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ORIGINAL ARTICLE

What helps people recover from floods? Insights from a survey among flood-affected residents in Germany

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Abstract The number of people exposed to natural hazards has grown steadily over recent decades, mainly due to increasing exposure in hazard-prone areas. In the future, climate change could further enhance this trend. Still, empirical and comprehensive insights into individual recovery from natural hazards are largely lacking, hampering efforts to increase societal resilience. Drawing from a sample of 710 residents affected by flooding across Germany in June 2013, we empirically explore a wide range of variables possibly influencing self-reported recovery, including flood-event characteristics, the circumstances of the recovery process, socio-economic characteristics, and psychological factors, using multivariate statistics. We found that the amount of damage and other flood-event characteristics such as inundation depth are less important than socio-economic characteristics (e.g., sex or health status) and psychological factors (e.g., risk aversion and emotions). Our results indicate that uniform recovery efforts focusing on areas that were the most affected in terms of physical damage are insufficient to account for the heterogeneity in individual recovery results. To increase societal resilience, aid and recovery efforts should better address the long-term psychological effects of floods.

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Introduction

Natural hazards affect millions of people each year (Fig. 1). On average, 147 million people were impacted annually by the climate-related hazards of floods, droughts, and storms globally between 1970 and 2013 according to the EM-DAT database (Guha-Sapir et al. 2015). As shown in Fig. 1, the natural hazard repeatedly affecting the largest number of people is flooding, which is therefore the focus of the present paper. Past increases in the number of affected people have mainly been attributed to the growing exposure of people and their assets in flood-prone areas (UNISDR 2011; Jongman et al. 2012). In the future, climate change and its projected effects on the frequency and intensity of some climate-related hazards in several regions could provide further impetus towards this trend (Hallegatte et al. 2013; IPCC 2014).

Floods and other natural hazards have far-reaching adverse impacts for those affected. According to the latest assessment report of the United Nations Office for Disaster Risk Reduction (UNISDR 2015), more than an estimated 1.3 billion "human life years," representing an aggregate measure of disaster impact, were lost globally due to internationally reported disasters between 1980 and 2012. The concept of human life years describes the time required to produce economic development and social progress, which can be lost due to natural disasters (UNISDR 2015).

Despite the large and potentially growing number of people affected by climate-related hazards, very few studies exist that empirically explore a comprehensive set of factors possibly related to self-reported recovery from such events. This is striking, because after disaster prevention, a speedy and full

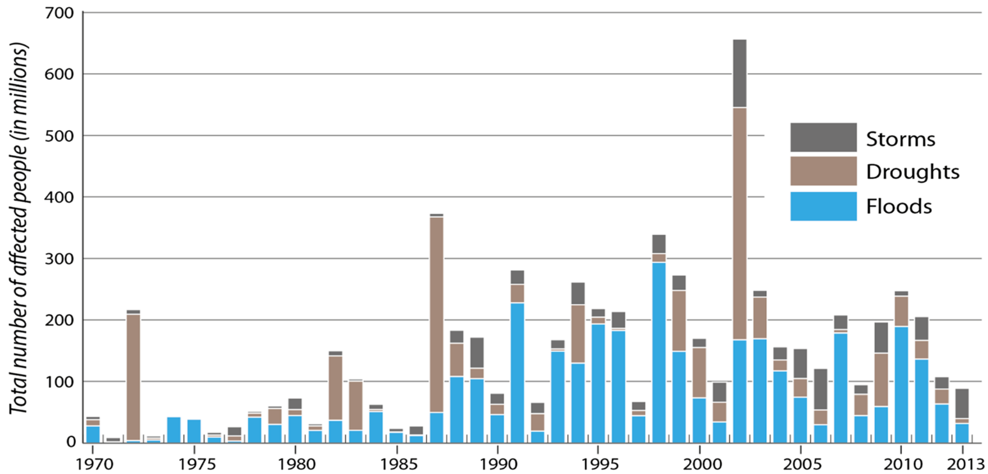

Fig. 1 Total number of people affected by floods, droughts, and storms worldwide between 1970 and 2013. *Source*: EM-DAT (Guha-Sapir et al. 2015); data retrieved on 4 September 2015

recovery is the ultimate goal of all disaster risk management efforts. Also, by far the largest share of disaster-related aid is spent on emergency response, reconstruction, and rehabilitation (Kellet and Caravani 2013). The limited set of peer-reviewed studies available in the natural hazard domain focus on the physical reconstruction or replacement of damaged buildings, infrastructures, and contents (Kates et al. 2006; Thieken et al. 2007; Kienzler et al. 2015), or economic recovery (e.g., Klomp 2016). A larger body of literature exists that examines factors related to mental health effects following a disaster (e.g., post-traumatic stress disorders, anxiety, or depression), thus focusing on one type of disaster impact (see Bonanno et al. 2010 for a comprehensive review). These studies mainly focus on earthquakes (e.g., Carr et al. 1997), terrorist attacks (e.g., Hoven et al. 2005), hurricanes (e.g., Ruggiero et al. 2009), or war experiences (e.g., Ahern et al. 2004). A few studies also address the (long-term) health effects of floods (e.g., Norris and Murrel 1988; Norris et al. 2002; Lowe et al. 2013; Lamond et al. 2015), but not self-reported recovery. In this paper, self-reported recovery captures to what extent residents still feel affected by a flood event they experienced 18 months ago. It thus indicates to which degree the respondents have returned to their original (preflood) state.

A study similar to the one presented here is Burton (2014), which examines a comprehensive set of resilience indicators for an assessment of the recovery of the built environment in three communities hit by Hurricane Katrina in 2005. However, the recovery and resilience indicators in this and other studies are applied at an aggregated level of local communities and not at the level of individuals (see also Sherrieb et al. 2010).

As a result, it is currently largely unclear to what extent self-reported recovery from natural hazards is dependent on flood-event characteristics, the circumstances of the recovery process itself (e.g., social assistance), socio-economic characteristics (e.g., income, sex, education), or psychological factors (e.g., risk aversion, risk perceptions, emotions). To the best of the authors' knowledge, this is the first study that empirically explores a comprehensive set of variables possibly influencing self-reported recovery of individuals affected by a flood. The aim of this study was to identify variables related to individual flood recovery and to assess the relative importance of the following four categories: event characteristics, circumstances of the recovery process, socio-economic characteristics, and psychological factors. Our insights into individual recovery from floods can be used to better plan, design, and implement measures and policies intended to support and enhance the long-term recovery of disaster-stricken areas, such as identifying places or social groups in particular need of specific types of support. Better insights are of great interest also because recovery (or "the ability to bounce back") is a key component of resilience, which is increasingly becoming an influential concept in the management of natural hazards and adaptation to climate change (USACE 2015; Weichselgartner and Kelman 2015). In the context of natural hazards, the concept of resilience usually comprises three aspects: resistance, recovery, and adaptive capacity (see e.g., Thieken et al. 2014).

The remainder of the article is organized as follows. "The 2013 flood event in Germany" section provides a brief summary of the flood event that affected large parts of Germany in 2013. The "Sample characteristics and methods" section presents the survey of flood-affected residents, sample characteristics, and the statistical analyses performed. Results are presented and discussed in the "Results and discussion" section. The "Conclusions" section concludes and discusses the implications of the findings for efforts to increase societal resilience.

The 2013 flood event in Germany

In June 2013, central Europe and especially Germany was affected by a severe flood event both in terms of its magnitude and its spatial extent, setting a new record for large-scale floods in Germany for the more recent past (Schröter et al. 2015). Exceptionally high amounts of rainfall during the second half of May had led to high antecedent soil moisture values. According to Germany's National Meteorological Service (DWD), new soil-moisture records were observed for 40% of the German territory (DWD 2013). Heavy, but not exceptionally high amounts of rainfall over the Elbe and Danube catchments between 31 May and 4 June 2013—on top of the already highly saturated soils—then triggered the flood event itself (Schröter et al. 2015; Merz et al. 2014). While all major catchments in Germany experienced flooding during this event, water levels were especially high in the Elbe and Danube catchments and several of their tributaries (Blöschl et al. 2013; Merz et al. 2014). At many gauges along the Danube and Elbe, new record discharge levels since the beginning of measurement were observed (Merz et al. 2014). In many areas especially along the Elbe, flood return periods exceeded 100 years, resulting in the failure of flood defense infrastructure and, consequently, widespread flooding. An overview of major German water bodies, flood-affected federal states, and the districts from which the surveyed respondents originate is provided in Fig. 2.

The flood event of 2013 had a severe impact in Germany, even though losses were lower compared to the other recent extreme flood in 2002, which is still the most expensive natural hazard event in Germany (Schröter et al. 2015). Overall, financial losses of € 6 to 8 billion occurred across 12 out of 16 German federal states (Thieken et al. 2016). Fourteen people lost their lives and 128 people were injured. Moreover, more than 80,000 residents in eight federal states had to be evacuated. The large-scale nature of the event is also exemplified by the fact that about 600,000 people were affected by the flood in 1800 municipalities (Thieken et al. 2016). Among other things, the flood event in 2013 also had a severe impact on the traffic network. Overall, 700 km of roads and 150 bridges were damaged, impeding road traffic in many federal states (Thieken et al. 2016). The German Railways Corporation was also severely affected and had to close up to 60 routes during the event. Flooding and destruction of railway infrastructure in the municipality of Stendal in Saxony-Anhalt disrupted the important high-speed connection between Berlin and Hannover for almost 5 months, affecting train services between the capital and important cities such as Cologne and Frankfurt (Deutsche Bahn 2013, 2014; Thieken et al. 2016).

Sample characteristics and methods

To gain insights into individual recovery from floods, computer-aided telephone interviews (CATIs) among 710 households directly affected by the flood event of 2013 were carried out twice, i.e., 9 and 18 months after the flood event in June 2013. The first survey primarily focused on the flood damage and event characteristics, while the second focused on the recovery process and flood impacts over the longer term, such as psychological factors. For the sampling, lists of affected streets were compiled, landline numbers were researched, and households were called. Only households that suffered property damage were included in the survey. In each household, the person with the best knowledge about the flood impact was questioned.

The main questionnaire implemented 18 months after the event comprised about 90 questions covering aspects such as risk perceptions, the recovery process, well-being, attitudes towards flood risk management, and socio-economic characteristics. The majority of questions were extensively tested and applied in previous surveys and are described in greater detail in Kienzler et al. (2015). The wording of a number of questions pertaining to emotional aspects and psychological factors were adopted from the German Socio-Economic Panel (SOEP), which is a well-established longitudinal study of private households in Germany, carried out by the German Institute for Economic Research, DIW Berlin.[1] A table providing information on all variables used in the analysis and their operationalization is provided in the Supplementary material in Table S1. Both data sets can be linked by a unique identifier for each household. The response rate of the target group was 74%. The mean duration of the interviews during the main survey was 30.5 min.

The majority of the respondents originated from the two federal states of Saxony-Anhalt (39%) and Saxony (29%) that were hit hardest by the flood event (DKKV 2015; see Fig. 2), followed by Bavaria (16%) and Thuringia (11%). The remaining 5% of the respondents resided in the federal states of Lower Saxony, Baden-Wurttemberg, Brandenburg, and Schleswig-Holstein (Fig. 2). At 83%, the majority of the respondents were property owners, with an average age of 61.5 years. The higher average age of the respondents compared to the average German population (44.2) stems from the fact that children were excluded from the survey and that only landlines were included. The higher average age and the fact that only landlines were included in the survey also resulted in a bias in terms of property owners (45.5% for Germany). With 59.9%, the sample is slightly biased towards women (compared with 51% in Germany), but appears to be representative as far as income is concerned.

To account for the ordinal scale of the dependent variable, ordered probit regression models were carried out to explore a wide range of variables possibly influencing self-reported recovery of flood-affected individuals using the IBM SPSS statistics software (version 22). In total, 37 predictors were grouped into four categories, namely, event characteristics (Table 1), circumstances of the recovery process (Table 2),

[1] http://www.diw.de/en/soep

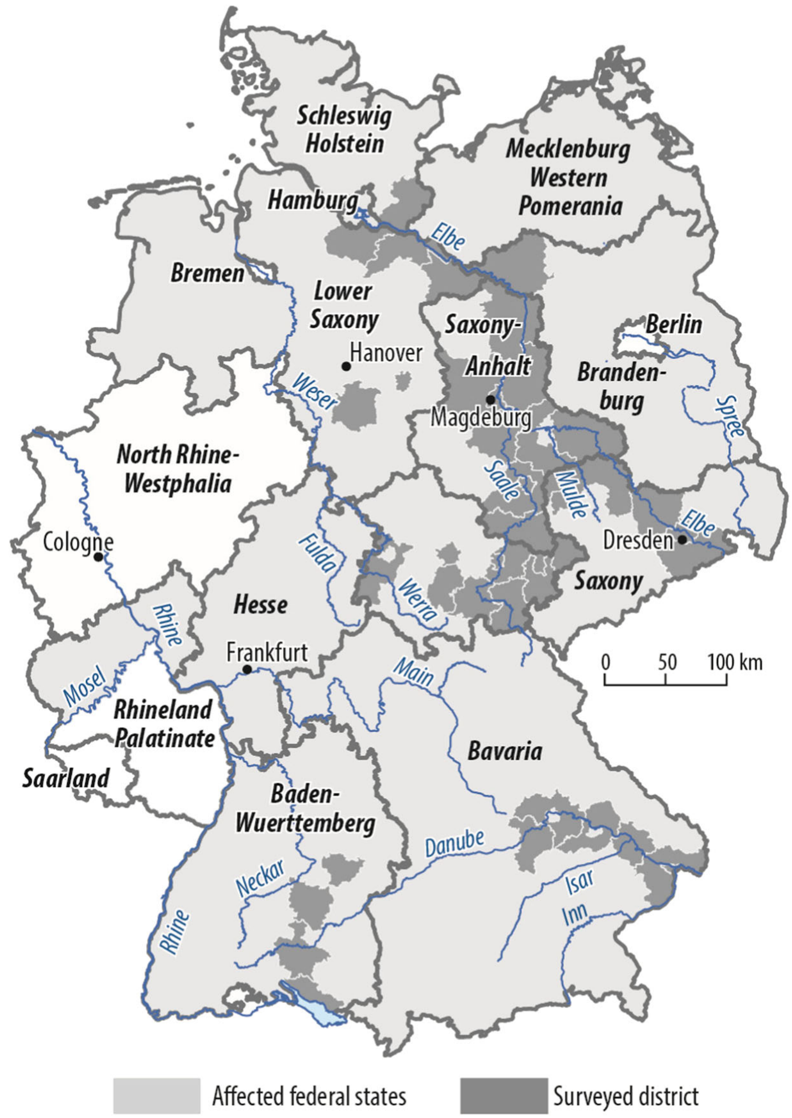

Fig. 2 Major German water bodies, federal states that were affected by the flood of 2013, and the districts where the surveyed respondents originate from

socio-economic characteristics (Table 3), and psychological factors (Table 4). To gain insight into significant variables and the explanatory power of these four categories, four separate regression models were constructed to predict self-reported recovery. The respondents' estimate of their overall recovery status 18 months after the flood event was entered as a dependent variable in all four models. The overall recovery status of the respondents was elicited using the following question: "To what extent does the flood event of May/June 2013 still affect you today?" Answer categories ranged from "It doesn't affect me at all anymore" to "It still affects me a lot," using a six-point answering scale. Differences in the number of observations between the models are due to missing answers.

Finally, a complete model was constructed comprising all the variables that were found to be significant at the 5% level in one of the four models presented above (Table 5). After all significant variables were first entered, non-significant variables were removed backwards until only significant variables remained in the complete model. The variable with the lowest *p* value was always removed. As income turned out to be non-significant, it was removed entirely from the model as it constrains the model in terms of sample size due to the usual missing cases for this variable.

Possible problems associated with heteroscedasticity were visually checked using *p-p* plots and partial plots of the residuals of the outcome variable and each of the predictors. The checks of the partial plots indicated possible problems associated with heteroscedasticity for some variables. Therefore, robust regressions were performed by applying bootstrapping to overcome this problem. For each of the five models, the significance values, standard errors, and 95% bias-corrected and accelerated confidence intervals were derived from 2000 bootstrap samples.

Results and discussion

In terms of physical recovery, the survey revealed that a considerable share of respondents had (almost) fully repaired the damage to their building structures (52%) and (almost) fully replaced damaged or destroyed household contents (62%) 18 months after the event. In contrast, 13.5 and 6.2%, respectively, answered that building structures or contents still show considerable deficits. One percent of the surveyed individuals reported that their house had to be demolished in the aftermath of the flood event, while 11.3 and 17.9% reported no damage to contents or building structure. In terms of self-reported recovery, which was used as a dependent variable in the regression models below (see Tables 1, 2, 3, 4, and 5), 27.9% of the respondents indicated that the flood event no longer had any effect, while 14.5% still chose the highest response category, indicating that the flood event still strongly affected them.

Flood damage and event characteristics

Flood-event characteristics determine the impact and thus the level (or shock) from which the recovery process starts. The literature on mental health outcomes of disasters (not restricted to natural hazards) suggests that greater exposure to a disaster is generally associated with poorer psychological adjustment (Bonanno et al. 2010; Elliott and Pais 2006). Known flood impact and resistance parameters (Thieken et al. 2005), such as inundation depth, flow velocity, damage suffered, and the level of precautionary measures undertaken by households, were entered in an initial model predicting self-reported recovery (see Table 1). The results show that, from the flood impact parameters, only higher flow velocities related negatively to recovery. Inundation depth, flood duration, and contamination of flood waters made no significant contribution to the model but might be (partially) reflected in the amount of damage that respondents suffered. The assumption that the severity of the shock has a negative influence on self-reported recovery is further confirmed by the fact that individuals who suffered more severe financial flood damage to contents and building structures indicated a lower recovery status. This finding is in line with the literature on differential mental health outcomes of disasters, showing that property losses were associated with greater post-disaster stress (Elliott and Pais 2006). No statistically significant effect on recovery was found for respondents who implemented precautionary measures such as mobile flood walls or adapted building use (Bubeck et al. 2012b; Kreibich et al. 2015). This finding differs from Lamond et al. (2015), who suggest that supporting households in implementing precautionary measures may improve mental health outcomes due to the perceived sense of control or to the actual damage-reducing effect of these measures.

Table 1 Ordered probit model of event characteristics predicting self-reported recovery ($n = 432$)

Explanatory variable	Estimate	SE	BCa 95% confidence interval	
			Lower	Upper
Inundation depth	−0.034	0.035	−0.102	0.033
Flood duration (ln)	−0.080	0.048	−0.173	0.014
Flow velocity	−0.070*	0.029	−0.127	−0.013
Emergency measures	−0.225	0.227	−0.671	0.220
Contamination	−0.054	0.110	−0.269	0.162
Evacuation	−0.036	0.103	−0.255	0.184
Precaution	0.034	0.020	−0.005	0.073
Flood damage (ln)	−0.115***	0.030	−0.174	−0.055

Confidence intervals, standard errors, and p values based on 2000 bootstrap samples. Nagelkerke $R^2 = 0.087$

*$p < 0.05$, ***$p < 0.001$

Circumstances of the recovery process

Following the initial shock, circumstances of the recovery process such as the time needed to repair and replace damaged assets, or the availability of social assistance from the government or relief organizations, can influence an individual's recovery status, as suggested by the literature on mental health outcomes of aversive life events and disasters (Bonanno et al. 2010; Brewin et al. 2000; Kaniasty and Norris 2009). Table 2 indeed shows that the longer it takes to repair buildings or replace home contents, the lower the reported recovery status is. Moreover, respondents who expressed their dissatisfaction with the process of loss compensation (payouts) provided by insurers and public authorities in the aftermath of the event (DKKV 2015) also report a lower recovery state. No positive effect was found for demands for assistance from public or relief organizations supporting flood victims.

Socio-economic characteristics of the respondents

Furthermore, individual recovery could differ according to respondents' socio-economic attributes, such as sex, age, income, or insurance cover, which were evaluated in a third model (Table 3). Studies on social vulnerability to flooding assume that socially vulnerable groups have a lower capacity to prepare for and cope with flooding events (e.g., Cutter and Finch 2008). The results show that especially women report a considerably lower recovery status than men. Often, women are in reality still the ones who take care of domestic duties, as indicated by a substantially higher rate of part-time employment of women in Germany (Bundesagentur für Arbeit 2016); while men go back to their (mainly) full-time positions, women are thus more directly exposed to the medium- and long-

Table 2 Ordered probit model of aspects of the recovery process predicting self-reported recovery ($n = 559$)

Explanatory variable	Estimate	SE	BCa 95% confidence interval	
			Lower	Upper
Status of the building	−0.085**	0.029	−0.142	−0.028
Status of contents	−0.112**	0.035	−0.181	−0.044
Duration compensation	−0.041	0.028	−0.096	0.014
Unsatisfied with compensation	−0.109**	0.038	−0.183	−0.034
Social assistance	0.159	0.098	−0.032	0.351

Confidence intervals, standard errors, and p values based on 2000 bootstrap samples. Nagelkerke $R^2 = 0.131$
**$p < 0.01$

term effects of the flood event on a daily basis. The lower recovery status of women could (in part) also be caused by a social desirability bias in self-reported data, which is the tendency of individuals to respond in line with societal norms and beliefs (Hebert et al. 1997). Since recovering reflects strength and an ability to take care of one's own problems—typical masculine stereotypes—men might overrate their recovery (Sigmon et al. 2005).

Besides, poor health status, disability, and the number of people living in a household also relate negatively to recovery. A better recovery status is found for tenants compared to homeowners, with the latter having a greater financial liability. Moreover, tenants are more flexible in their ability to move away if they need or want to, while owners are bound to their properties and might even face problems selling a flood-affected home (Daniel et al. 2009). While a higher educational level in general was found to have no effect on recovery, specific knowledge of how to protect the house prior to the flood relates positively to self-reported recovery. A positive relation is furthermore found for income; wealthier people indicated a higher score in terms of self-reported recovery, ceteris paribus. Similar findings are reported by Lamond et al. (2015) and Norris et al. (2002), as far as the mental health status of flood victims is concerned. Significant differences in recovery status were also found between federal states. Compared with Saxony, people in Bavaria and Thuringia recovered better, while no difference was observed for Saxony-Anhalt. This could possibly result from differences in compensation policies which were administered by the federal states in the aftermath of the event (DKKV 2015), or it could be an indicator of the flood severity, as Saxony and Saxony-Anhalt were hit the hardest (Thieken et al. 2016).

No positive effect on recovery was found for insurance coverage. People who had bought an insurance policy against flood damage before the event and were thus entitled to financial compensation did not report a better

Table 3 Ordered probit model of socio-economic parameters predicting self-reported recovery ($n = 392$)

Explanatory variable	Estimate	SE	BCa 95% confidence interval	
			Lower	Upper
Gender	0.491***	0.116	0.264	0.718
Age	0.001	0.005	−0.008	0.010
Education	−0.027	0.036	−0.098	0.044
Insurance coverage	−0.111	0.122	−0.349	0.128
Health status	−0.191**	0.064	−0.316	−0.066
Number of household members	−0.122*	0.049	−0.218	−0.025
Ownership	−0.459**	0.145	−0.742	−0.175
Disability	−0.608***	0.171	−0.272	−0.943
Specific protection knowledge	0.078*	0.031	0.017	0.139
Income	0.129**	0.049	0.033	0.225
Bavaria vs. Saxony-Anhalt	−0.375*	0.178	−0.724	−0.026
Thuringia vs. Saxony-Anhalt	−0.381*	0.185	−0.744	−0.018
Saxony vs. Saxony-Anhalt	0.096	0.135	−0.169	0.360
Other federal states vs. Saxony-Anhalt	−0.543	0.283	−1.098	0.013

Confidence intervals, standard errors, and p values based on 2000 bootstrap samples. $R^2 = 0.208$
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 4 Ordered probit model of personal traits, perceptions, and emotions predicting individual recovery (n = 581)

Explanatory variable	Estimate	SE	BCa 95% confidence interval	
			Lower	Upper
Perceived protection level	−0.187***	0.033	−0.251	−0.123
Mental preoccupation	−0.285***	0.028	−0.340	−0.231
Efficient personality	0.055	0.047	−0.038	0.147
Low stress resistance	−0.096**	0.035	−0.164	−0.027
Feeling angry	−0.018	0.046	−0.107	0.072
Feeling anxious	−0.046	0.052	−0.147	0.056
No trust in others	0.153*	0.060	0.036	0.271
Low future consequences	0.121***	0.032	0.057	0.184
Wishful thinking	−0.031	0.027	−0.084	0.022
Avoidance	0.000	0.030	−0.059	0.060
Positive about future	−0.031	0.068	−0.164	0.102
Concern about climate change	−0.008	0.069	−0.144	0.127
Low risk aversion	0.102*	0.044	0.016	0.188

Confidence intervals, standard errors, and p values based on 2000 bootstrap samples. R^2 = 0.351

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

recovery status. This may result from the fact that substantial financial compensation of € 8 billion was also provided by public authorities in the aftermath of the event. Flood-affected households could claim 80% of their damages from the relief fund (Thieken et al. 2016).

Psychological factors

Finally, psychological factors can also have an influence on the way people respond to and recover from shocks such as a flood event (Bonanno et al. 2010; Norris et al. 2002). For instance, the perceived risk of being flooded again could lead to additional emotional stress hampering the recovery process. Also, well-known psychological responses for coping with emotional stress due to perceptions of high risk are the so-called non-protective responses, such as wishful thinking or avoidance (Festinger 1957; Bubeck et al. 2013, 2012a). Therefore, a wide range of variables capturing psychological factors, emotions, and perceptions were entered in a fourth model (see Table 4). The variable that had a particularly strong influence on self-reported recovery captured how often respondents still think about the flood event (=mental

Table 5 Complete ordered probit model explaining self-reported recovery (n = 546)

Explanatory variable	Estimate	SE	BCa 95% confidence interval	
			Lower	Upper
Flow velocity	−0.072**	0.027	−0.125	−0.020
Gender	0.308**	0.099	0.114	0.503
Disability	−0.273	0.152	−0.570	0.024
Perceived protection level	−0.198***	0.034	−0.265	−0.131
Mental preoccupation	−0.309***	0.029	−0.366	−0.251
Low stress resistance	−0.083*	0.033	−0.147	−0.018
No trust in others	0.189**	0.061	0.069	0.309
Low future consequences	0.096**	0.033	0.031	0.161
Low risk aversion	0.101*	0.046	0.011	0.190
Bavaria vs. Saxony-Anhalt	−0.208	0.146	−0.493	0.078
Thuringia vs. Saxony-Anhalt	−0.427*	0.156	−0.732	−0.122
Saxony vs. Saxony-Anhalt	0.111	0.116	−0.117	0.339
Rest Bula vs. Saxony-Anhalt	−0.201	0.239	−0.669	0.268

Confidence intervals, standard errors, and p values based on 2000 bootstrap samples. Nagelkerke R^2 = 0.413

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

preoccupation). This shows that especially respondents who are still emotionally affected by the event report a significantly lower recovery status than others, ceteris paribus. Consistent with the results on gender differences reported in Table 3, an analysis of interaction effects shows that women in particular are still emotionally affected (Supplementary Table S2). Moreover, those who considered flood protection standards to be low in their region and expected adverse consequences of future flood events reported a lower recovery status. This was also the case for risk-averse persons who emphasized the importance of personal safety and those who reported lower ratings of trust in others. In contrast, respondents who considered themselves able to handle stress well indeed indicated a higher recovery status. Here, no interaction effects with gender were found (Supplementary Table S2). No significant effect was found for non-protective responses such as wishful thinking or avoidance. Also, concern about climate change made no significant contribution to this model.

Relative importance of the categories

In addition to exploring individual factors and characteristics, it is also of interest to better understand the overall relevance of the four categories in terms of individual recovery. These insights can provide crucial information for the design and implementation of effective recovery policies and measures. They indicate, for instance, whether public recovery efforts should predominantly focus on areas that were affected the most in physical terms (flood damage and event characteristics), support timely reconstruction and replacement of damaged assets (circumstances of the recovery process), be targeted based on socio-economic characteristics of the flood-affected population, or focus on emotional and psychological support for certain groups of society with specific personality characteristics (psychological factors).

A comparison of all four models shows that flood damage and event characteristics have the lowest explanatory power of all four categories, explaining only 8.7% of the variance in self-reported recovery. Also, the circumstances of the recovery process only explain 13.1% of the variance in individual recovery. Considerably higher values were found for socio-economic parameters (20.8%) and especially psychological factors (35.1%), indicating the importance of these two categories for individual recovery from floods. This is further supported by the fact that also the significant regression coefficients of these models show comparably larger effect sizes.

Complete model

The results of the complete model are presented in Table 5. The complete model further supports the finding that socio-economic characteristics and personality traits are key to self-reported recovery. These variables in particular make a significant contribution to the model. For instance, both gender and extensive mental preoccupation with the flood are significant and exhibit a large effect size compared with other variables. In contrast, physical damage suffered by the respondents was dropped from the complete model after being found to be non-significant. The only flood-event characteristic that was found to be significant in the complete model was flow velocity. However, the effect size is rather small compared to other variables. Overall, the complete model explains 41% of the variance in self-reported recovery, which is considered a good explanatory power for a model comprising aspects of human behavior (Morss et al. 2016; Grothmann and Reusswig 2006), and is in line with other studies addressing coupled human-environmental interactions (e.g., Morss et al. 2016; Grothmann and Reusswig 2006; Siegrist and Gutscher 2006).

Conclusions

Despite the severe impact of natural hazards, insights into individual recovery are scare, which hampers efforts to increase societal resilience. In the present study, we provide novel insights into the self-reported recovery of flood-affected residents. Our results show that recovery is a heterogeneous process which is significantly influenced by socio-economic characteristics and psychological factors. The amount of damage suffered and other flood-event characteristics appear less important. Based on these results, we conclude that uniform recovery efforts focusing on areas most affected in terms of physical damage are insufficient to account for the heterogeneity in self-reported recovery results. Instead, aid and recovery efforts should better address the long-term mental health effects of natural hazards.

Our results indicate that information on the socio-economic characteristics of the flood-affected population, which is usually available from statistical offices, can be used to better tailor recovery efforts to the needs of the target population. The fact that women in particular are still emotionally affected 18 months after the event calls for more psychological assistance for this group, which is often more directly exposed to the medium- and long-term effects of the flood event on a daily basis. In addition, recovery efforts should particularly consider societal groups that are socially vulnerable, such as people with disabilities, poor health status, and fewer financial resources. To increase societal resilience, plans for supporting the heterogeneous long-term recovery should be better integrated into strategies and plans for disaster risk reduction and adaptation to climate change.

In the present article, we presented an analysis of a wide range of factors influencing the recovery of flood-affected residents in Germany. Future research should examine whether the results are transferable to other hazards and geographical regions. The reported models show levels of explanatory power that are considered good for models comprising aspects of human behavior. Still, a significant proportion of variance remains unexplained. While we can only speculate about this, the predictive strength of the models might be further improved by adding additional personality traits found to influence mental health outcomes from disasters, such as neuroticism, a sense of self-efficacy, or rumination (Bonanno et al. 2010).

Longitudinal studies covering longer time spans would be needed to better understand the full recovery process. Such longitudinal studies could also provide important insights into the effectiveness of different measures to support recovery.

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