

Turning regret into future disaster preparedness with no-regrets

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Abstract. Global efforts are focusing on long-term preparedness for disasters highlighting the need for taking well-informed decisions in advance to avoid panic behaviour when a disaster strikes. Taking well-informed decisions includes the evaluation of the potential outcomes of a decision or action to avoid regretting them afterwards. Yet, little is known about what we regret about our actions and inactions in the context of disasters. Using the responses of a survey disseminated in flood affected areas in German in 2021, this study dives into the post-disaster regrets of citizens ~~and the reasons for their regrets~~. The results showed ~~the~~ that participants only regretted preparedness actions when they threatened their life, but foremost, participants regretted their inaction. Overall, the results indicate the need for promoting long-term preparedness which can be supported with the no-regrets ~~actions approach which in addition need to be easy to implement~~. Furthermore, the need for integrating actions supporting psychological preparedness was identified. ~~To increase citizens preparedness motivation, their self responsibility needs to be enhanced which could be achieved through fostering collective action.~~

1 Introduction

'I was woken up by the rising water as I swam across the room on my couch.'

(Original: 'Ich wurde von dem steigenden Wasser geweckt, als ich mit meiner Schlafcouch durchs Zimmer schwamm.')

After a flood, we would probably reflect on the moment when we woke up on the couch because it was floating through the room. In this moment, we would start thinking what if I had received a warning and prepared for the flood. The reflections on the past and thinking about the 'what if' can make us regret decisions and actions that had negative outcomes, or actions we failed to take (Feldman and Chen, 2019; Feldman et al., 1999; Gilovich and Medvec, 1994; Zeelenberg et al., 2002). Regret is an emotion of blaming ourselves, but regret and the experience itself, also supports us in adapting for future flooding (Hung, 2020; Kuang and Liao, 2020; Zeelenberg and Pieters, 2007).

The floods in Germany of July 2021 have left many regrets but also starting points for enhancing future disaster preparedness. Although, the event was forecasted well in advance at both European and national level (~~A.-H.~~Thieken et al., 2023), the floods took hundreds of citizens by surprise because they did not receive any warning or did not take warnings seriously (Fekete and Sandholz, 2021). Those citizens who did not expect flooding, did not have had time to prepare and, therefore, were overwhelmed by the water entering their homes (Lemnitzer et al., 2021; ~~A.-H.~~Thieken et al., 2023). Citizens who received

warnings may not have been able to imagine the approaching flood and hence, did not prepare (Ommer, Neumann, et al., 2024). In addition, it is widely acknowledged in risk perception studies that the preparedness action is dependent on peoples' (perceived) ability to act (Kuhlicke, Seebauer, et al., 2020; Bubeck et al., 2012). While ability refers to our physical ability as well as psychological or even financial. The lack of preparedness together with people taking risky actions such as driving through flood water or going downstairs into flooded basements caused a high number of lost lives (A. H. Thieken et al., 2022).

The floods further reminded us that many citizens have a ~~rather~~ reactive or flood defensive mindset, rather than a proactive one (Ommer, Blackburn, et al., 2024; ~~Surminski & Thieken, 2017~~). Moreover, this study further reflected on disaster and risk governance structures in Germany as they are perceived by citizens: by law, citizens are responsible for preparing their own property for hazards such as flooding but the survey responses highlighted that citizens show high dependencies on governance authorities as they project most governance responsibilities to them.

Rare events like this disaster in 2021 are deeply uncertain and therefore, need to be adapted to in advance rather than taking action only after a warning (which sometimes may not arrive) (Marchau et al., 2019). A proactive mindset can enhance our ability to act fast when we receive a warning which otherwise perhaps results in irrational, reflexive, or panic decision taking (L. Geaves et al., 2023; Xenidis & Kaltsidi, 2022). Hence, for taking good decisions on preparedness actions, we need time to evaluate the potential impact of our actions to ensure that we will not regret them in the future (Robinson and Botzen, 2018; Sunderrajan and Albarracín, 2021; UNDRR, 2022).

This raises the research question of which (in)actions do we actually regret and why do we regret them. Commonly communicated preparedness actions include preparing the home for intruding water by moving valuable things upstairs, installing pumps in a basement, or preparing an emergency kit (Kreibich et al., 2011; Martins et al., 2019). These actions can be performed in a relatively short time, for instance, after receiving a warning. Although, these actions taken are very valuable for protecting our home and properties, they were recently claimed as 'weak preparations' where we are 'blindly following' instructions (Katsikopoulos, 2021). In fact, (proactive) disaster preparedness shall target the strengthening of knowledge and capabilities 'to effectively anticipate, respond to and recover from the impacts' (Sendai Framework Terminology on Disaster Risk Reduction, 2023) which may not ~~be~~ always be achieved with so-called weak preparedness actions. Hence, stronger and long-term preparedness actions rather include developing a (household) emergency plan and practising it (Katsikopoulos, 2021).

Considering that the uncertainty about whether we will be affected by a hazard or not (especially, if we have no prior hazard experience) is one major barrier to long-term preparedness, an interdisciplinary strategy for decision-making under uncertainty could be applied: the no-regrets approach (Marchau et al., 2019). First integrated into climate policies in the 1990s, the no-regrets approach fosters taking actions which are robust in different future scenarios (i.e., no, low, or high impact hazards). According to Heltberg et al., (2009), actions shall firstly, not be regretted in any future scenario, and secondly, not be costly, and entail benefits. These values have motivational factors to take the actions since our decisions are driven by the aim to avoid regret but also by economics and benefits which are representing a reward (Sunderrajan and Albarracín, 2021).

The no-regrets decision-making strategy was later adopted in disaster risk reduction research (Plume, 1995; Heltberg et al., 2009; Debele et al., 2023). Despite the widespread application of the no-regrets approach, its potential to guide individual preparedness actions remains largely unexplored. In fact, current research neglects the applicability of the approach to individual decision-making and preparedness where actions generally need to be easy to implement, of low cost, and (psychologically) robust. Moreover, disaster preparedness research often emphasises proactive measures and risk perception but rarely considers the post-disaster emotional and cognitive reflections (e.g., regret) and its role in shaping future preparedness. Integrating the no-regrets approach with insights from post-disaster reflections can support the development of practical strategies for individual preparedness. ~~but has not been applied in context with individual disaster preparedness. Gaining a better understanding of the regrets linked to flood preparedness can help shape advice on preparedness behaviour for citizens.~~

~~For this purpose~~ To fill these two gaps, this study explores the flooding event in Germany in 2021 from a regret perspective. Using an online survey disseminated in flood affected areas, this study dives into citizens' preparedness actions before the event and for the future. The main objective is to gain insights into what participants regretted, or not, and why. Acknowledging that regret is a cognitive process and therefore, highly subjective, this study aims to derive a broad overview on potential regrets of citizens. Secondly, the outcomes of the survey will then be used to form recommendations for long-term disaster preparedness and the suitability of the no-regrets approach as a framework for individual disaster preparedness. To learn more about the flooding event, Section 1.1 provides a summary about the floods and impacts. Section 2 presents the survey design and data analysis. The results providing insights into the regrets and no regrets are ~~discussed~~ introduced in Section 3, ~~and discussed a conclusion towards long term disaster preparedness is provided~~ in Section 4, and concluded in Section 5.

1.1 The floods in Germany in 2021

The low-pressure system 'Storm Bernd' brought heavy precipitation in Western Europe between 12th and 15th July 2021 which cascaded into flooding and caused devastating impacts (Kreienkamp et al., 2021; Lemnitzer et al., 2021).

Germany (and its neighbouring countries) experienced severe rainfall after a three-week-period of wet days (Dietze et al., 2022). While heavy rainfall hit many parts of the country, the federal states Rhineland-Palatinate and North Rhine-Westphalia experienced particularly high amounts of precipitation causing local flooding. The two states are located in the western region of Germany bordering to the Netherlands, Luxembourg, Belgium, and France. In these states, many small and medium sized rivers exceeded their banks during the flooding event (Lehmkuhl et al., 2022).

Heavy precipitation of up to 180 mm within 72 hours led to various types of flooding (Dietze et al., 2022; Junghänel et al., 2021; Lehmkuhl et al., 2022). The initial high saturation level of soils led quickly to surface runoff and pluvial flooding (Dietze et al., 2022). While the runoff on hillslopes transformed into small streams forming gullies (Lemnitzer et al., 2021). Flash floods occurred in the middle hills' catchments where steep slopes are a common landscape feature (~~A. H.~~ Thicken et al.,

2023). Additionally, water reservoirs filled up quickly and proved danger to their dams and the downstream population (Lehmkuhl et al., 2022). Lastly, urban fluvial flooding occurred in cities along rivers and streams (A. H. Thieken et al., 2023). In Germany, about 162 km² were inundated, primarily affecting the agricultural sector with 88 km² of flooded agricultural land (He et al., 2022). The event was referred to as 400-year event but highlighting the fact that these kinds of events can occur more often (Kreienkamp et al., 2021). The results of this study further suggested an influence of climate change on the intensity of the rainfall event and future ones.

Overall, the floods led to devastating damages of EUR 32 billion (Mohr et al., 2022). The damage to roads, bridges and other critical infrastructure further complicated evacuation and emergency response (Fekete and Sandholz, 2021; Koks et al., 2022). Most importantly, more than 180 people lost their lives and hundreds of people were injured or displaced (Dietze et al., 2022; A. H. Thieken et al., 2023). According to an evaluation in the federal state North Rhine-Westphalia (A. H. Thieken et al., 2022), most people lost their lives in their cars, on the street, in a basement, or on the ground floor. Most of these people drowned in the flood waters, a few lost their life due to heart failure, and two because of burn injuries from oil-fired heating. ~~The event was referred to as 400-year event but highlighting the fact that these kinds of events can occur more often (Kreienkamp et al., 2021). The results further suggested an influence of climate change on the intensity of the rainfall event and future ones. According to another study, land cover changes, for instance in America, could further intensify these rainfalls in the future (Insua-Costa et al., 2022).~~

2 Methods

2.1 Online survey

To gain a better understanding on the perspective of affected citizens on this event and their own (in)action, an online survey was designed to gather a spatially wide collection of responses. To give these citizens a voice, the survey (Supplementary Material) encompassed primarily open questions regarding the flood source, risk estimation, preparedness, response, early warning, issues that were perceived and suggested solutions for these, and basic demographic questions (age, living situation, and postcode). The survey was designed in two languages (German and English). After approval by the SAGES Ethics Committee of the University of Reading (February 2022), the survey was open from March to July 2022 and invited flood affected citizens (18 years and older) from the two states Rhineland Palatinate and North Rhine-Westphalia to share their experiences. It was disseminated using Microsoft Forms via social media channels such as Facebook, Twitter, LinkedIn, and WhatsApp. The nature of the design of the study and dissemination strategy could lead to biases (i.e., Ong et al. (2023)) in age groups, risk awareness, or the personality of participants as it may have promoted the participation of generally more active and engaging people.

2.2 Data analysis

The responses were stored in Microsoft Excel and pre-processed which included the translation of responses in English, the correction of postcodes, and the adding of municipality and district names (based on the postcodes).

130 Descriptive statistics were used to analyse basic questions regarding age structure and living situation, location, and flood experience. In total, 438 responses were collected. The majority of participants (87,7%) were living in North Rhine-Westphalia at the time of the flooding and 12,3% in Rhineland Palatinate. 65% of the participants were aged between 25 and 54 years but also covered the age groups 18-24 years (6%), 55-64 years (19%), and 65 years and older (9%). The age structure of the survey participants is comparable to the German national age structure of 2022 (Population in Germany, 2024), but shows a slight
135 overrepresentation of the age group 25 to 54 years. Almost two thirds of the participants were owning a house in July 2021, and about one-fifth were living in a rental apartment. Other participants were living in a rented house (7%), owning a flat (4%), or living with their parents or guardians (3%).

Open questions were analysed qualitatively utilising thematic analysis (Braun and Clarke, 2006). This allowed a deeper insight into the survey results by identifying overarching themes. Applying the thematic analysis, all questions were analysed to distil
140 themes that appear across these questions. The workflow included the familiarisation with the responses followed by an initial coding in Nvivo (release 1.7.1) which highlighted the themes of inaction and regret. Using Microsoft Excel, these themes were explored in more depth by manually coding the responses into i.e., reasons for inaction. The results of the thematic analysis are presented and discussed in Section 3 and concluded in Section 4.

The main questions used for the thematic analysis were: (Question 5 (Q5)) actions after a warning message was received, (Q6) actions when the water arrived, and (Q15) what people would do differently if they received a warning today. All responses were filtered by participants expressing (no-)regret in their replies. This process showed that most people who expressed regret did experience flooding directly (as selected in Q2). More details on how and why people expressed regrets is presented in the following section.

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3 Results

150 The is-reflection on previous behaviours and their outcomes and the question of ‘what if’ is a typical process that can lead to regret (Feldman et al., 1999; Zeelenberg et al., 2002). Overall, some participants implied ~~different~~ regrets about their preparedness behaviour, especially, about the actions they did not take – their inaction (Section 3.1) - and actions that posed a risk to their lives (Section 3.2). While a few participants explicitly mentioned that they do not regret anything about their own behaviour (Section 3.3). Regret was further expressed in their replies on what they would do differently if another flood
155 approaches in the future (Section 3.4). This showed that the participants have been evaluating their actions and inactions and probably thought about what they could have done (differently). ~~This reflection and the question of ‘what if’ is a typical process that can lead to regret (Feldman et al., 1999; Zeelenberg et al., 2002).~~ What participants regretted and why is discussed in the following Section 3.1. In contrast, Section 3.2 discusses what participants did not regret and indications for why.

3.1 What do we regret?

Overall, participants mentioned that they undertook a variety of short-term emergency measures (Kreibich et al., 2011; Martins et al., 2019) such as preparing the house and basement for potential water intrusion, moving valuable furniture, documents, photos, and more upstairs, preparing emergency escape bag packs, storing food, and filling water canisters. Interestingly, none of the participants mentioned that they regretted having taken any of these actions. Only if the action caused a threat to the life of the participant, then regret was expressed.

'I cleaned out the basement.

Which, in retrospect, was very dangerous. I wouldn't do that anymore.'

(Original: 'Ich habe den Keller ausgeräumt.

Was im Nachhinein sehr gefährlich war. Das würde ich nicht mehr machen.')

This can be explained by the regret theory that when an action had or might have had a negative outcome, we start thinking about the 'what if'—imagining what we could have done differently to achieve a more positive outcome (Zeelenberg et al., 2002). In the above quote, the participant recognised afterwards that going into a flooded basement can be very dangerous, indeed drowning in the basement was one of the major threats of this flooding event (A. H. Thieken et al., 2022). Causes of death were also linked to driving or walking in flood water which was regretted by another participant.

'Stay at home and stop trying to drive the car.'

(Original: 'Zuhause bleiben und nicht mehr versuchen mit dem Auto zu fahren.')

3.1 Inaction arising the feeling of regret

Similarly, negative outcomes were associated with the trust in the early warning. The majority of regrets expressed by participants were related to inaction. Inaction regrets were found in regard to flood mitigation and preparedness measures, evacuation, seeking information, and helping others. Missing the chance to take actions because of different reasons is a common cause for regret (Gilovich and Medvec, 1994). 29.6%¹ of the participants wrote that they did nothing ('nichts', 'nix') for preparedness. This preparedness inaction was linked to the lack of time to take action because of the unexpectedness of the event. More reasons for not preparing were the fact that e.g., people did not understand the warning properly or they could simply not imagine an event like this (N=31); they were not at home (N=9); they were in shock (N=3); they could not act because they felt powerless (N=3); or for other reasons (N=10).

Flooding was largely unexpected by the survey participants primarily because of untimely, late, or no warning. Roughly half of the participants did not receive any warning considerably in advance of the event (24h or more). Asking the participants

¹ Note: This and the following numbers were derived from a non-mandatory question (Q5): How did you react and what did you do when you learnt about potential flooding?

190 when they received the first warning, about 20% did not receive any warning before the water arrived, 26% noted that they received warning only a few hours before and about 14% were ‘warned’ by the arriving or entering water itself. Not receiving warning in time left several participants in the situation that they had to evacuate immediately. In this context, participants highlighted that they regret to trust in the dissemination of early warning and the support by the local authorities which they see as the cause for this stressful and dangerous situation they found themselves in.

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~~*‘No warning’ ‘Escape’ ‘Trust no one’ ‘Do everything (differently)’*~~
~~*(Original: ‘Keine warnung’ ‘Flucht’ ‘Keinem vertrauen’ ‘Alles (anders machen)’)*~~

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~~*‘I no longer rely on warnings! In case any come!!!*~~
~~*Keep an eye on the surroundings/nature myself.’*~~
~~*(Original: ‘Ich verlasse mich nicht mehr auf Warnung[en]! Falls welche kommen!!!*~~
~~*Selber die Umgebung/Natur in Auge behalten.’)*~~

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In disaster situations, it is important to take well informed decisions which involves considering the potential outcomes of a decision (Sunderrajan and Albarracín, 2021; UNDRR, 2022). These surprise moments have left participants no or minimal time; thus, decisions were made in panic or reflexive leading to irrational action taking (L. Geaves et al., 2023; Xenidis & Kaltsidi, 2022).

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~~*‘I tried to save things and forgot important things. One acts irrationally.’*~~
~~*(Original: ‘Ich habe versucht Dinge zu retten und habe wichtige Dinge vergessen.*~~
~~*Man handelt irrational.’)*~~

Overall, most any regrets were related to time as participants would have like to prepare earlier (‘früher’), in time (‘rechtzeitig’), or immediately (‘sofort’ ‘direkt handeln’ ‘zeitig’).

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~~*‘In the short time, less than an hour before the event, there was nothing more one could do.’*~~
~~*(Original: ‘In der kurzen Zeit, keine Stunde vor dem Ereigniss, konnte man nichts mehr machen.’)*~~

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The majority of regrets expressed by participants were related to inaction. Missing the chance to take actions because of different reasons is another common cause for regret (Gilovich and Medvec, 1994). 29.6% of the participants wrote that they did nothing (‘nichts’, ‘nix’) as preparedness. This preparedness inaction was primarily linked to the lack of time to take action because of the unexpectedness of the event. More reasons for not preparing were the fact that people were e.g., sleeping (since the flooding started during the night in some areas); they were not at home; they did not understand the warning properly; they

could simply not imagine an event like this; they did not know what to do; or they could not act because they were not the legal owners.

Inaction regrets were found in regard to flood mitigation and preparedness measures, evacuation, seeking information, and helping others. Considering the debate in research about whether actions or inactions are more regretful (Feldman and Chen, 2019), it can be concluded that in this real-life experience, inactions were regretted more as participants perhaps wanted to take actions but could not because there was not enough time.

This lack of time and negative experiences from the flooding were associated with the trust in the early warning. In this context, participants highlighted that they regret to trust in the dissemination of early warning and the support by the local authorities which they see as the cause for this stressful and dangerous situation they found themselves in.

'No warning' – 'Escape' – 'Trust no one' – 'Do everything (differently)'

(Original: 'Keine warnung' – 'Flucht' – 'Keinem vertrauen' – 'Alles (anders machen)')

'I no longer rely on warnings! In case any come!!!'

'Keep an eye on the surroundings/nature myself.'

(Original: 'Ich verlasse mich nicht mehr auf Warnung[en]! Falls welche kommen!!!'

Selber die Umgebung/Naturi m Auge behalten.'

Contrarily, some participants received warnings but did not take them seriously and hence, did not take any preparedness actions. Regardless, the reason for participants' inaction, it was commonly regretted. Also, in this following case, where the participant did not act upon received warnings a few days earlier but then responded to the water entering the basement. Inaction was further explained by the fact that participants did not take the received warnings seriously which they regretted afterwards.

'Unfortunately, I did not pay enough attention to the warning, so [I prepared] nothing.'

(Original: 'Ich habe der Warnung leider nicht genug Beachtung geschenkt, also nichts [vorbereitet].')

One reason for not taking the warning seriously was that there have been too many warnings, especially, also considering the recent Covid-19 pandemic for which the same warn app was utilised. This effect is commonly referred to as alert fatigue (Potter et al., 2018; Roberts et al., 2022). Another participant who did not take warning seriously mentioned that when the flood arrived, the person tried to react but gave up at some point. Experiencing the flood and the regret has triggered that the person would take warnings more seriously and take different actions next time. This learning from floods is very common and acknowledged in research (Carone et al., 2019; Köhler et al., 2023; Kuang & Liao, 2020; Kuhlicke, Masson, et al., 2020).

Their intent for the future was to not trust nor depend on local authorities and warnings. Trust is an important pillar for the relations between citizens and authorities which is especially needed in emergency situations (Earle, 2010). However, trust is very dynamic and fragile (Seebauer and Babeicky, 2018); thus, it is often observed that after a devastating event, the trust in authorities diminishes if expectations are not reached (Seebauer and Babeicky, 2018; Whitmarsh, 2008). This case shows how the regret has initiated that participants are willing to take more responsibilities which is a typical effect of regret (Zeelenberg et al., 2002). At the same time, these participants now aim to be more proactive by taking measures in advance and being more attentive to the nature and environment to detect changes to avoid surprises in the future.

‘Now, one is aware of what 200L/sqm means. With similar amounts, I would have packed my suitcase long ago and would move to higher elevations for safety.’

(Original: ‘Jetzt ist man sich bewusst was 200L/qm bedeutet. Bei ähnlichen Mengen hätte ich schon längst den Koffer gepackt und würde mich in Höhere Lagen in Sicherheit bringen.’)

In this context, one participant implied regrets about the person’s own knowledge and threat appraisal. In this case, the person perhaps did not have enough knowledge or information about what 200ml of rain would mean and hence, had to take decisions under greater uncertainty (Marchau et al., 2019).

‘Public warnings are not reliable.’ ‘No trust in those in charge’ ‘Escape’ ‘Take all measures in advance yourself to avoid being caught off guard.’

(Original: ‘Auf die öffentlichen Warnungen ist kein Verlass.’ ‘Kein Vertrauen in die Verantwortlichen.’ ‘Flucht’ ‘Selbst im Vorfeld alle Maßnahmen treffen um nicht überraschend zu werden.’)

~~In disaster situations, it is important to take well informed decisions which involves considering the potential outcomes of a decision (Sunderrajan and Albarracín, 2021; UNDRR, 2022). These surprise moments have left participants no or minimal time; thus, decisions were made in panic or reflexive leading to irrational action taking (L. Geaves et al., 2023; Xenidis & Kaltzidi, 2022).~~

~~*‘I tried to save things and forgot important things. One acts irrationally.’*~~

~~*(Original: ‘Ich habe versucht Dinge zu retten und habe wichtige Dinge vergessen. Man handelt irrational.’)*~~

~~Overall, many regrets were related to time as participants would have like to prepare earlier (*‘früher’*), in time (*‘rechtzeitig’*), or immediately (*‘sofort’* *‘direkt handeln’* *‘zeitig’*).~~

~~'In the short time, less than an hour before the event, there was nothing more one could do.'~~
~~(Original: 'In der kurzen Zeit, keine Stunde vor dem Ereigniss, konnte man nichts mehr machen.')~~

~~The majority of regrets expressed by participants were related to inaction. Missing the chance to take actions because of different reasons is another common cause for regret (Gilevich and Medvec, 1994). 29.6% of the participants wrote that they did nothing ('nichts', 'nix') as preparedness. This preparedness inaction was primarily linked to the lack of time to take action because of the unexpectedness of the event. More reasons for not preparing were the fact that people were e.g., sleeping (since the flooding started during the night in some areas); they were not at home; they did not understand the warning properly; they could simply not imagine an event like this; they did not know what to do; or they could not act because they were not the legal owners.~~

~~Inaction regrets were found in regard to flood mitigation and preparedness measures, evacuation, seeking information, and helping others. Considering the debate in research about whether actions or inactions are more regretful (Feldman and Chen, 2019), it can be concluded that in this real-life experience, inactions were regretted more as participants perhaps wanted to take actions but could not because there was not enough time.~~

~~Inaction was further explained by the fact that participants did not take the received warnings seriously which they regretted afterwards.~~

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~~One reason for not taking the warning seriously was that there have been too many warnings, especially, also considering the recent Covid 19 pandemic for which the same warn app was utilised. This effect is commonly referred to as alert fatigue (Potter et al., 2018; Roberts et al., 2022). Another participant who did not take warning seriously mentioned that when the flood arrived, the person tried to react but gave up at some point. Experiencing the flood and the regret has triggered that the person would take warnings more seriously and take different actions next time. This learning from floods is very common and acknowledged in research (Carone et al., 2019; Köhler et al., 2023; Kuang & Liao, 2020; Kuhlicke, Masson, et al., 2020).~~

3.2 Actions arising the feeling of regret

Flooding was largely unexpected by the survey participants primarily because of untimely, late, or no warning. Roughly half of the participants did not receive any warning considerably in advance of the event (24h or more). Asking the participants when they received the first warning, about 20% did not receive any warning before the water arrived, 26% noted that they received warning only a few hours before and about 14% were 'warned' by the arriving or entering water itself. Not receiving warning in time left several participants in difficult situations as these surprise moments have left participants no or minimal

time; thus, decisions were made in panic or reflexive leading to irrational action taking (L. Geaves et al., 2023; Xenidis & Kaltsidi, 2022).

'I tried to save things and forgot important things. One acts irrationally.'
(Original: 'Ich habe versucht Dinge zu retten und habe wichtige Dinge vergessen.
Man handelt irrational.')

One participant started acting when the water was already filling up in the basement because no warnings were received in advance. The person believed that small flooding might occur and reflected on the wishful thinking that the rain would stop soon. However, when the water entered the home, the participant described the following actions as just functioning without thinking:

'I cleaned out the basement.
Which, in retrospect, was very dangerous. I wouldn't do that anymore.'
(Original: 'Ich habe den Keller ausgeräumt.
Was im Nachhinein sehr gefährlich war. Das würde ich nicht mehr machen.')

Regret was expressed by this participant when the action turned into a threat to the life. This can be explained by the regret theory that when an action had or might have had a negative outcome, we start thinking about the 'what if' – imagining what we could have done differently to achieve a more positive outcome (Zeelenberg et al., 2002). In the above quote, the participant recognised afterwards that going downstairs to a flooded basement can be very dangerous. Indeed, drowning in the basement was one of the major threats to lives of this flooding event (Thieken et al., 2022).

Similarly, driving or walking in flood water was assessed as a major cause of death during this event in 2021. In this regard, one participant who expected usual flooding but was surprised by extreme flooding reflected that driving should have been avoided to stay safe.

'Stay at home and stop trying to drive the car.'
(Original: 'Zuhause bleiben und nicht mehr versuchen mit dem Auto zu fahren.')

3.32 What don't we regret? No-regret actions

~~Despite the many regrets that are summarised above, a few participants clearly stated that they did not regret anything about their actions. Overall, participants mentioned that they undertook a variety of short-term emergency measures (Kreibich et al.,~~

355 2011; Martins et al., 2019) such as preparing the house and basement for potential water intrusion, moving valuable furniture,
documents, photos, and more upstairs, preparing emergency escape bag packs, storing food, and filling water canisters.
Interestingly, none of the participants mentioned that they regretted having taken any of these actions.
In addition, a ~~Despite the many regrets that are summarised above, a few participants~~ directly expressed ~~clearly stated that they~~
did not regret anything about their actions.

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~~As surprise and stress situations can cause reflexive behaviour, it is important to be psychologically prepared to stay calm~~
~~(APS, 2018).~~ For instance, o One participant living in a rental apartment mentioned that they were worried but managed to stay
calm ~~despite the fact that~~ even though they would have liked to evacuate if they had received warning.

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*‘We were somewhat worried but kept calm. Had we known beforehand
that it would be much worse than predicted, we would have left our home.’*

*(Original: ‘Wir waren schon etwas besorgt, aber haben Ruhe bewahrt. Hätten wir vorher gewusst, dass es viel schlimmer
wird als vorhergesagt, hätten wir unser Heim verlassen.’)*

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~~As surprise and stress situations can cause reflexive behaviour, it is important to be psychologically prepared to stay calm~~
~~(APS, 2018).~~

A Similarly, another participant who experienced extreme flooding on his/her property highlighted that acting very prudently
was not to be regretted.

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*‘Actually nothing, I proceeded very prudently, however,
prior information from the municipality would have been helpful.’*
*(Original: ‘Tatsächlich nichts, ich bin sehr besonnen vorgegangen, allerdings wäre
eine vorherige Information seitens der Gemeinde helfend gewesen.’)*

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~~This quote also reflects an earlier finding that people did not claim any regrets on the actions they took unless they (almost)
had negative outcomes. Reversing this finding, it can be assumed that all actions that were taken somehow improved the
overall outcome or at least did not have any negative effects. Furthermore, taking actions can avoid the regret about failing to
do something. It can be related to a statement from another study ‘at least doing something’ (Nalau et al., 2021) meaning that
doing something is better than doing nothing. The preparedness actions taken by participants were not regretted; thus, they can
be categorised as no regret actions which are better than inaction.~~

385

Moreover, n No regrets were expressed by participants who stated that they have done everything they could do within their
(perceived) abilities to act and self-organise (self-efficacy; Kievik and Gutteling, 2011).

'Tried to stop it, saved the most important things, then saved myself.'

(Original: 'Versucht es aufzuhalten, das Wichtigste gerettet, dann selbst gerettet.')

'Packed things, brought family, neighbours, and friends to safety.'

(Original: 'Sachen gepackt, Familie, Nachbarn und Freunde in Sicherheit gebracht.')

395 Helping others to prepare, evacuate, or similar was one major aspect-action which was not regretted by participants. Helping
others was also one action that was taken by many participants, in general. Interestingly, even if these actions may have caused
a threat to the person's own life, they were not regretted. ~~This helping behaviour and not regretting it may be explained by
different psychological backgrounds such as anticipating the guilt of not having helped someone in need, because it may bring
us pleasure to help others, or because we have a moral responsibility to help others (Erlandsson et al., 2016).~~

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'But I was also standing up to my chest in water to get people out. I would do that again.'

(Original: 'Aber ich stand auch bis zur Brust im Wasser um Leute da raus zu holen. Das würde ich wieder tun.')

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This helping behaviour and not regretting it may be explained by different psychological backgrounds such as anticipating the
guilt of not having helped someone in need, because it may bring us pleasure to help others, or because we have a moral
responsibility to help others (Erlandsson et al., 2016).

3.4 Turning regret into future preparedness?!

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Throughout participants' responses provide hints on how regret on (in)actions are paving the path for future preparedness. For
instance, some participants intend to not trust nor depend on local authorities and warnings due to the lack of received warnings.
This will have a negative impact on (collaborative) risk governance (Ommer, Blackburn, et al., 2024). However, from a
positive perspective, these participants now aim to be more proactive by taking measures in advance and being more attentive
to the nature and environment to detect changes to avoid surprises in the future.

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'Public warnings are not reliable.' – *'No trust in those in charge'* – *'Escape'* – *'Take all
measures in advance yourself to avoid being caught off guard.'*

(Original: 'Auf die öffentlichen Warnungen ist kein Verlass.' – *'Kein Vertrauen in die Verantwortlichen.'* – *'Flucht'* –
'Selbst im Vorfeld alle Maßnahmen treffen um nicht überraschend zu werden.')

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Similarly, one participant implied regrets about the person's own knowledge and threat appraisal. In this case, the person
perhaps did not have enough knowledge or information about what 200ml of rain would mean and hence, had to take decisions

under greater uncertainty (Marchau et al., 2019). However, now the person has a better knowledge on e.g., what 200ml rainfall might turn out to be; thus, the person would be able to take better decisions in the future.

'Now, one is aware of what 200L/sqm means. With similar amounts, I would have packed my suitcase long ago and would move to higher elevations for safety.'

(Original: 'Jetzt ist man sich bewusst was 200L/qm bedeutet. Bei ähnlichen Mengen hätte ich schon längst den Koffer gepackt und würde mich in Höhere Lagen in Sicherheit bringen.')

In addition, not taking warnings seriously and experiencing the flood triggered that a participant would take warnings more seriously and take different actions next time. This learning from floods is very common and acknowledged in research (Carone et al., 2019; Köhler et al., 2023; Kuang & Liao, 2020; Kuhlicke, Masson, et al., 2020).

~~Contrarily, some participants believed that they could not have done anything to prepare for an event like the one in July 2021, and that it is only possible to respond reactively.~~

~~*'That's the force of nature, one can only react.'*~~

~~*(Original: 'Das ist Naturgewalt, man kann nur reagieren.')*~~

~~In contrast to the above quote~~Moreover, intended behaviour changes ~~and taken measures~~ imply that the flooding experience evoked a more proactive mindset. Increasing risk awareness and learning from flooding is a common process building on the reflections of past events (Kuang and Liao, 2020; Kuhlicke et al., 2020). In this regard, one participant it was who had the responsibility to evacuate animals from the farm –mentioned that it is important to have a plan for actions to be taken in emergency cases which can be an easy step towards preparedness.

'Create an emergency plan and then execute it.'

(Original: 'Einen Emergency Plan erstellen und dann durchführen.')

Having an emergency plan and drills are considered stronger preparedness actions and, simultaneously, present proactive actions that can be implemented any time even without an imminent hazard (Katsikopoulos, 2021; Marchau et al., 2019).

~~However, Contrarily, some participants believed that they could not have done anything to prepare for an event like the one in July 2021, and that it is only possible to respond reactively.~~

~~*'That's the force of nature, one can only react.'*~~

~~*(Original: 'Das ist Naturgewalt, man kann nur reagieren.')*~~

4 Discussion 4 Conclusion

This study explored the flooding event in Germany in 2021 from the perspective of regret to gain a deeper understanding on citizens (no) regrets on disaster preparedness actions to derive lessons learnt towards long term preparedness actions. In this study we analysed what was regretted (or not) and identified reasons that led to the regret. The aim of this study was to firstly, gain a better overview on post-disaster (no) regrets of citizens and how these insights can support shaping a no-regrets approach to individual disaster preparedness. Hence, the following will discuss firstly, the regrets and no-regrets that were expressed; secondly, the effect of these regrets on future disaster preparedness; and lastly, how this gained knowledge can shape the no-regrets approach. The results of this study suggest the following implications for disaster preparedness.

4.1 Post-disaster regrets

Firstly, short term emergency measures are valuable but long term preparedness is more important. Participants used various emergency measures to prepare their home in a hurry- and they did not claim any regrets on the actions they took unless they life-threatening outcomes. Reversing this finding, it can be assumed that all actions that were taken somehow improved the overall outcome or at least did not have any negative effects. In the sense of ‘at least doing something’ (Nalau et al., 2021), taking actions was not regretted as people perceived that they did (everything) what they could. In contrast, citizens regretted their inaction because they sort of failed to do things they could have done, but there was not enough time due to the lack of time. Hence, considering the debate in research about whether actions or inactions are more regretful (Feldman and Chen, 2019), it can be concluded that in this real-life experience, inactions were regretted more as participants perhaps wanted to take actions but could not because there was not enough time or due to other reasons.

Overall, the results highlighted the need to take the following actions in advance – basically from today onwards: developing an emergency plan including evacuation scenarios, learning to understand the environment better to be able to spot changes or to know what forecasted values will be like like in reality. These actions can be categorised as long-term actions which can be taken well in advance. As we have seen that it was not regretted when people perceived that they acted prudently or calm which is often not the case in sudden stress situations. In general, in disaster situations, it is important to take well-informed decisions which involves considering the potential outcomes of a decision (Sunderrajan and Albarracín, 2021; UNDRR, 2022). Therefore, short-term emergency measures are valuable and non-regretted but long-term preparedness is even more important. These actions were referred to as weak actions (Katsikopoulos, 2021), but not useless as none of the participants regretted having taken those. However, more awareness needs to be raised on the fact that taking these measures in the very last minute such as preparing the basement when flood water is already intruding, can pose a threat to life and therefore, could become regrettable. In the sense of ‘at least doing something’ (Nalau et al., 2021), taking actions was not regretted as people perceived that they did (everything) what they could. In contrast, citizens regretted their inaction because they sort of failed to do things they could have done, but there was not enough time. Overall, the results highlighted the need to take the following actions in

advance—basically from today onwards: developing an emergency plan including evacuation scenarios, learning to understand the environment better to be able to spot changes or to know what forecasted values will be like in reality.

4.2 Self-responsibility and trust for future preparedness

This survey responses indicated how the regret has initiated that participants are willing to take more responsibilities which is a typical effect of regret (Zeelenberg et al., 2002). Taking more responsibilities was expressed in the context of acquiring knowledge on hazards, taking warnings more seriously, being more proactive in preparedness including short-term actions but foremost, long-term actions such as emergency drills or plans. This shift towards proactive disaster behaviour is widely acknowledged in disaster literature (Kuang and Liao, 2020) but has not been directly linked to regret yet.

Another factor for the increasing self-responsibility of the participants is related to the decrease in trust in authorities primarily due to the late or lack of warnings. Trust is an important pillar for the relations between citizens and authorities which is especially needed in emergency situations (Earle, 2010). However, trust is very dynamic and fragile (Seebauer and Babicky, 2018); thus, it is often observed that after a devastating event, the trust in authorities diminishes if expectations are not reached (Seebauer and Babicky, 2018; Whitmarsh, 2008). This case could be observed within the survey responses which on the one hand, reduces the dependency of citizens on public authorities but on the other hand, can have an immense impact on future risk and disaster governance. Hence, it is important to move towards joint responsibilities and collective governance (Ommer, Blackburn et al., 2024).

~~Secondly, actions need to create a feeling of awareness, responsibility, and independence. Citizens were greatly dependent on authorities in this flooding event (Ommer et al., 2024). This dependency and their trust in authorities to manage the flooding caused great regrets when the expectations were not met, and this created a difficult situation for the participants. This is a common issue also in other countries i.e., in the UK (Cologna et al., 2017; Thorne, 2014). To anticipate these impasses citizens were in, and to avoid increasing distrust in authorities, actions should support the creation of awareness on risks, build environmental knowledge, and loosen dependencies of citizens while increasing their feeling of responsibility.~~

4.3 Implications for a no-regrets approach for individual disaster preparedness

The second aim of this research was to understand how these insights from citizens' regrets support the development of practical strategies for future (no-regrets) disaster preparedness. The following will discuss the main implications for designing a no-regrets approach for individual disaster preparedness.

Short-term preparedness actions (e.g., preparing the house, moving important documents, photos, etc. upstairs, storing food) taken by participants were not regretted; thus, they can be categorised as no-regret actions (also because they are easy-to-implement and of low cost). Furthermore, as inaction was largely regretted, these short-term actions were perceived as better than doing nothing. In literature, short-term actions were referred to as weak actions (Katsikopoulos, 2021), but they are not

useless as none of the participants regretted having taken those. However, more awareness needs to be raised on the fact that taking these measures in the very last-minute such as preparing the basement when flood water is already intruding, can pose a threat to life and therefore, can become regrettable.

However, as we have seen, participants rather suggested to move towards long-term preparedness actions for future preparedness including developing emergency plans or conducting drills, gaining knowledge, and being more attentive to the environment. In this sense, it can be argued that these actions are stronger actions as claimed by Katsikopoulos (2021). Nonetheless, whether weak or strong actions, all the actions listed by participants can be categorised as no-regret actions for individual disaster preparedness.

Other important (long-term) no-regrets actions need to focus on. ~~Thirdly, long-term preparedness needs to integrate actions that increase~~ the psychological preparedness of citizens. As surprise and stress situations can cause reflexive behaviour, it is important to be psychologically prepared to stay calm (APS, 2018).

In addition, ~~Lastly,~~ many actions that were taken in advance of the flooding were focusing on helping others in various situations and people did not regret this even if their own life was at risk. This finding acknowledges the importance of supporting family, friends, neighbours, and even unfamiliar people. In response to this finding, individual long-term preparedness could be enhanced by focusing on collective action.

Furthermore, actions need to create a feeling of awareness, responsibility, and independence. Citizens were greatly dependent on authorities in this flooding event (Ommer et al., 2024). This dependency and their trust in authorities to manage the flooding caused great regrets when the expectations were not met, and this created a difficult situation for the participants. This is a common issue also in other countries i.e., in the UK (Cologna et al., 2017; Thorne, 2014). To anticipate these impasses citizens were in, and to avoid increasing distrust in authorities, actions should support the creation of awareness on risks, build environmental knowledge, and loosen dependencies of citizens while increasing their feeling of responsibility.

Overall, actions need to be within the capabilities of citizens as the results showed that citizens have taken actions that were within their abilities and in some cases had to give up. Therefore, it can be argued that the no-regrets approach can be influential as these actions shall be within the abilities (psychologically, physically, and financially) of citizens but further should have co-benefits even under great uncertainty (Heltberg, Siegel, et al., 2009).

Summarising the findings, it was highlighted that citizens need to be motivated to take long-term preparedness actions in order to cope with future (unexpected) hazards and their impacts. The findings of this study suggest that the no-regrets approach could be a suitable framework combining short-term (emergency) preparedness and, foremost, long-term preparedness due to the robustness of actions in different scenarios, the no regret factor in case no hazard may be happening, and its motivational elements. However, in addition to the introduced characteristics and to ensure actions are taken and not regretted, the findings of this study showed that no-regrets actions must be easy-to-implement; thus, citizens are able to take them and support the idea of collective action as a motivational and enhancing factor for individual preparedness and self-responsibility, respectively.

Overall, this study has highlighted that regret and the experience of a flood can increase future preparedness which is responding to a large amount of findings from other studies. Yet, the question is whether we really need to experience and regret flooding first before starting to consider long-term preparedness? One major barrier for individual disaster preparedness is low risk perception (Kuhlicke, Seebauer et al., 2020; Bubeck et al., 2012) further including limited imagination of potential disasters (Ommer, Neumann et al., 2024). Hence, citizens without prior disaster experiences (and regret) may lack the motivation to prepare themselves for potential hazards especially in a long-term perspective.

A few participants showed that staying calm in this kind of stress situation where the water is imminent, it is very important to take decisions and not just act reflexive or in panic (APS, 2018).

Fourthly, actions need to be within the capabilities of citizens. The results showed that citizens have taken actions that were within their abilities and in some cases had to give up. Therefore, actions need to be easy to implement.

Lastly, many actions that were taken in advance of the flooding were focusing on helping others in various situations and people did not regret this even if their own life was at risk. This finding acknowledges the importance of supporting family, friends, neighbours, and even unfamiliar people. In response to this finding, individual long term preparedness could be enhanced by focusing on collective action.

Secondly, actions need to create a feeling of awareness, responsibility, and independence. Citizens were greatly dependent on authorities in this flooding event (Ommer et al., 2024). This dependency and their trust in authorities to manage the flooding caused great regrets when the expectations were not met, and this created a difficult situation for the participants. This is a common issue also in other countries i.e., in the UK (Cologna et al., 2017; Thorne, 2014). To anticipate these impasses citizens were in, and to avoid increasing distrust in authorities, actions should support the creation of awareness on risks, build environmental knowledge, and loosen dependencies of citizens while increasing their feeling of responsibility.

5 Conclusion

This study explored the flooding event in Germany in 2021 from the perspective of post-disaster regret to gain a deeper understanding on citizens (no) regrets on disaster preparedness actions to derive lessons learnt towards long-term preparedness actions for the application of the no-regrets approach for individual disaster preparedness. In this study we analysed what was regretted (or not) and identified reasons that led to the regret.

Summarising the above findings, it was highlighted that citizens need to be motivated to take long-term preparedness actions in order to cope with future (unexpected) hazards and their impacts. The findings of this study suggest that the no regrets approach could be a suitable framework combining emergency preparedness and, foremost, long-term preparedness due to the robustness of actions in different scenarios, the no regret factor in case no hazard may be happening, and its motivational elements. However, in addition to the introduced characteristics and to ensure actions are taken and not regretted, the findings

of this study showed that no-regrets actions must be easy to implement; thus, citizens are able to take them and support the idea of collective action as a motivational and enhancing factor for individual preparedness and self-responsibility, respectively. Overall, this study has highlighted that regret and the experience of a flood can increase future preparedness which is responding to a large amount of findings from other studies. Yet, the question is whether we really need to experience and regret flooding first before starting to consider long-term preparedness? The no-regrets approach can pave the way towards long-term preparedness of citizens, but more research is needed on how to facilitate citizens walking this way.

The findings of a survey with citizens affected by the flooding event showed that regret can be primarily associated with inaction (instead of actions) which is contrasting psychological studies from other fields than disaster science. Furthermore, the responses showed that affected citizens learnt from their experiences (and regret) and rather pursue long-term preparedness for the future but noting that short-term preparedness is not regrettable and hence, not neglectable. However, the importance of long-term preparedness including emergency plans/drills, acquiring hazard information, attentiveness to nature, and especially, psychological preparedness, are highly valuable to stay calm and act prudently in (sudden) stress situations. The insights into non-regretted actions can help to shape a no-regret approach for individual disaster preparedness which is lacking by date. Hence, building on this study, the no-regrets approach can pave the way towards long-term preparedness of citizens, but more research is needed on how to facilitate citizens walking this way.

Data availability

The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research, the survey data is not available.

Author contributions

Joy Ommer (conceptualisation, investigation, visualisation, writing, review & editing); Milan Kalas (conceptualisation, supervision, review & editing); Jess Neumann (conceptualisation, supervision, review & editing); Sophie Blackburn (conceptualisation, supervision); Hannah L. Cloke (conceptualisation, supervision, review & editing).

Competing interests

The authors declare that they have no conflict of interest.

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