regions, systematic bias is unlikely [78, 79]. The interviews have been anonymized by removing all information about the expert (e.g., name, age, and position within the company) and the company (e.g., name and location). Anonymization was highly relevant due to the confidentiality concerns of the interviewees. It allowed them to discuss key challenges and responsibilities from their perspective, rather than representing official company positions. To ensure that the interviewees reflect on their personal experiences, the semi-structured interviews, which were based on an interview guide, began with personal questions about how long they had already worked in their specific field of expertise. Afterwards, they were asked to reflect on changes in the (re-)insurance sector concerning extreme weather events and climate change over the years (see table 3).

The explorative semi-structured interviews have been analyzed using qualitative content analysis as suggested by Kuckartz [80]. He proposes a systematic, rule-guided approach that combines deductive and inductive coding, focusing on thematic content rather than linguistic or interactional aspects. Firstly, the anonymized interview transcripts were coded using a combination of in vivo and thematic coding in a data-driven approach. Secondly, the codes were grouped into more general themes. The themes and related interview passages were transferred into a thematic matrix for better comparability and clarity [80,81]. The analysis process identified three main challenges that affect household vulnerability to flood events, which will be elaborated on in the following section. For this article, the interviews conducted in German were translated into English.

5. Challenges and responsibilities

In Germany, the increasing frequency and intensity of flood events [82] have sparked an ongoing debate about the introduction of elemental flood insurance [1,12]. These debates are the backdrop of the insurance industry's understanding of responsibility and capacity for an effective response, as reflected in our data. The interviewees have placed particular emphasis on the role of households, identifying three key dimensions that challenge household resilience to extreme weather events: (1) risk awareness, (2) access to and comprehension of relevant data and information, and (3) the implementation of adaptation measures (compare Table 1). This knowledge-centered framing of household responses highlights critical gaps and raises broader questions about additional social, economic, and contextual factors that influence household decision-making in the face of environmental hazards.

5.1. Risk awareness

From the perspective of insurance experts, households and in particular the ones that do not live close to the water, underestimate the risk of flooding due to heavy rain events: "[I]f you focus on that [river flooding], many people can rightly say: 'Oh, where I live here, there is no scenario where I assume that we are affected […]'. And that's true for most people. And […] they then say: 'It can't happen to me'. Correct so for many but not correct for all. And then the question that heavy rain can affect anyone remains abstract if it doesn't affect the neighbor" (Expert 3). This view is also supported by Truedinger et al. [83] who showed for the 2021 Ahr Valley flooding that "the vast majority of respondents did not know that they lived in a flood-prone area before the 2021 event" [83]. In addition, insurance experts emphasized that insufficient risk awareness or the miscalculation of risk affects the decision to rebuild in high-risk regions that have been severely affected by extreme weather events: "I think the topic of water is underestimated per se, i.e., the strength and destruction of water" (Expert 13). According to Expert 18, this is also due to the high complexity of severe rain events that can result in flooding: "So this complexity of the effects [of climate change and severe rain] is simply much greater than the basic human fear of a house burning down". As several insurance experts state, risk awareness can be increased by implementing an environmental hazard identification card (Naturgefahrenausweis), which provides information on the environmental hazards to which a specific building is exposed (Experts 3, 8, 12, 17, 24) [84].

The lack of risk awareness not only affects decisions on where to move and build, but also the adoption of mitigation measures, such as the uptake of elemental insurance or structural measures (e.g., floodproofed doors and windows or backflow prevention) (Experts 2, 24). Households decide not to insure since they believe "[t]his will not happen to me. This has never happened before" (Expert 2). This is considered a key factor in the low elemental insurance rates in some parts of Germany. Following the Ahr Valley flood, several insurers observed an increase in the take-up of elemental insurance. Still, after a few months, the insurance take-up rates normalized again (Experts 2, 3, 9): "[W]e had a significant increase in insurance take-up after this flood event […]. People were sensitized to the issue. Yes, we had the inclusion in almost three out of four contracts. This is 75 %. But now we have to say that the further the event moves into the past, the more it unfortunately returns to a normal level" (Expert 9). Some experts therefore consider a compulsory insurance necessary to increase the overall insurance take-up in Germany over the long-term (Experts 3, 9, 10, 13, 16): "[…] without a binding element, we will not get out of this 50 % and 1, 2, 3 percent increase per year" (Expert 3). However, most experts see several disadvantages – especially moral hazards, (re-) building in high-risk areas, and the lack of mitigation measures by the federal states and the government – in implementing a mandatory insurance (e.g., Experts 4, 8, 9, 20).

Overall, insurance experts consider risk awareness to be a crucial element in the context of extreme weather events. However, insurance take-up and historical events indicate that households frequently demonstrate inadequate risk awareness, particularly concerning pluvial flooding. This implies that there are also other factors, besides risk awareness, such as financial considerations, that influence household decision-making.

5.2. Accessing and understanding data and information

As literature and interviews show, people's understanding of and access to data and information are common concerns [85]. As one expert states, the information about regions at risk of extreme weather events can be found online, but "people do not know about it" (Expert 24). This implies that risk awareness is shaped by access to information and whether households actively try to inform themselves about possible risks. Expert 3 adds: "You can certainly find evidence in archives […]. But that is, of course, something that is not anchored on the ground, not even personally experienced. And unpleasant events are also suppressed. In this respect, the interesting question really is how to create risk awareness" (Expert 3). Grothmann and Reusswig [86] share the views of the insurance experts by showing that, in many cases, the provision of risk information, such as flood maps, does not increase household prevention.

Table 1
Obstacles for increasing insurance coverage

Risk Awareness	Data and Information	Adaptation
Underestimation of flood risk	Information unknown or inaccessible	No penalties for household's inaction
High complexity of the risks of severe rain	Poorly communicated or visualized risk data	Higher premiums or future uninsurability
Risks are abstract, not experienced, or visible	Suppression and avoidance of undesired information	Emotional factors like place attachment
Disasters lead to temporary awareness that fades	Lacking or fragmented data on pluvial flooding	Authorities considered responsible
		Moral hazard when state supports

Insurers have acknowledged these challenges: "In the autumn of 2021, we, for example, have introduced a text message-based warning for severe weather events to warn our customers of impending events […]. And that is a component for us that we warn customers who have taken out building insurance in advance […] so that they can then protect their building and, above all, themselves in terms of prevention" (Expert 9). This implies that insurers take on new roles in the context of awareness raising and the distribution of risk information, which also helps decrease the costs for insurers: "[I]f someone has the chance to protect themselves or take preventive measures, the probability of damage occurring, for which one [the insurer] has to pay, is smaller in the end" (Expert 21). However, as Kreibich et al. [87] found, warnings alone do not reduce damage. Instead, it has to be accompanied by household knowledge on how to behave when receiving flood warnings.

Although there is a lot of risk information available for households, according to Fekete and Sandholz [4] there is still a lack of (publicly) available flood data and models, especially when it comes to pluvial flooding and "flood risk mapping [needs] to become even more micro-scale" [4]. As a result, even when households would like to inform themselves about flood risks, relevant data might not be available. The lack of data related to pluvial floods was also addressed by several interviewees (Experts 3, 4, 5, 7, 8, 14): "Where we are not good at is heavy rain. I think we need to collect more data in this regard" (Expert 14). However, some experts stated they created a reliable model for pluvial flooding events in cooperation with universities (Experts 15, 25, 26). Another reason for the lack of data and information regarding flood models, according to Expert 8, is the issue of finance. In many cases, the models and maps are "[…] limited by the financial resources that the federal states have […]. You have a river of the first or second order and a tributary flow into it, and then the modelling ends abruptly […]. But behind it, there are also houses […]". Additionally, the EU Floods Directive, which requires flood risk maps to be published and made accessible, does not apply to pluvial floods. Therefore, the legal situation regarding the publication of pluvial floods is currently unclear [88].

In addition to the lack of data, Expert 8 states that much of the data is difficult to access and understand: "It [the risk models and data] is now incomprehensible for the average person and hidden somewhere in a sub-URL […]. [I]t's not Google Maps for extreme weather events which has a certain accessibility". This suggests that more user-friendly access is necessary (e.g., using language and displaying data in a way that laypeople can understand). Similar findings were highlighted by Meyer et al. [89], who developed recommendations for flood maps regarding content and visualization for different user groups, including the public and emergency management. However, these have not been implemented in Germany.

Most experts referred to HORA (*Natural Hazard Overview & Risk Assessment Austria*) as a best practice example (Experts 3, 8, 11, 14, 15, 17, 18, 19, 22, 24). In this regard, Expert 21 considers the role of insurance in informing households about their risks: "I think we have a duty as an insurance industry to provide information in this regard."

However, even when people have access to risk information and are aware of their risks, they do not necessarily follow expert advice, and their responses to recommendations and information vary. Amongst the reasons are financial aspects when deciding where to move or whether to take out insurance. In addition, personal reasons such as place attachment are crucial when it comes to rebuilding in an at-risk region (Expert 13) [14,86,90].

5.3. Lack of adaptation

For most insurance experts, private households are primarily responsible for protection. However, according to Expert 8, the responsibility of households is not efficiently regulated since there are no consequences when not implementing precautionary measures: "In Germany, for example, there is paragraph five, section two of the Water Resource Act. It says that you and I are obliged to take flood precautions […]. [T]here are no consequences if you don't do it. […] it's not enough to achieve changes."

For the insurance experts, households should implement adaptation measures and reconsider how they build their homes in the future (Experts 8, 18, 19, 21). It is therefore important to not only take into account extreme events such as the Ahr Valley floods but also smaller events: "[W]e experience it again and again that issues, such as light wells or entrances at ground level lead to major damages, even in the event of minor incidents because 2 cm of water over a time of half an hour adds up in the cellar at some point" (Expert 8). The so-called *'build back better' approach,* emphasized in the German strategy for increasing resilience to catastrophes [43] and by the German Insurance Association [91], aims to improve the resilience of buildings by applying building measures such as the use of water-resistant building materials or water-impermeable windows and doors.

Insufficient adaptation measures lead to rising insurance premiums, as insurers price the risk based on its likelihood of occurrence and the severity of the threat, measured monetarily [49]. For households facing climate change, this results in higher insurance costs. Insurers may even choose not to provide coverage in certain regions [33]. While insurability is not currently a concern for the interviewed insurance experts, it could become one due to climate change if adaptation measures are not implemented: "At the moment, I would not consider insurability to be an urgent issue […]. If I look 50 years into the future, then I do believe that this could become an issue" (Expert 13). To encourage households to increase their adaptation measures, some insurers adjust their premiums based on the measures adopted (Expert 12, 13): "If you have installed certain security technologies for your home, there are discounts on them [insurance premiums]" (Expert 13). This implies that insurers are becoming increasingly relevant and feel responsible for household adaptation: "I would therefore assume that in the future there will be a stronger focus on prevention. It's not just about what happens when the damage occurs, but also about offering insurance cover and working much harder to prevent damage from occurring or, if it does occur, to keep it to a minimum" (Expert 12).

For the interviewees, household adaptation and elemental insurance are only part of the solution for dealing with extreme weather events. A relevant factor that also affects the question of insurability is housing development and rebuilding in at-risk regions (Expert 12, 13). The experts consider federal states, cities, and councils responsible (Experts 7, 8, 12, 13, 17, 19). However, according to Expert 8, different interests challenge changes in building regulations: "And where steps have already been taken forward, it has to be

coordinated between 16 federal states in one building code. And that's where we have the next issue. One considers it a problem, the other does not [.]." Allowing (re-)building in at-risk areas, together with low to medium insurance coverage [51], results in a situation where, in the event of a major extreme weather event, the state has to step in by providing recovery funds. According to Expert 13, this makes it more "difficult to provide the market with higher cover for extreme weather events" (Expert 13). As Expert 24, for example, reports, "[p]eople who were insured and got their money [from their insurance] have now cancelled their contracts because they say 'why should I pay a premium when the other person who wasn't insured is now getting something [money] anyway? I am paying twice'" (Expert 24). Ultimately, this might lead to a situation where people drop insurance and rely on the state instead (Expert 6, 13, 24).

In summary, from the insurance experts' perspective it is due to *moral hazards* and the heavy reliance on the perceived responsibility of the state, accompanied by a lack of risk awareness, that households may be prevented from implementing adaptation measures, which can negatively affect their vulnerability to extreme weather events. Therefore, most experts considered clarifying the responsibilities of each stakeholder (households, insurers, and governmental authorities) and stronger cooperation desirable when it comes to mitigation measures and increasing risk awareness.

6. Discussion: insurance perspective versus everyday life responses to hazards

As research on risk communication and everyday life risk management has shown, people are often aware of the risks but respond strategically by, for example, deciding against the implementation of adaptation measures in addition to taking out insurance or relying on (financial) state support [33,34,92]. However, adequate information sources that are understandable and accessible to households (for example, when formulated in natural probabilities [93]) can still help people reduce strategic risk-taking and, therefore, support the implementation of adaptation measures, thereby decreasing social and monetary costs (Expert 21). However, several other factors might easily be overlooked when focusing primarily on information deficits:

As Tim Harries [94] has argued, people might resist such measures when they endanger their feelings of ontological security. This is when their feelings of security are challenged by such measures, which contradict deeper beliefs, such as the notion that their home is a safe place, that the state will take care of preventing severe disasters, or that nature is generally benign [94].

Different worldviews [95] might also contribute to people attributing responsibility to the state rather than to households or turning to other resources such as everyday wisdom or conspiracy theories. Since experts and laypeople routinely use both their intuitive knowledge and formalized expertise, it is essential to be cautious when past experiences do not provide reliable guidance for new climate change-related hazards [96,97]. Laypeople and experts alike are often surprised when hazards unfold in real life, exceeding what they had ever thought could happen. It is crucial for efficiently preparing for the unexpected that not only evidence and normative frameworks, but also people's subjective beliefs and experiences, are acknowledged [98], which may hinder the consideration of new hazards sufficiently.

At the same time, people often take risks not because they lack knowledge and awareness of those risks, but because they balance and value various risks differently than the experts do. They consider their limited resources and strive to create a life worth living [37, 99]. Therefore, approaches that primarily rely on the assumption of laypeople's misinformation are usually inefficient or fail when they do not consider people's local experiences and desires in the face of risk. When people's engagement with risk is primarily shaped by their material resources, attitudes, and practices they have developed over time, merely providing information is insufficient.

Survey research based on sociopsychological models points in a similar direction. To enhance household resilience, it is insufficient to focus solely on risk knowledge and awareness. Instead, attention must also be given to the various rationales underpinning household decision-making. These include socio-economic factors such as age, income, and home ownership, as well as socio-psychological aspects like reliance on governmental (structural) protection measures, experience with hazards, emotional responses (such as fear), and perceptions of threat probability [86].

German insurers are increasingly recognizing the various factors influencing household decision-making and risk perception as a means to address the growing challenge of moral hazards associated with extreme weather events. This is, for example, realized by acknowledging adaptation measures in their insurance premium calculations, alerting customers via text message to impending (extreme) weather events, and providing guidance on mitigating potential damage. By doing so, insurers assume more responsibility for adaptation measures (Experts 9, 13). However, these incentives primarily reach their customers, and there is a need to increase adaptation across the entire population [9]. In this context, it still needs to be acknowledged that at its core, insurance in general only addresses the aspect of (financial) recovery [100] and relies heavily on market mechanisms. As a result, it can only support household resilience to a certain extent. Other international examples, such as those from Australia, demonstrate that a heavy reliance on insurance can, with a growing number of extreme weather events and a lack of adaptation measures, result in increasing insurance premiums, thereby leading to an affordability challenge as well as high rates of noninsurance [101]. It seems increasingly evident that enhancing resilience to climate change cannot rely on neoliberal politics and market dynamics, which tend to heighten social inequalities, but demands a more integrated approach involving shared responsibility across multiple stakeholders [102]. A similar point has been made by Jarzabkowski et al. [103] in their study on Switzerland's disaster insurance and risk management system.

7. Conclusions and perspectives

The article addresses the under-researched challenges that may arise from implementing mandatory elemental insurance in Germany from the insurance industry's perspective. The interviewed experts identified three central dimensions that challenge household resilience and current responsibility structures: risk awareness, access to and understanding of data and information, and adaptation

measures. The findings suggest that these dimensions mutually influence one another and are considered essential components of household resilience to extreme weather events. However, past flooding events have shown that household resilience is lacking, resulting in varied reactions from federal states, the federal government, and insurers:

Due to insufficient insurance coverage, the federal states (Bundesländer) and the federal government (Bundesregierung) increasingly had to step in as last insurers and support the (financial) recovery of the affected households [1]. Consequently, the implementation of compulsory elemental insurance has been discussed repeatedly. Insurers responded to inadequate household resilience by recognizing adaptation measures in their insurance premium calculations or alerting customers via text message to impending (extreme) weather events. However, the insurers' encouragement for households to acknowledge the risky uncertainties of the future may prove ineffective when people adhere to different values and preferences or have limited resources. They might therefore manage hazards differently, using risk-taking or coping strategies such as hope, belief systems, and subjective 'truths' [104, 105]. This reality of people's engagement with risk and uncertainty is often neglected in expert views, which tend to focus on information and insurance coverage. Consequently, the insurance industry may efficiently exert pressure on the insured and implement behavioral advice but is arguably less prepared to consider broader social issues that influence insurance decisions, such as biographical patterns of decision-making shaped by socio-structural factors underlying unequal climate change-related resilience of households and communities. Overall, for the development of sustainable solutions that entail a shared responsibility approach, it is crucial to acknowledge social rationales of households' decision-making when it comes to dealing with extreme weather events. These rationales, among others, are shaped by lifestyle decisions, emotional ties, place attachment, and social networks (see, for example, Boon [106] or Plass and Zinn [107] in Australia, or Bakke Lie et al. [108], in Norway). However, the question remains as to how these factors can be connected to the technical aspects of household resilience.

The social and subjective dimensions seem to be underestimated in the perspectives of the interviewed experts. However, research from Australia has emphasized the importance of acknowledging social and subjective dimensions when sharing responsibilities in the context of dealing with extreme weather events [107].

Although implementing mandatory insurance would help increase the insurance uptake and reduce state responsibilities for financial recovery, it can only be one part of a forward-thinking solution to tackle the rising frequency and intensity of extreme weather events. Political decision-making is essential and cannot completely rely on neoliberal policy approaches when shifting responsibility to insurance markets and households; it requires establishing the social, material, and physical conditions necessary for markets and individual decision-making to operate effectively. Additionally, broader cultural and structural factors must be addressed to prevent old inequalities to intensify and new inequalities to develop. Therefore, climate change demands holistic approaches and requires a sharing of responsibilities among various stakeholders.

CRediT authorship contribution statement

Julia Plass: Writing – review & editing, Writing – original draft, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Jens O. Zinn:** Writing – review & editing, Writing – original draft, Conceptualization.

Funding

No funding has been obtained.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Annex.

Table 2
Overview Experts

Interviewee	Years of Experience	Areas of Expertise
Expert 1: Reinsurance	18 Years	Climate Change, NatCat Modelling, Research, Reinsurance
Expert 2: Insurance	37 Years	Product Management, Claims Management, Insurance
Expert 3: Insurance	26 Years	NatCat Modelling, Statistics, Insurance
Expert 4: Insurance	38 Years	Agriculture, Statistics, Insurance
Expert 5: Insurance	13 Years	Insurance, Reinsurance, Environmental Risks
Expert 6: Insurance	24 Years	Environmental Risks, Insurance
Expert 7: Reinsurance	20 Years	Climate Change, NatCat Modelling, Reinsurance
Expert 8: Insurance	25 Years	Regulation, Environmental Risks, Insurance
Expert 9: Insurance	12 Years	Product Management, Claims Management, Insurance
Expert 10: Reinsurance	32 Years	Reinsurance, Environmental Risks

(*continued on next page*)

Table 2 (*continued*)

Interviewee	Years of Experience	Areas of Expertise
Expert 11: Reinsurance	24 Years	Risk Management, Reinsurance
Expert 12: Insurance	13 Years	Product Management, Environmental Risks, Insurance
Expert 13: Insurance	30 Years	Risk Management, Claims Management, Insurance
Expert 14: Reinsurance	34 Years	ESG, Reinsurance, Environmental Risks
Expert 15: Reinsurance	18 Years	Reinsurance, Environmental Risks
Expert 16: Reinsurance	11 Years	ESG, Reinsurance, Environmental Risks
Expert 17: Insurance	<20 Years	Environmental Risks, Insurance, House and Contents Insurance
Expert 18: Insurance	4 Years	NatCat Modelling, Environmental Risks, Insurance
Expert 19: Insurance	<20 Years	NatCat Modelling, Environmental Risks, Insurance
Expert 20: Insurance	22 Years	Regulation, Risk Management, Insurance
Expert 21: Insurance	39 Years	Insurance, Product Management, Reinsurance, Claims Management
Expert 22: Insurance	<30 Years	Environmental Risks, Insurance, House and Contents Insurance
Expert 23: Reinsurance	19 Years	NatCat Modelling, Reinsurance, Statistics
Expert 24: Insurance	9 Years	Environmental Risks, Insurance
Expert 25: Reinsurance	34 Years	NatCat Modelling, Reinsurance, Insurance, Actuarial Mathematics
Expert 26: Reinsurance	1,5 Years	NatCat Modelling, Reinsurance, Environmental Risks, Insurance
Expert 27: Insurance	9 Years	Politics, Environmental Risks, Insurance

Table 3
Interview Guide (translated from German)

1.	How long have you already worked in the field of (re-)insurance and since when do you focus on elemental hazards?
2.	During this time, have you experienced any changes within the insurance sector regarding the relevance of elemental hazards and climate change?
3.	How are increasing extreme weather events impact the insurance sector already today, but also in the future?
4.	What will be the main challenges the insurance sector will have to face concerning the increasing effects of climate change?
4.1.	What are current trends in the insurance sector?
5.	Insurances are supposed to help deal with different risks such as the effects elemental risks. How important do you consider elemental insurance in this context?
5.1.	What role plays the insurance sector when it comes to dealing with the effects of extreme weather events?
5.2.	Who are other relevant stakeholders?
5.3.	What is the role of the government when it comes to dealing with the effects of extreme weather events?
5.4.	Does governmental financial support in the event of severe floodings or other major events have an impact on households' insurance decisions?
6.	Do climate change and increasing extreme weather events impact German households already today? If yes, how?
7.	What are the risks and challenges that result from the insurance coverage (elemental insurance) in Germany?
7.1.	What are the reasons for the insurance coverage in Germany and how will the insurance penetration develop in the future?
7.2.	Does underinsurance play a role in Germany?
8.	Since the Ahr Valley flood, the introduction of a compulsory elemental insurance has been discussed once again. Which effects would have such a compulsory insurance on the insurance sector and what would this mean for households?
9.	Extreme weather events are increasing on a global scale. Are the effects (e.g. on the reinsurance sector) already being felt in Germany?
9.1.	Insurance premiums are likely to rise due to climate change. How does that impact the insurance sector, households and other actors?
10.	What is the future of elemental insurance?
11.	Are there any other aspects we have not addressed during the interview that you consider highly relevant?

Data availability

The data that has been used is confidential.

References

[1] BMI (Bundesministerium des Inneren und für Heimat, Bericht zur Hochwasserkatastrophe 2021: katastrophenhilfe, Wiederaufbau und Evaluierungsprozesse. https://www.bmi.bund.de/SharedDocs/downloads/DE/veroeffentlichungen/2022/abschlussbericht-hochwasserkatastrophe.pdf?_blob=publicationFile&v=1, 2022. (Accessed 1 January 2025).
[2] M. Szönyi, et al., PERC Floods Following "Bernd, Zurich Insurance Company, Zurich, 2022.
[3] A.H. Thieken, et al., Performance of the flood warning system in Germany in July 2021 – insights from affected residents, Nat. Hazards Earth Syst. Sci. 23 (2023) 973–990, https://doi.org/10.5194/nhess-23-973-2023.
[4] A. Fekete, S. Sandholz, Here comes the flood, but not failure? Lessons to learn after the heavy rain and pluvial floods in Germany 2021, Water 13 (2021) 3016, https://doi.org/10.3390/w13213016.
[5] K.-U. Schanz, Understanding and Addressing Global Insurance Protection Gaps, Zurich, The Geneva Association, 2018.
[6] EIOPA (European Insurance and Occupational Pensions Authority), Dashboard on insurance protection gap catastrophes. https://www.eiopa.europa.eu/tools-and-data/dashboard-insurance-protection-gap-natural-catastrophes_en, 2024. (Accessed 27 March 2025).
[7] C. Gross, et al., Maßnahmen Für Eine Zukunftsgerechte Naturgefahren-Absicherung, Sachverständigenrat für Verbraucherfragen, Berlin, 2019.
[8] C. Eriksen, et al., Why insurance maters: insights from research post-disaster, Aust. J. Emerg. Manag. 35 (4) (2020) 42–47.
[9] EEA (European Environment Agency), European Climate Risk Assessment, Publications Office of the European Union, Luxemburg, 2024.
[10] J. Ragnitz, M. Thum, Pflichtversicherung gegen Flutschäden? ifo Dresden berichtet 20 (5) (2013) 33–35.
[11] Deutscher Bundestag, Elementarschadenversicherung. Die Diskussion zur Einführung einer Pflichtversicherung. https://www.bundestag.de/resource/blob/494534/0fd3691cf25a389ac575cc030f0e1504/wd-7-001-09-pdf-data.pdf, 2009. (Accessed 27 March 2025).
[12] R. Schwarze, G. Wagner, In the aftermath of dresden: new directions in German flood insurance, Geneva Pap. Risk Insur. - Issues Pract. 29 (2004) 154–168, https://doi.org/10.1111/j.1468-0440.2004.00279.x.

[13] J. Plass, J.O. Zinn, Shifting risks back to the state? Flood insurance and responsibility in the face of climate change in Australia, Int. J. Disaster Risk Reduct. 113 (2024) 104874, https://doi.org/10.1016/j.ijdrr.2024.104874.
[14] K. Booth, B. Tranter, When disaster strikes: under-Insurance in Australian households, Urban Stud. 55 (2018) 3135–3150, https://doi.org/10.1177/0042098017736.
[15] P. Hudson, et al., An assessment of best practices of extreme weather insurance and directions for a more resilient society, Environ. Hazards 19 (2019) 301–321, https://doi.org/10.1080/17477891.2019.1608148.
[16] S. Surminski, A.H. Thieken, Promoting flood risk reduction: the role of insurance in Germany and England, Earths Future 5 (2017) 979–1001, https://doi.org/10.1002/2017EF000587.
[17] GDV (Gesamtverband der Versicherer), "Stellungnahme des Gesamtverbandes der Deutschen Versicherungswirtschaft Lobbyregister-Nr. R000774 zum Bericht der Bundesregierung an die Konferenz der Regierungschefinnen und Regierungschefs der Länder zur Einführung einer Pflichtversicherung für Elementarschäden.". https://www.gdv.de/resource/blob/136436/b39be0b71de065b89e257998b69e9042/pflichtversicherung-data.pdf, 2023. (Accessed 1 March 2025).
[18] D. Osberghaus, et al., Extremwetterereignisse: staatshilfe oder private Vorsorge – wer trägt die Kosten? Ifo Schnelld. 74 (11) (2021) 3–32.
[19] P. Blaikie, et al., At risk. Natural Hazards, People's Vulnerability and Disasters, second ed., Routledge, London, New York, 2004.
[20] K. Hewitt (Ed.), Interpretations of Calamity: from the Viewpoint of Human Ecology, Routledge, London, 1983.
[21] C.S. Holling, Resilience and stability of ecological systems, Annu. Rev. Ecol. Systemat. 4 (1973) 17–23.
[22] W.N. Adger, Social and ecological resilience: are they related? Prog. Hum. Geogr. 24 (3) (2000) 347–364, https://doi.org/10.1191/030913200701540465.
[23] B. Manyena, et al., Disaster resilience: a bounce back or bounce forward ability? Local Environ.: The International Journal of Justice and Sustainability 16 (5) (2011) 417–424, https://doi.org/10.1080/13549839.2011.583049.
[24] P. O'Malley, Resilient subjects: uncertainty, warfare and liberalism, Econ. Soc. 39 (4) (2010) 488–509, https://doi.org/10.1080/03085147.2010.510681.
[25] UNDRR, Sendai Framework for Disaster Risk Reduction 2015 – 2030, UNDRR, Geneva, 2015.
[26] S.B. Manyena, The concept of resilience revisited, Disasters 30 (4) (2006) 434–450, https://doi.org/10.1111/j.0361-3666.2006.00331.x.
[27] D. Paton, D. Johnston, Disaster resilience. An integrated approach. Springfield, Illinois, US: Charles C, Homas Publishers Ltd, 2017.
[28] N. Matin, et al., What is equitable resilience? World Dev. 109 (2018) 197–205, https://doi.org/10.1016/j.worlddev.2018.04.020.
[29] Pelling, M. Adaptation to Climate Change. from Resilience to Transformation. London: Routledge.
[30] P. Masci, The history of insurance: risk, uncertainty and entrepreneurship, Journal of the Washington Institute of China Studies 5 (3) (2011) 25–68.
[31] F. Ewald, L'Etat Providence, B. Grasset, Paris, 1986.
[32] T. Baker, J. Simon, Embracing risk, in: T. Baker, J. Simon (Eds.), Embracing Risk: the Changing Culture of Insurance and Responsibility, The University of Chicago Press, Chicago, London, 2002, pp. 1–25.
[33] P. Jarzabkowski, et al., Insurance for Climate Adaptation: Opportunities and Limitations, Rotterdam and Washington DC: Global Commission on Adaptation, 2019.
[34] P. O'Hare, et al., Insurance as maladaptation: resilience and the 'business as usual' paradox, Environ. Plann. C Govern. Pol. 34 (2016) 1175–1193, https://doi.org/10.1177/0263774X15602022.
[35] P. O'Malley, S. Hutchinson, Reinventing prevention: why did 'Crime Prevention' develop So late? Br. J. Criminol. 47 (2007) 373–389, https://doi.org/10.1093/bjc/azl092.
[36] T. Sewell, et al., Disaster declarations associated with bushfires, floods and storms in New South Wales, Australia between 2004 and 2014, Sci. Rep. 6 (2016) 1–11, https://doi.org/10.1038/srep36369.
[37] J.O. Zinn, Risk-taking and social inequality, J. Sociol. 60 (2024) 364–381, https://doi.org/10.1177/14407833231162865.
[38] A.H. Thieken, et al., Review of the flood risk management system in Germany after the major flood in 2013, Ecol. Soc. 21 (2016) 51, https://doi.org/10.5751/ES-08547-210251.
[39] DKKV (Deutsches Komitee für Katastrophenvorsorge e.V.), Das Hochwasser im Juni 2013: bewährungsprobe für das Hochwasserrisikomanagement in Deutschland, DKKV-Schriftenreihe 53 (2015).
[40] T. Petrow, et al., Entwicklungen in der Gesetzgebung zum Hochwasserrisikomanagement, in: DKKV (Ed.), Das Hochwasser Im Juni 2013: Bewährungsprobe Für Das Hochwasserrisikomanagement in Deutschland, DKKV-Schriftenreihe 53: Bonn, 2015, pp. 47–49.
[41] J. Ragnitz, M. Thum, Versicherungspflicht für Elementarschäden? Zeitschrift für, Wirtschaftspolitik 70 (2021) 257–263, https://doi.org/10.1515/zfwp-2021-2062.
[42] H. Kreibich, et al., Flood loss reduction of private households due to building precautionary measures – lessons learned from the elbe flood in August 2002, Nat. Hazards Earth Syst. Sci. 5 (2005) 117–126, https://doi.org/10.5194/nhess-5-117-2005.
[43] Die Bundesregierung, Deutsche Strategie Zur Stärkung Der Resilienz Gegenüber Katastrophen, 2022. Umsetzung des Sendai Rahmenwerks für Katastrophenvorsorge (2015-2015) – Der Beitrag Deutschlands 2022 – 2023. Berlin: BMI.
[44] DKKV (Deutsches Komitee für Katastrophenvorsorge e.V., Hochwasservorsorge in Deutschland, in: Lernen Aus Der Katastrophe 2002 Im Elbegebiet. DKV-Schriftenreihe 29, 2003.
[45] LAWA (Bund/Länder-Arbeitsgemeinschaft Wasser), Empfehlungen zur Aufstellung, in: Überprüfung Und Aktualisierung Von Hochwasserrisikomanagementplänen, Erfurt: Bund/Länderarbeitsgemeinschaft Wasser, 2019.
[46] BMI (Bundesministerium des Innern und für Heimat, Wer macht was beim Zivil- und Katastrophenschutz?. https://www.bmi.bund.de/DE/themen/bevoelkerungsschutz/zivil-und-katastrophenschutz/gefahrenabwehr-und-katastrophenschutz/gefahrenabwehr-und-katastrophenschutz-node.html;jsessionid=906EB4FC30814F1AEBC762F225B22553.live891, 2024. (Accessed 14 January 2025).
[47] StMUV (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz), Hochwasserstrategie in Bayern, 2024. https://www.stmuv.bayern.de/themen/wasserwirtschaft/hochwasser/index.htm#:~:text=Seit%20dem%2001.01.2021%20ist,die%20Säulen%20Ökologie%20und%20Sozialfunktion. (Accessed 6 March 2025).
[48] BMWSB (Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen), Fragen und Antworten zum Bundesraumordnungsplan für den Hochwasserschutz (BRPH). https://www.bmwsb.bund.de/SharedDocs/faqs/Webs/BMWSB/DE/raumordnung/hochwasserschutz/hochwasserschutz-faqs.html#doc17403026bodyText1, 2024. (Accessed 6 March 2025).
[49] F. Ewald, Insurance and risk, in: G. Burchell, et al. (Eds.), The Foucault Effect. Studies in Governmentality. Hemel Hempstead: Harvester-Wheatsheaf, 1991, pp. 197–210.
[50] GDV (Gesamtverband der Versicherer), Elementarschaden-versicherung in Baden-Württemberg am meisten verbreitet. https://www.gdv.de/gdv/statistik/datenservice-zum-naturgefahrenreport/sachversicherung-elementar/elementarschaden-versicherung-in-baden-wuerttemberg-am-meisten-verbreitet–147666, 2023. (Accessed 20 March 2025).
[51] GDV (Gesamtverband der Versicherer), "Nur die Hälfte der Gebäude in Deutschland ist richtig gegen Naturgefahren versichert.". https://www.gdv.de/gdv/themen/schaden-unfall/nur-die-haelfte-der-gebaeude-in-deutschland-ist-richtig-gegen-naturgefahren-versichert-12176, 2024. (Accessed 20 March 2025).
[52] GDV (Gesamtverband der Versicherer), Versicherungsquote bei Elementarschadenversicherung steigt kontinuierlich. https://www.gdv.de/gdv/statistik/datenservice-zum-naturgefahrenreport/sachversicherung-elementar/versicherungsquote-bei-elementarschadenversicherung-steigt-kontinuierlich–147644, 2024. (Accessed 20 March 2025).
[53] H. Kreibich, A.H. Thieken, Coping with floods in the city of Dresden, Germany, Nat. Hazards 51 (2009) 423–436, https://doi.org/10.1007/s11069-007-9200-8.
[54] H. Kreibich, et al., Recent changes in flood preparedness of private households and businesses in Germany, Reg. Environ. Change 11 (2011) 59–71, https://doi.org/10.1007/s10113-010-0119-3.
[55] R. Schwarze, G.G. Wagner, Naturgefahrenversicherung in Europa – Unterschiedliche Antworten auf den Klimawandel, Vierteljahreszeitschrift zur Wirtschaftsforschung. 77 (4) (2008) 5–17.

[56] R. Schwarze, G.G. Wagner, The political economy of natural disaster insurance: lessons from the failure of a proposed compulsory insurance scheme in Germany, Eur. Environ. 17 (2007) 403–415, https://doi.org/10.1002/eet.456.
[57] T. Hartung, Versicherungspflicht für Elementargefahren – unvermeidbar oder unverzeihlich? in: Infrastruktur Forschungszentrum Risiko, Sicherheit und Konflikt, Universität der Bundeswehr München (Eds.), Wie Viel Sicherheit Verträgt Die Gesellschaft? Munich: Universität Der Bundeswehr München, 2017, pp. 16–21.
[58] Wasserhaushaltsgesetz of July 31, 2009 (BGBl. I p. 2585), last amended by Article 7 of the Act of December 22, 2023 (BGBl. 2023 I No. 409).
[59] K.A.W. Snel, et al., Unpacking notions of resident's responsibility in flood risk governance, Environmental Policy and Governance 32 (2022) 217–231, https://doi.org/10.1002/eet.1985.
[60] LfU (Bayerisches Landesamt für Umwelt), Hochwasser-Eigenvorsorge: fit für den Ernstfall, Augsburg: LfU (2018).
[61] European Commission, Floods. https://environment.ec.europa.eu/topics/water/floods_en, 2023. (Accessed 25 March 2025).
[62] J.S. Tradowsky, et al., Attribution of the heavy rainfall events leading to severe flooding in Western Europe during July 2021, Clim. Change 176 (2023) 90, https://doi.org/10.1007/s10584-023-03502-7.
[63] Umweltbundesamt, Vorsorge Gegen Starkregenereignisse Und Maßnahmen Zur Wassersensiblen Stadtentwicklung – Analyse Des Standes Der Starkregenvorsorge in Deutschland Und Ableitung Zukünftigen Handlungsbedarfs, Dessau-Roßlau: Umweltbundesamt, 2019.
[64] S. Surminski, et al., Flood risk management in Germany, Building flood resilience in a changing climate (2020). Zurich: The Geneva Association.
[65] Zurich Insurance Company, Risk Nexus. Central European Floods 2013: a Retrospective, Zurich Insurance Company, Zurich, 2014.
[66] M. Garschagen, et al., Verortung von Verantwortung für die Notfallversorgung bei Ausfällen, in: A. Fekete, , et al.Wege zu einem Mindestversorgungskonzept (Eds.), Kritische Infrastrukturen Und Resilienz, Technische Hochschule Köln, Köln, 2019, pp. 32–33.
[67] L. Dillenardt, et al., Urban pluvial flood adaptation: results of a household survey across four German municipalities, Journal of Flood Risk Management 15 (3) (2022) e12748, https://doi.org/10.1111/jfr3.12748.
[68] L.T. De Rulg, et al., How the USA can benefit from risk-based premiums combined with flood protection, Nat. Clim. Change 12 (2022) 995–998, https://doi.org/10.1038/s41558-022-01501-7.
[69] S. Kienzler, et al., After the extreme flood in 2002: changes in preparedness, response and recovery of flood-affected residents in Germany between 2005 and 2011, Nat. Hazards Earth Syst. Sci. 15 (2015) 505–526, https://doi.org/10.5194/nhess-15-505-2015.
[70] E. Tate, et al., Flood exposure and social vulnerability in the United States, Nat. Hazards 106 (2021) 435–457, https://doi.org/10.1007/s11069-020-04470-2.
[71] BMZ (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung), Loss and damage. V20 and G7 agree on financial protection cooperation, to formally launch global shield against climate risks at COP27. https://www.bmz.de/en/news/press-releases/v20-g7-agree-launch-global-shield-against-climate-risks-cop27-125782, 2022. (Accessed 4 February 2025).
[72] P. Hudson, A.H. Thieken, The presence of moral hazards regarding flood insurance and German private businesses, Nat. Hazards 112 (2022) 1295–1319, https://doi.org/10.1007/s11069-022-05227-9.
[73] M. Meuser, U. Nagel, Das Experteninterview – konzeptionelle Grundlagen und methodische Anlage, in: S. Pickel, et al. (Eds.), Methoden Der Vergleichenden Politik- Und Sozialwissenschaft. Neue Entwicklungen Und Anwendungen, VS Verlag für Sozialwissenschaften, Wiesbaden, 2009, pp. 465–479.
[74] M. Frank, et al., Beyond risk shifting: the knowledge-transferring role of audit liability insurers, Contemp. Account. Res. 38 (2021) 224–2263, https://doi.org/10.1111/1911-3846.12670.
[75] J. Waters, Snowball sampling: a cautionary tale involving a study of older drug users, Int. J. Soc. Res. Methodol. 18 (4) (2015) 367–380, https://doi.org/10.1080/13645579.2014.953316.
[76] H. Deakin, K. Wakefield, Skype interviewing: reflections of two PhD researchers, Qual. Res. 14 (2014) 603–616, https://doi.org/10.1177/1468794113488126.
[77] B. Malsch, S.E. Salterio, "Doing good field research": assessing the quality of audit field research, Audit J. Pract. Theor. 35 (2016) 1–22, https://doi.org/10.2308/ajpt-51170.
[78] H. Merkens, Selection procedures, sampling, case construction, in: U. Flick, E.v. Kardorff, I. Steinke (Eds.), A Companion to Qualitative Research, Sage, London, 2004, pp. 165–171.
[79] G. Gobo, Sampling, representativeness and generalizability, in: C. Seale, et al. (Eds.), Qualitative Research Practice, Sage, London, 2004, pp. 435–456.
[80] U. Kuckartz, Qualitative text analysis: a systematic approach, in: G. Kaiser, N. Presmeg (Eds.), Compendium for Early Career Researchers in Mathematics Education, Springer Open, Cham, 2019, pp. 181–197.
[81] A. Wæraas, Thematic analysis: making values emerge from texts, in: G. Espedal, et al. (Eds.), Researching Values. Methodological Approaches for Understanding Values Work in Organisations and Leadership, Palgrave Macmillan, Cham, 2022, pp. 153–170.
[82] W. Kahlenborn, et al., Climate Impact and Risk Assessment 2021 for Germany, Dessau-Roßlau: Umweltbundesamt, 2021.
[83] A. Truedinger, et al., Adaptation after extreme flooding events: moving or staying? The case of the Ahr Valley in Germany, Sustainability 15 (2023) 1407, https://doi.org/10.3390/su15021407.
[84] GDV (Gesamtverband der Versicherer), Versicherer für Naturgefahrenausweis – aufklärung und Prävention wichtig. https://www.gdv.de/gdv/medien/medieninformationen/versicherer-fuer-naturgefahrenausweis-aufklaerung-und-praevention-wichtig–105900, 2022. (Accessed 15 January 2025).
[85] K. Burningham, et al., 'It'll never happen to me': understanding public awareness of local flood risk, Disasters 32 (2008) 216–238, https://doi.org/10.1111/j.1467-7717.2007.01036.x.
[86] T. Grothmann, F. Reusswig, People at risk of flooding. Why some residents take precautionary action while others do not, Nat. Hazards 38 (2006) 101–120, https://doi.org/10.1007/s11069-005-8604-6.
[87] H. Kreibich, et al., Knowing what to do substantially improves the effectiveness of flood early warning, Bull. Am. Meteorol. Soc. 1–38 (2021), https://doi.org/10.1175/bams-d-20-0262.1.
[88] M. Riese, et al., Synergien und Hemmnisse einer möglichen Integration von Starkregen in die Bearbeitung der europäischen Hochwasserrisikomanagementrichtlinie, Hydrol. Wasserbewirtsch. 63 (4) (2019) 193–202, https://doi.org/10.5675/HyWa_2019.4_1.
[89] V. Meyer, et al., Recommendations for the user-specific enhancement of flood maps, Nat. Hazards Earth Syst. Sci. 12 (2012) 1701–1716, https://doi.org/10.5194/nhess-12-1701-2012.
[90] H. Kunreuther, E. Michel-Kerjan, Managing Catastrophes Through Insurance: Challenges and Opportunities for Reducing Future Risks. Pennsylvania: Risk Management and Decision Process Center, The Wharton School of the University of Pennsylvania, 2009.
[91] GDV, Leitfaden "Build Back Better, Unverbindliche Orientierungshilfe zum Umgang mit "Build Back Better" in der Wohngebäudeversicherung. Berlin: GDV, 2024.
[92] P.A. Raschky, H. Weck-Hannemann, Charity Hazard: a Real Hazard to Natural Disaster Insurance? Working Papers in Economics and Statistics, No. 2007-04, University of Innsbruck, Department of Public Finance, Innsbruck, 2007.
[93] G. Gigerenzer, Rationality for mortals. How People Cope with Uncertainty, Oxford University Press, Oxford, 2010.
[94] T. Harries, Feeling secure or being secure? Why it can seem better not to protect yourself against a natural hazard, Health Risk Soc. 10 (2008) 479–490, https://doi.org/10.1080/13698570802381162.
[95] M. Douglas, Natural Symbols. Explorations in Cosmology, Routledge, London, New York, 2003 [1970].
[96] J.O. Zinn, Heading into the unknown: everyday strategies for managing risk and uncertainty, Health Risk Soc. 10 (2008) 439–450, https://doi.org/10.1080/13698570802380891.
[97] J.O. Zinn, 'In-between' and other reasonable ways to deal with risk and uncertainty: a review article, Health Risk Soc. 18 (2016) 348–366, https://doi.org/10.1080/13698575.2016.1269879.
[98] J.O. Zinn, M. Schulz, Rationalization, enchantment, and subjectivation – lessons for risk communication from a new phenomenology of everyday reasoning, J. Risk Res. 27 (2024) 295–312, https://doi.org/10.1080/13669877.2024.2328195.
[99] J.O. Zinn, The meaning of risk-taking – key concepts and dimensions, J. Risk Res. 22 (2019) 1–15, https://doi.org/10.1080/13669877.2017.1351465.

[100] C. Kousky, The role of natural disaster insurance in recovery and risk reduction, Annual Reviews of Resource Economics 11 (2019) 399–418, https://doi.org/10.1146/annurev-resource-100518-094028.
[101] Actuaries Institute, Home Insurance Affordability and Socioeconomic Equity in a Changing Climate, Institute of Actuaries of, Australia, 2022.
[102] B. McLennan, J. Handmer, Reframing responsibility-sharing for bushfire risk management in Australia after black Saturday, Environ. Hazards 11 (2012) 1–15, https://doi.org/10.1080/17477891.2011.608835.
[103] Jarzabkowski, et al., Disaster insurance in Switzerland: the cantonal public sector insurance system, 2022. (Accessed 27 March 2025).
[104] M. Schulz, J.O. Zinn, Rationales of risk and uncertainty and their epistemological foundation by new phenomenology, J. Risk Res. 26 (3) (2023) 219–232, https://doi.org/10.1080/13669877.2022.2162105.
[105] J.O. Zinn, Understanding Risk-Taking, Palgrave Macmillan, Cham, Switzerland, 2020.
[106] H.J. Boon, Disaster resilience in a flood-impacted rural Australian town, Nat. Hazards 71 (1) (2014) 683–701, https://doi.org/10.1007/s11069-013-0935-0.
[107] J. Plass, J.O. Zinn, The Australian housing affordability trap – how environmental, institutional, and structural factors can immobilize Australian households in the face of extreme weather events – a case study on flooding, Climate Risk Management 48 (2025) 100713, https://doi.org/10.1016/j.crm.2025.100713.
[108] L.B. Lie, et al., “Here, I will stay until I die” – exploring the relationship between place attachment, risk perception, and coping behavior in two small Norwegian communities, Reg. Environ. Change 23 (2023) 115, https://doi.org/10.1007/s10113-023-02106-2.