

Systematic Review

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The Impact of “Soft” and “Hard” Flood Adaptation Measures on Affected Population’s Mental Health: A Mixed Method Scoping Review

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Abstract

Background: The frequency and severity of floods has increased in different regions of the world due to climate change. It is important to examine how adaptation measures impact the mental health of individuals affected by these disasters.

Objective: The goal of this scoping review was to document the existing studies on the impact of flood adaptation measures in affected populations to identify the best preventive strategies and limitations that deserve further exploration.

Methods: This study followed the PRISMA-ScR guidelines. Inclusion criteria focused on studies in English or French available in MEDLINE and Web of Science that examined the impact of adaptation measures on the mental health of flood victims. Literature reviews or non-study records were excluded from the analysis.

Results: A total of 857 records were obtained from the examined databases. After 2 rounds of screening, 9 studies were included for full-text analysis. Six studies sought to identify the factors that drive resilience in flood victims, whereas 3 studies analyzed the impact of external interventions on their mental health.

Conclusions: The limited number of studies demonstrates the need for public health policies to develop flood adaptation measures that can be used to support the mental health of flood victims.

Floods are broadly defined as overflowing water bodies such as rivers, streams, and main channels leading to inundations.¹ These events are among the most common types of disasters, and they are the leading cause of disaster fatalities worldwide, with an economic impact estimated in the range of billions of dollars.^{2,3} Flood occurrence increased during the 20th century due to climate change,⁴ and it is expected that the number of regions threatened by flood hazards will expand in the near future.⁵

The continued threat that floods represent has motivated the study of their impact on human health. In this regard, it has been shown that flooding can greatly affect human populations at the physical and mental levels. For example, it is estimated that mortality rates can increase by 50% following a flood event, with a concomitant increase in the risk of disease outbreaks such as hepatitis E, gastrointestinal diseases, and leptospirosis,⁶ as well as increased rates of wounding, poisonings, and infections.⁷ Other studies have analyzed how floods affect mental health, showing that post-traumatic stress disorder, depression, and anxiety are among the sequelae to this type of disaster.⁸

However, with the increased occurrence of floods, there has been an increased interest in adaptation measures, which are broadly defined as anticipatory, autonomous, or planned actions that reduce the negative impact of floods while taking advantage of potential new opportunities, involving the adjustment of actions due to climate changes.⁹ These adaptation measures can be taken by individuals, communities, or governments. Examples of adaptation measures at the individual level include purchasing home insurance, warning or helping others, or adapting their household,¹⁰ whereas at the community level, they can include the preparation of disaster response plans.¹¹ At the government level, adaptation measures can include the construction of flood protection systems, reservoirs, water gates, and embankments.^{12–14} Other measures, such as the adoption of renewable energy sources, can be more geared toward mitigation strategies with long-term implications.¹⁵

Moreover, adaptation measures can be further classified as “hard” and “soft” depending on their area of implementation. “Hard adaptation measures” are associated with physical interventions such as the government-level measures previously indicated, as well as individual- or community-level measures such as building barriers around properties, elevating appliances and

furniture, installing pump systems, planning a systematic evacuation, and preparing shelters.¹⁶ However, “soft adaptation measures” are associated with education, information, behavior, resilience, and community response to a disaster.^{17–19}

Historically, soft adaptation measures have been less explored than their physical counterparts.¹⁸ Additionally, the implementation of these types of measures are further complicated by the fact that typically mental health interventions such as the promotion of resilience and coping, psychological first aid, the development of skills for psychological recovery, and the implementation of anxiety-reduction techniques are usually put into practice after a disaster.^{20–22} Recent studies have indicated the need for a change in this approach, where mental health and psychosocial support are instead focused on preparedness and prevention. For example, it has been proposed that the mental health outcomes of a disaster can be mitigated by fostering the resilience of affected individuals.^{23–25} From this perspective, flood adaptation measures that are focused on resilience and behavior can be considered as well as mental health risk reduction strategies.^{26,27} This is in accordance with the Intergovernmental Panel on Climate Change (IPCC) definition of adaptation measures, which recognizes 10 categories of approaches to manage climate change risks through adaptation, and where the “social” category includes 3 subcategories: educational options, informational options, and behavioral options.²⁸

However, in contrast with the amount of literature that explores the impact of flood adaptation measures on physical health, the impact of adaptation measures on mental health and its interplay with resilience remains relatively unexplored.²⁹

The goal of this scoping review is to document the existing body of research on flood adaptation measures, resilience, and their impact on the mental health of affected individuals and populations to identify best practices, limitations, and areas that deserve further exploration in light of the expected increase of flood frequency and severity due to climate change.

Methods

The strategy used for this scoping review was developed and validated with the help of Sylvie Fortin, a librarian from the Université de Montréal. The review was conducted following the recommendations of the PRISMA-ScR extension (Preferred Reporting Items for Systematic Reviews and Meta-Analysis: extension for Scoping Reviews).³⁰ Three core concepts were included in the analysis: floods, mental health factors, and adaptation measures. For this scoping review, floods were defined as “the overflowing of a stream or other body of water, or the accumulation of water over areas that are not normally submerged, including fluvial, flash, urban, pluvial, sewer, coastal, and glacial lake outburst floods” in accordance with the definition of the IPCC.³¹ Mental health was defined as the state of psychological and emotional well-being. Because of the relationship between mental health, coping skills (i.e., how individuals manage stressful situations), and self-esteem,³² these 3 factors were considered indicators of mental health status. Finally, adaptation measures were defined following the definition of Richardson.⁹

Eligibility Criteria

Inclusion and exclusion criteria were based on the Population, Intervention, Comparison, and Outcome (PICO) framework.³³ The study population was defined as flood victims, the intervention was defined as flooding adaptation measures, and the outcome was

defined as the mental health of the population. No specific study comparators were defined; hence, the comparator element of the PICO framework did not apply to this review. The criteria for exclusion were based on language, study setting, population, intervention, study design, and outcome. First and foremost, any record not written in English or French was excluded. As for the setting, any record about a pre- or post-flood event caused by another disaster such as an earthquake, cyclone, or hurricane was excluded. Records referring to studies not conducted with flood victims, literature reviews, or non-study records were also excluded. Non-peer-reviewed papers were not excluded. Finally, any study whose outcomes did not pertain to mental health, or an indicator of mental health as defined above, were also excluded. All records that met the criteria at the end of the screening process were included for full-text reading to assess whether they were relevant to this scoping review.

Information Sources

Two databases were searched for this scoping review: MEDLINE, which was accessed through the Ovid platform, and Web of Science. MEDLINE was chosen because it is considered the reference library for health literature. Web of Science was used to obtain records on floods and flood adaptation measures from journals not indexed on MEDLINE.

Search Strategy

The search was first carried out on March 8, 2021, and updated on September 26, 2022, using the 3 core concepts of floods, mental health, and adaptation measures, as indicated before. No time frame was specified for the search; thus, all studies from database inception until the search date were screened (September 26, 2022).

The following keywords were used for the first concept: *inundation, flood, heavy precipitation, rain, rains, river, lake, and high water*. For the second concept, keywords were *mental health, psychological, substance abuse, mental disorder, mental illness, and distress*. For the third concept, keywords were *disaster, risk, reduction, preparedness, resilience, planning, management, adaptation, planning, strategy, measure, decision, and approach*. The search strategies for both databases are available in the supplementary material.

Selection of Sources of Evidence

All the queries were imported into Covidence, a systematic review software platform that automatically removed duplicate entries (<https://www.covidence.org/>). Covidence was used to perform the first round of screening. The review of titles and abstracts was done by 2 independent reviewers trained in global environmental health and epidemiology (FEM and RB). In case of disagreement, a senior reviewer (BN) assessed the conflict and decided if the manuscript should be included in a full-text review. In the second round of screening, the same 2 reviewers (FEM, RB) read the full text of each study and determined its inclusion based on the PICO framework and the exclusion criteria. In case of disagreement regarding the inclusion of the study for analysis, conflicts were solved by the senior reviewer (BN).

Data Charting Process and Data Items

For data extraction, an Excel spreadsheet was used to obtain the following information from each study: authors, publication year,

title, country, study design, year of the flooding event analyzed, sample size, data collection date, climate indicators, health indicators, methods stated in the abstract, results stated in the abstract, detailed methods from the methods section, main findings from the results section, relevant comments, and paper citations. Data extraction was done by the same reviewers involved in the first round of screening.

Synthesis of Results

The studies were grouped based on their focus on analyzing mental health outcomes in communities or individuals affected by floods. For each study, information about the methodology and instruments used to collect data, sample sizes (when applicable), and principal findings is presented.

Results

Selection of Sources of Evidence

The database queries resulted in 693 records from MEDLINE and 266 records from Web of Science. Upon transfer of the records to the Covidence platform, 102 duplicates were identified and removed, leading to a total of 857 records for title and abstract screening. After the first screening round, 18 studies that met the screening criteria were included for full-text reading. Following the

second round of screening, 9 studies were relevant and included in the review (Figure 1).

Characteristics of Included Studies

The included studies are presented in Table 1. Among them, 5 studies (56% of the total) used statistical models to examine the relationship between socioeconomic covariates and mental health outcomes.^{34–38} However, 4 studies (44% of the total) used information collected via interviews and surveys to qualitatively assess the impact of floods on the mental health of flood survivors.^{39–42} Furthermore, 2 studies were conducted in China^{37,38} and 2 in Malaysia.^{35,41} The remaining studies were conducted in 5 different countries: Austria,³⁴ Australia,³⁹ Germany,³⁶ the United States,⁴² and the United Kingdom.⁴⁰

Results of Individual Sources of Evidence

Two categories of studies were identified based on their focus on analyzing mental health outcomes in affected communities or individuals. The first category included studies that focused on resilience as an indicator of mental health (soft adaptation measures), whereas the second category included studies that focused on the impact of external interventions (hard adaptation measures) on the mental health of flood victims, either from preventive measures (such as planned shelters) or from post-disaster measures (such as evacuation).

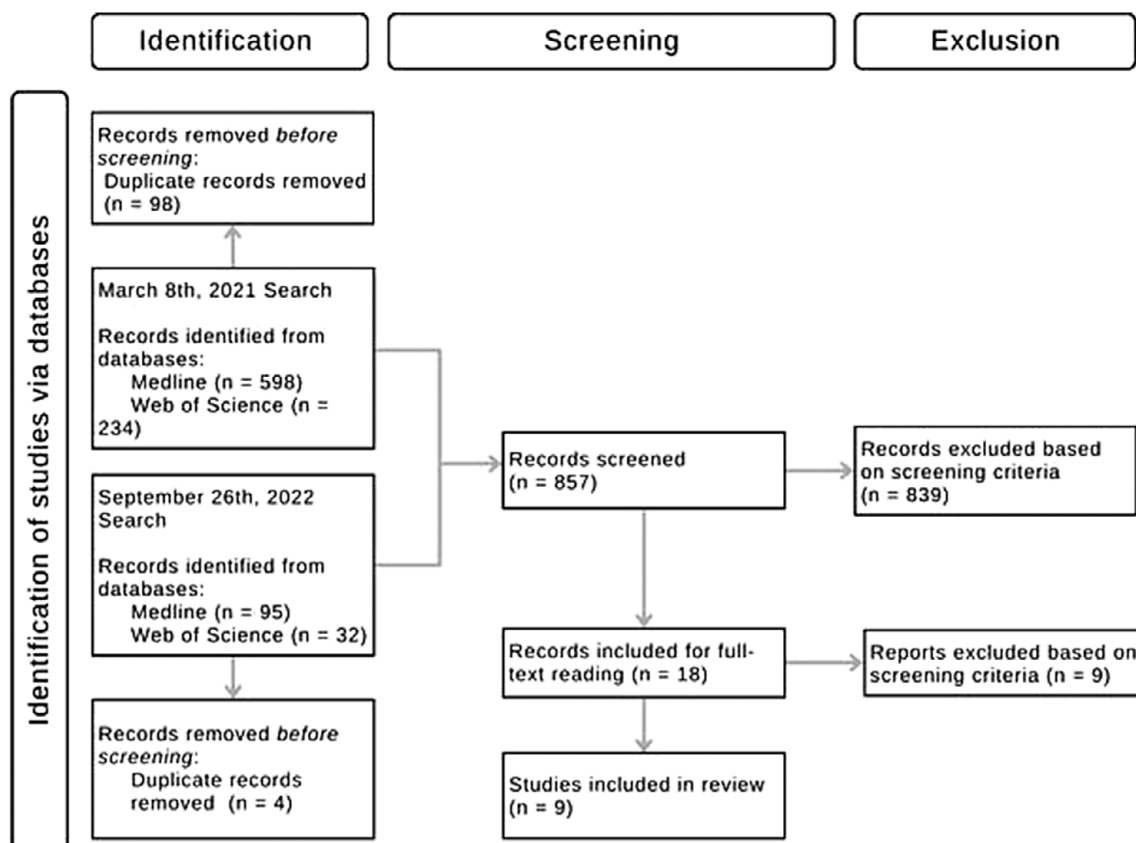


Figure 1. Flow diagram of the study selection process. A total of 857 records were obtained from Medline and Web of Science. Following two rounds of screening 9 studies were included in the study. Flow diagram template adapted from Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

Table 1. Methodological details, adaptation measures, and mental health outcomes of articles included for full-text analysis

Title	Authors	Year of publication	Country	Methodology	Adaptation measure	Adaptation measure type	Mental health outcomes assessed
The two faces of social capital in private flood mitigation: opposing effects on risk perception, self-efficacy and coping capacity	Babcicky & Seebauer	2017	Austria	Cross-sectional mail survey (n=226) to obtain scores of risk perception at multiple levels regarding 2 flooding events, and sociodemographic information from participants. Multivariable linear regression models were used to understand the relationship between perception of risk and self-efficacy and some measured predictors.	Social capital was distinguished into 2 components: cognitive social capital and structural social capital. Cognitive social capital pertains to the emotional experiences of people, whereas structural social capital refers to the actions and behaviors of people. Cognitive social capital was measured through perceptions of trust, the perception of fairness and helpfulness, the extent of consideration, involvement in community activities, and overall participation in the community. However, structural social capital was assessed through assessments of assistance given and received.	Soft adaptation measure	The results showed that social capital enhances the belief in coping capacities in a flooding context and that social capital plays an important role in recovering from floods. Informal social ties are essential factors in fortifying resilience against severe flooding, encompassing 2 discernible subtypes: cognitive social capital and structural social capital.
Understanding older adults' resilience during the Brisbane floods: social capital, life experience, and optimism	Brockie & Miller	2017	Australia	In-depth interviews with participants aged over 65 that were evacuated during 2 flooding events (n=10). The interviews were recorded, and the verbatim conversations were analyzed using inductive reasoning.	Resilience through 1) supportive social capital using closed networks (family, neighbors, etc.) and strangers and 2) having previously experienced a flooding incident.	Soft adaptation measure	Three major themes emerged as key drivers of resilience in flood survivors: sources of support, previous experiences, and social capital.
Narratives of recovery after floods: mental health, institutions, and intervention	Butler et al.	2018	United Kingdom	Longitudinal data were collected through semistructured qualitative interviews conducted 6 months after floodwaters were removed and again 12–14 months later. The participants in the study were self-selected, with a total of 9 individuals (n=9). Participants were interviewed regarding various aspects, including their community's reactions, their post-flood experiences, their perceptions of the community's responses, their mental health, and future expectations.	Measures taken by authorities (evacuation) and institutional support	Hard adaptation measure	Institutional support for the mental health of flood survivors can have both positive and negative effects. The nature and the way of delivery of provided support matter.
The association between social cohesion and	Ludin et al.	2018	Malaysia	A survey was conducted among individuals affected by floods in the district of Kelantan (n=386).	Community cohesion and community resilience were measured using two index	Soft adaptation measure	Enhanced social connections and cohesion contribute to the resilience of individuals

(Continued)

Table 1. (Continued)

Title	Authors	Year of publication	Country	Methodology	Adaptation measure	Adaptation measure type	Mental health outcomes assessed
community disaster resilience: a cross-sectional study				The survey collected demographic information pertaining to the participants, as well as information on community cohesion and resilience as indicators of the community's well-being. The data were collected using Buckner's Index of Cohesion (BIC) and the Index of Perceived Community Resilience (IPCR). Associations between demographic characteristics, BIC, and IPCR were determined.	scales: 1) Buckner's index of cohesion, which measures overall cohesion including psychological sentiment of belonging to community, neighboring, and attraction of neighborhood; and 2) the index of Perceived Community Resilience, which measures overall resilience including leadership, involvement within the community, and challenges related to geographic factors.		impacted by flooding, promoting mental well-being and overall welfare.
"We can help ourselves": does community resilience buffer against the negative impact of flooding on mental health?	Masson et al.	2019	Germany	In-person and online surveys were conducted among 118 participants at 6 weeks following the flood. The survey questions covered various aspects, including the perceptions of the flood impacts, flood-related mental and physical health burdens, perceived social support (collective and interpersonal), and adaptation capacity (ego resilience), among other relevant factors. Hierarchical multivariable regressions were used to assess the significance of community resilience in relation to flooding.	Community resilience was measured using 2 instruments: 1) the "Communities Advancing Resilience Toolkit Assessment Survey," which assesses community members' perceptions regarding their ability to handle disaster-related emergencies; and 2) ego resilience scale designed to measure individual capacities and differences to manage stress.	Soft adaptation measure	The perception of community resilience to flooding, brought by collective social support, helps alleviate the negative impacts of flooding on mental health, specifically stress.
Understanding Malaysian Malays communication characteristics in reducing psychological impact on flood victims	Mustaffa et al.	2018	Malaysia	In-depth interviews were conducted with flood victims (n=13), recruited by purposive sampling. The interview comprised 8 questions addressing participants' views and opinions toward communication at the time of the disaster, encompassing the communication approach of relief workers and its effects on the psychological well-being of those impacted.	Effective communication between relief workers and victims constitutes a major value that has a positive impact on well-being.	Hard adaptation measure	In the communication practices of community relief workers, core values such as "respect, sincerity, caring attitude, professionalism, and dignity maintenance" play an essential role in the communication discourse of community relief workers to help maintain the psychological well-being of victims.
Mitigating flood exposure: reducing disaster risk and trauma signature	Shultz et al.	2013	United States of America	Trauma signature analysis was used to examine the interrelationship between the exposure of the population of 2 distinct cities during a flooding	Community resilience was evaluated based on the presence of disaster resources at the community level, which aids community members in	Soft adaptation measure	Enforcing community-driven strategies to mitigate exposure to flood-related risk can effectively diminish both the physical and psychological

(Continued)

Table 1. (Continued)

Title	Authors	Year of publication	Country	Methodology	Adaptation measure	Adaptation measure type	Mental health outcomes assessed
				event and the disaster's physical and psychological impacts. The hazard profile of flooding for each city was determined using census data and published reports, among other variables, and compared the psychological risk factors associated with the flood events in both locations.	effectively adapting to potential risks. Connectivity and involvement, dedicated participation, clearly defined responsibilities and mandates, easily accessible resources, supportive and nurturing behaviors, enhancement of abilities for communication, and preventing, mitigating, preparing for, and responding to disasters were all determined to be critical factors within the communities' resilience.		impact. The implementation of these strategies relies on resilience exhibited within the affected community.
Linkage between the environment and individual resilience to urban flooding: a case study of Shenzhen, China	Song and Li	2019	China	Voluntary participants (n=733) engaged in a survey designed to explore individual resilience in the context of flooding events. Survey questions collected information about participants' coping and adaptive behaviors in response to urban flooding and sociodemographic factors, among others. A hierarchical linear model was used to fit the data.	Individual and community factors that influence individual resilience in the context of urban flooding were assessed through the survey questions. These factors include self-efficacy, awareness of disaster, physical and social context's perception, leadership, mutual trust, and support of the community.	Soft adaptation measure	Perception of leadership, physical and social environments, disaster awareness, and well-being in social networks are factors that increase individual resilience during urban flooding.
Assessing the effectiveness and pathways of planned shelters in protecting mental health of flood victims in China	Zhong et al.	2020	China	The study was conducted on a sample of individuals living in 69 shelters (n=338) and individuals living in their homes (n=327) across 4 cities to investigate the impact of designated shelters on the participants' mental health. The initial phase of the study centered on evaluating the implemented interventions in the shelters 1 month after evacuation and assessing the integrated health management framework. The second phase focused on gathering insights from individuals residing in the shelters. Data analysis was done via structural equation modeling and logistic regression.	Establishment of designated shelters to accommodate internally displaced individuals.	Hard adaptation measure	Individuals relocated to designated shelters after a flood exhibit a lower prevalence of mental health conditions such as anxiety, post-traumatic stress, and depression compared to non-displaced individuals.

Note: Adaptation measures reported in each study are categorized as soft (associated with education, information, behavior, or resilience), or hard (associated with physical interventions).

Summary of the Included Studies

Studies that focused on resilience as an indicator of mental health (soft adaptation measures)

Babcicky and Seebauer executed a cross-sectional study where a Likert scale survey was done in the cities of Oberwölz and Kössen in Austria, which experienced floods in 2011 and 2013, respectively.³⁴ A total of 226 individuals from both cities were surveyed to obtain measured scores for cognitive risk perception, affective risk perception, combined (cognitive and affective) risk perception, self-efficacy, and cognitive social capital, in addition to sociodemographic characteristics. Multivariable linear regression models were used to identify the relationships between the variables. The study's findings show that social capital increased the perception of self-efficacy, promoted coping capacity, decreased risk perception of private households (which were, therefore, less likely to apply flood mitigation measures), and enhanced households' trust in their own coping abilities. The authors conclude that informal social ties are essential for resilience against severe flooding.

Brockie and Miller followed a qualitative approach by interviewing a total of 10 participants aged 65 years and over who experienced flooding events in 2011 and 2013 while living in their own homes in the city of Ipswich in Queensland, Australia.³⁹ After verbatimizing the interviews' recordings, analyses were done following an inductive approach. The study found that social interactions, in the form of bonding capital from friends and family, were strongly linked to the practical and mental resilience of participants, in addition to their previous flood experience. The study also highlighted the shift in the social capital network and communication techniques when comparing past and recent flood experiences.

Ludin et al. surveyed 386 respondents who experienced the floods of 2014 in Kelantan, Malaysia.³⁵ The survey consisted of 2 parts: 1 collecting demographic information about the participants and 1 measuring community cohesion and community resilience by using Buckner's Index of Cohesion (BIC)⁴³ (which was based on answers of 18 items to measure neighborhood cohesion) and the Index of Perceived Community Resilience (IPCR)⁴⁴ (which is obtained from a series of questions that address community resilience). The authors then estimated mean scores for BIC and IPCR and used these scores as the variables of interest in regression models that examined the influence of demographic factors on cohesion and resilience. This study showed that certain characteristics that indicate individual preparedness through their social connections and cohesion, such as participating in emergency groups, volunteering work, and having experience with disaster emergency situations, were associated with increased resilience and social cohesion.

Masson et al. surveyed 118 participants from the town of Simbach am Inn, in Germany, who experienced severe flash floods in 2016.³⁶ The survey consisted of questions about the perceptions of the flood impacts, flood-related mental and physical health burdens, perceived social support (collective and interpersonal), adaptation capacity (ego resilience), and life satisfaction, to which respondents answered using a 6-point Likert scale that ranged from "not affected" to "very severe." The association of the survey responses and post-disaster mental health was analyzed using multiple hierarchical regression and path analysis, showing that the perception of community resilience (e.g., collective support) positively impacted mental health after disasters. Conversely, low levels of community resilience and a severe perception of flood events correlated with poorer mental health outcomes following such incidents.

Shultz et al. used "trauma signature analysis," a scientific approach that explores how a population's exposure to a disaster correlates with its physical and mental health aftermath.⁴² This technique was used to assess the consequences of 2011 flood events on the populations of Fargo and Minot, 2 demographically similar cities in North Dakota. The aim of this technique was to provide timely and actionable mental health and psychosocial support by understanding these interrelationships. The authors used census and civic data, among other variables, to compare both cities' resources and established the physical risk profile of the flood for each city based on official sources (e.g., government) and expert guidance. Additionally, major disaster stressors, flood preparedness, and flood response actions for each city were identified, and the trauma signature for each city was summarized by comparing the psychological risk factors for the flood events in each city. The availability of disaster resources at the community level was used to evaluate community resilience. The authors found that the presence of resources aids community members in effectively adapting to disasters. In fact, the community of Fargo was able to establish preventive measures to reduce their exposure to flood risk, and there were strong indices of community resilience, allowing the city to reduce disaster risk and impact and therefore reduce the trauma signature in the population. However, insufficient or absence of resources in its broad sense made prevention measures in the city of Minot difficult, which resulted in the distress of the population as the city was inundated. The authors concluded that reducing risk exposure reduces flood trauma signature, both on the physical and psychological levels.

Finally, Song and Li surveyed 733 individuals from the city of Shenzhen in southeast China, a location that experienced several flooding events between 2012 and 2015, and collected sociodemographic factors of the participants and measures of disaster awareness (such as being assured in overcoming disasters, previous experience with disasters, and level of preparedness).³⁷ The authors then used multiple hierarchical linear models to determine the association between socioeconomic factors and the resilience of individuals who live in areas where floods occur in order to determine coping and adaptive behaviors toward urban flooding (such as green areas in and around the community and support from community organizations). The main findings of this study were that an individual's resilience in a flood context is positively influenced by factors such as the condition and appearance of their natural surroundings, effective leadership, and the dynamics of their social environment. Additionally, resilience is further strengthened when there is a presence of well-functioning and dependable social networks within the community.

Studies that focused on the impact of external interventions on the mental health of flood victims (hard adaptation measures)

Zhong et al. analyzed the establishment of designated shelters to accommodate "internally displaced individuals" after floods in China.³⁸ The study focused on individuals who experienced the flood event in June 2016 in the province of Anhui. For analysis, 338 flood victims from 69 designated shelters in the province of Anhui were considered the intervention group and 327 flood victims who did not live in shelters were considered the control group. The study used multivariable logistic regression (using socioeconomic information and flood exposure among other covariates) and structural equation modeling (using the effect of different policy interventions) to determine the impact of designated shelters on mental health. The findings of the study provided evidence that individuals displaced in designated shelters experienced fewer

mental health issues in terms of prevalence compared to victims who did not leave their homes.

In the longitudinal study of Butler *et al.*, 2 semistructured qualitative interviews were conducted with 9 participants affected by floods that occurred in Somerset, in South West England (United Kingdom), in the winter of 2013. The 9 participants were interviewed at 6 months and at 12 to 14 months after the flooding.⁴⁰ The study showed that, based on the narrative provided by the participants, indirect or direct measures taken by authorities and institutions in the face of floods (such as the process of evacuating the victims from their homes), as well as inaction, have implications for the mental health of the affected populations. Moreover, the authors indicated that community support alone is not enough, and hence, institutional support remains necessary, especially to address post-flood mental health issues. However, the nature and the way of delivery of this support could affect whether it has positive or negative effects.

Mustaffa *et al.* performed a qualitative study that comprised interviews with 13 victims of the 2014 floods in Malaysia.⁴¹ The verbatim conversations of the interviews were coded using a comparative interpretive approach. The authors analyzed the answers of the participants using thematic data analysis techniques and following the guidelines for qualitative research of Creswell in order to identify the main factors discussed by the respondents.⁴⁵ The results showed that the communication practices of relief workers at disaster relief centers encompassed values of Malaysian society, such as treating the victims with dignity and respect (mutual respect and dignity maintenance), compassion, and care; this type of treatment was required to maintain the psychological well-being of the victims and to ensure effective communication in a post-flood context.

Discussion

The implementation of adaptation measures to manage floods should become more prevalent with the increase in the severity and frequency of these disasters. This scoping review collected studies from the literature about the impact of adaptation measures on the mental health of flood victims. Based on their analysis of mental health, the 9 studies that were included for full-text analysis (Table 1) were divided into 2 categories: 1) studies about resilience as an indicator of mental health and 2) studies about other indicators of mental health in flood victims.

The first category included 6 studies that were focused on factors that influence resilience in flood victims. In a mental health context, resilience is broadly defined as the capacity to maintain mental health through adversity and to positively adapt afterward.^{46,47} In the context of disasters and climate change, the ability to regenerate, reorganize, and redevelop to an improved state in the long term is also a component of resilience.^{48,49} Considering that floods are expected to become more severe in the near future, there is a pressing need for governments and public health agencies to focus on expanding the amount of social/behavioral adaptation measures that can help develop resilience in individuals and communities that are likely to be affected by this type of disaster in order to ensure that an improved state is indeed achieved.

In this regard, the studies of the first category identified various components of social capital as driving factors of resilience in flood victims (Table 1). In the context of disasters, social capital can be broadly defined as the social ties and social networking of an individual that facilitates collective action.^{50,51} Specifically, the studies

identified social ties,³⁴ bonding,³⁹ community involvement,³⁵ social sources of support,³⁶ community preparedness,⁴² and social cohesion³⁷ as factors associated with resilience in individuals or communities affected by floods. These results provide a broad view of some of the factors that would need to be considered in the development of preemptive and post-flood intervention measures that are aimed at not only dealing with the physical aspect of this type of disaster but also ensuring a positive mental health outcome for flood victims.

However, resilience is a multifaceted topic, and social capital can be affected by the interactions between individuals and institutions or governments.⁵² This aspect is particularly important in the context of floods, as it has been shown that inadequate state or government responses can have a lasting impact on affected communities.^{53,54} In other words, resilience is not only determined by the interactions within a community but also can be improved (or damaged) by external factors. Because governments and authorities will continue to have a central role in the planning and implementation of adaptation measures to floods in the future, there is a need to determine how decisions by these entities influence the resilience of affected individuals and communities. So far, this topic remained unexplored in the studies analyzed, but it needs to be considered in future analyses that seek to provide a holistic understanding of resilience in the context of floods.

The studies in the second category analyzed the impact of external interventions on the mental health of flood victims, either from preventive measures (as in the case of Zhong *et al.*,³⁸ who analyzed the effect of designated sheltering in flood victims) or from post-disaster measures (as in the case of Butler *et al.*,⁴⁰ who examined how decisions made by authorities in the aftermath of a flooding event impact the mental health of individuals, or in the case of Mustaffa *et al.*,⁴¹ who explored how the language used by relief workers reduced the mental health impact on flood victims). These studies assessed mental health outcomes that were different from resilience (e.g., anxiety, depression, and post-traumatic stress disorder in the study of Zhong *et al.*³⁸ and qualitative data about mental health and psychological well-being in general in the studies of Butler *et al.*⁴⁰ and Mustaffa *et al.*⁴¹).

Overall, these studies show that measures taken by authorities have an important impact on the mental health of those affected by floods. However, one important aspect that was not addressed in these studies is how measures taken within the community influence the mental health of its individuals. Usually, communities that have been affected by floods (or that are threatened by them) have some level of preparedness that is driven by actions at the local level, which can include certain intervention measures (such as preparing sandbags,³⁸ implementing early warning systems,⁵⁵ or conducting risk reduction workshops⁵⁶). Sometimes, these measures can cause confusion or be dysfunctional when a disaster occurs, thereby negatively impacting the mental health of individuals.⁵⁷ However, this aspect was not addressed in the analyzed studies in the second category but remains an important area that needs to be explored in order to determine the relative importance of external and internal interventions in a mental health context and to identify areas that need to be prioritized in the event of a disaster to ensure that individuals are able to be resilient.

Generally speaking, the studies analyzed in this scoping review presented results that were in agreement with other works in the area of climate change, resilience, and social capital.^{58,59} However, certain limitations that affect the robustness of the results and that limit their application in a broader context were identified. First, in most of the studies, mental health information was provided by the

victims themselves according to their perception of their mental health status, which, at best, is only a rough estimate of the true mental health status of the individuals.⁶⁰ Ideally, the mental health status of an individual should be evaluated by a mental health professional, and the fact that this was not considered in the analyzed studies raises the possibility of bias in the collected data, which would compromise the robustness of the findings.

Second, most of the studies utilized a cross-sectional design by collecting data after the flooding event, and because of this, there was neither a comparison nor a follow-up over time to determine if the attitudes and beliefs from individuals (which were collected using a Likert scale in most cases) changed over time. The perceptions, attitudes, and responses from an individual are not stationary, and in the event of flooding, it is important to quantify changes in these factors over time⁶¹ in order to not only establish relationships but also adequately measure the dynamics of human behavior in this context.⁶² From all the studies analyzed, only the study of Butler et al. had a longitudinal design, but the qualitative nature of this study limited the possibility of obtaining numerical estimates of participants' beliefs and attitudes and their change over time.⁴⁰ Although performing longitudinal studies on flood victims is challenging due to inherent environmental and logistic limitations during this type of disaster,⁶¹ there is a pressing need for studies that adhere to this methodology. Only by having a time-resolved view of mental health indicators, it will be possible not only to measure if affected individuals have been able to be resilient but also to determine which opinions and attitudes toward intervention measures change over time, which in turn can be used by decision-makers to refine the implementation of such policies.

Finally, it should be noted that the small sample size or the sampling process used in the studies poses a significant limitation to the robustness of their findings. In the first case, the majority of the studies that followed a qualitative approach were based on a sample size that ranged between 9 and 13 individuals.^{39–41} Although the information provided by these individuals is valuable, the analysis in each paper was focused on communities or areas with populations orders of magnitude higher than these sample numbers, and therefore, it is likely that the findings in each case only represent a partial view of the effects of the flooding event analyzed. This is an important limitation because aspects derived from the experience of other victims, which could be equally important to contextualize the impact of floods on mental health, might not have been identified. It is important to mention that the study of Shultz et al. also followed a qualitative approach but relied on third-party information (census information, local data sources, and expert consultation) to create a profile of flood hazard for the communities analyzed.⁴² Because the sources of information used are not referenced, it is not easy to determine if the methodology used can be applied in a different context, considering that in other areas of the world, there might be a limited amount or a complete lack of information sources that can be used to build a flood hazard profile of impacted communities.

In the second case, there were certain issues with the sampling processes used by studies that used a quantitative approach (using regression models to determine the association between different variables). These issues included the use of samples not representative of all affected areas,³⁵ a drastic reduction in the amount of observations due to dropping entries with missing data,³⁶ low response rates,^{34–36} not correcting for having low representativity of certain age groups,³⁸ and relying on self-assessment of resilience,³⁷ which introduced subjective bias. Although these studies had significantly

higher sampling numbers than the papers that used a qualitative approach, the problems with the sampling process raise the possibility that certain important factors were omitted or deemed not significant in the analysis. Collecting data from flood victims is a delicate task, but it is important that future studies that aim to quantitatively analyze the impact of intervention measures in flood victims are based on data that adequately reflect the sociodemographic characteristics of the affected population and that minimize the introduction of bias in order to ensure the robustness of the findings.

There are some limitations to this scoping review. First, only 2 databases were considered for this review, and therefore, it is possible that a limited number of relevant studies indexed in other platforms might have been missed. Second, the research strategy was limited to studies written in English and French, which might have led to the omission of relevant studies written in languages specific to certain areas affected by floods (such as Spanish and Portuguese). Future studies will seek to broaden the choice of languages to incorporate studies that allow a geographically based analysis. Finally, the number of studies analyzed is relatively small with heterogeneous methodologies, which complicates the ability to make generalizations that are broadly applicable. Nonetheless, the small number of studies analyzed emphasizes the ongoing need of additional research on the interaction of mental health and disasters, which is likely to become more significant in the near future.

Conclusion

Flood frequency and severity has increased, and a broader range of the population is likely to be affected by floods. Existing literature that examines the effects of adaptation measures on the mental health of flood victims and factors that impact resilience in affected individuals is limited. The applicability of the findings of these studies is limited due to small sample sizes, data representativity, and the introduction of biases in the analysis due to the sampling processes used. Therefore, there is a pressing need for additional studies that examine how mental health in flood victims is affected by adaptation measures as governments or public entities increase the use of these interventions to limit the effect of flooding events and for studies that examine the role that community resilience plays in the mental health outcome of a disaster. It is necessary to develop public policies that adequately consider the impact of these measures on the mental health of flood victims in order to avoid unnecessary suffering in those most affected by these disasters.

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Data availability statement. Not applicable

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AM: contributed to the critical revision of the article; FEB, RB, AM, and BN: contributed to final approval of the version to be submitted; BN: supervised this work and is considered as a senior author.

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References

- Şen Z. *Flood Modeling, Prediction and Mitigation*. Springer International Publishing; 2018. doi:10.1007/978-3-319-52356-9
- Doocy S, Daniels A, Murray S, et al. The human impact of floods: a historical review of events 1980-2009 and systematic literature review. *PLoS Curr*. Published online 2013. doi:10.1371/currents.dis.f4deb457904936b07c09daa98ee8171a
- Svetlana D, Radovan D, Ján D. The economic impact of floods and their importance in different regions of the world with emphasis on Europe. *Procedia Economics and Finance*. 2015;34:649–655. doi:10.1016/S2212-5671(15)01681-0
- Milly PCD, Wetherald RT, Dunne KA, et al. Increasing risk of great floods in a changing climate. *Nature*. 2002;415(6871):514–517. doi:10.1038/415514a
- IPCC, Pörtner HO, Roberts DC, et al., eds. *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*; 2022.
- Alderman K, Turner LR, Tong S. Floods and human health: a systematic review. *Environ Int*. 2012;47:37–47. doi:10.1016/j.envint.2012.06.003
- Saulnier DD, Brodin Ribacke K, Von Schreeb J. No calm after the storm: a systematic review of human health following flood and storm disasters. *Prehosp Disaster Med*. 2017;32(5):568–579. doi:10.1017/S1049023X17006574
- Mason V, Andrews H, Upton D. The psychological impact of exposure to floods. *Psychol Health Med*. 2010;15(1):61–73. doi:10.1080/13548500903483478
- Richardson GRA. *Adapting to Climate Change: An Introduction for Canadian Municipalities*. Natural Resources Canada; 2010.
- Brink E, Wamsler C. Citizen engagement in climate adaptation surveyed: the role of values, worldviews, gender and place. *J Clean Prod*. 2019;209:1342–1353. doi:10.1016/j.jclepro.2018.10.164
- Ebi KL, Semenza JC. Community-based adaptation to the health impacts of climate change. *Am J Prev Med*. 2008;35(5):501–507. doi:10.1016/j.amepre.2008.08.018
- Liang Y, Jiang C, Ma L, et al. Government support, social capital and adaptation to urban flooding by residents in the Pearl River Delta area, China. *Habitat Int*. 2017;59:21–31. doi:10.1016/j.habitatint.2016.11.008
- Osberghaus D, Dannenberg A, Mennel T, et al. The role of the government in adaptation to climate change. *Environ Plann C Gov Policy*. 2010;28(5):834–850. doi:10.1068/c09179j
- Matos Silva M, Costa JP. Urban flood adaptation through public space retrofits: the case of Lisbon (Portugal). *Sustainability*. 2017;9(5):816. doi:10.3390/su9050816
- Eriksen SH, O'Brien K. Vulnerability, poverty and the need for sustainable adaptation measures. *Clim Policy*. 2007;7(4):337–352. doi:10.1080/14693062.2007.9685660
- Nofal OM, Van De Lindt JW. High-resolution approach to quantify the impact of building-level flood risk mitigation and adaptation measures on flood losses at the community-level. *Int J Disaster Risk Reduct*. 2020;51:101903. doi:10.1016/j.ijdr.2020.101903
- Drolet JL. Societal adaptation to climate change. In: Letcher TM, ed. *The Impacts of Climate Change*. Elsevier; 2021:365–377. doi:10.1016/B978-0-12-822373-4.00011-2
- He Y, Wu B, He P, et al. Wind disasters adaptation in cities in a changing climate: a systematic review. *PLoS One*. 2021;16(3):e0248503. doi:10.1371/journal.pone.0248503
- Sayers P, Penning-Rowsell EC, Horritt M. Flood vulnerability, risk, and social disadvantage: current and future patterns in the UK. *Reg Environ Change*. 2018;18(2):339–352. doi:10.1007/s10113-017-1252-z
- Math SB, Nirmala MC, Moirangthem S, et al. Disaster management: mental health perspective. *Indian J Psychol Med*. 2015;37(3):261–271. doi:10.4103/0253-7176.162915
- Wade D, Crompton D, Howard A, et al. Skills for psychological recovery: evaluation of a post-disaster mental health training program. *Disaster Health*. 2014;2(3-4):138–145. doi:10.1080/21665044.2015.1085625
- Milligan G, McGuinness TM. Mental health needs in a post-disaster environment. *J Psychosoc Nurs Ment Health Serv*. 2009;47(9):23–30. doi:10.3928/02793695-20090731-01
- Gray B, Hanna F, Reifels L. The integration of mental health and psychosocial support and disaster risk reduction: a mapping and review. *Int J Environ Res Public Health*. 2020;17(6):1900. doi:10.3390/ijerph17061900
- Bourque F, Cunsolo Willox A. Climate change: the next challenge for public mental health? *Int Rev Psychiatry*. 2014;26(4):415–422. doi:10.3109/09540261.2014.925851
- IASC Reference Group on Mental Health and Psychosocial Support in Emergency Settings. *Technical Note: Linking Disaster Risk Reduction (DRR) and Mental Health and Psychosocial Support (MHPSS) - Practical Tools, Approaches and Case Studies*; 2021. Accessed October 28, 2023. <https://reliefweb.int/report/world/technical-note-linking-disaster-risk-reduction-drr-and-mental-health-and-psychosocial>
- Hudson P. The potential for property-level flood adaptation as a flood disaster mental health intervention. *Public Health*. 2023;218:173–175. doi:10.1016/j.puhe.2023.03.008
- Quinn T, Heath S, Adger WN, et al. Health and wellbeing implications of adaptation to flood risk. *Ambio*. 2023;52(5):952–962. doi:10.1007/s13280-023-01834-3
- Intergovernmental Panel on Climate Change, ed. *Climate Change 2014: Synthesis Report*. Intergovernmental Panel on Climate Change; 2015.
- Sharifi A, Pathak M, Joshi C, et al. A systematic review of the health co-benefits of urban climate change adaptation. *Sustain Cities Soc*. 2021;74:103190. doi:10.1016/j.scs.2021.103190
- Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467–473. doi:10.7326/M18-0850
- Field CB, Barros V, Stocker TF, et al, eds. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press; 2012. doi:10.1017/CBO9781139177245
- Mann M. Self-esteem in a broad-spectrum approach for mental health promotion. *Health Educ Res*. 2004;19(4):357–372. doi:10.1093/her/cyg041
- Amir-Behghadami M, Janati A. Population, Intervention, Comparison, Outcomes and Study (PICOS) design as a framework to formulate eligibility criteria in systematic reviews. *Emerg Med J*. 2020;37(6):387–387. doi:10.1136/emered-2020-209567
- Babcicky P, Seebauer S. The two faces of social capital in private flood mitigation: opposing effects on risk perception, self-efficacy and coping capacity. *J Risk Res*. 2017;20(8):1017–1037. doi:10.1080/13669877.2016.1147489
- Ludin SM, Rohaizat M, Arbon P. The association between social cohesion and community disaster resilience: a cross-sectional study. *Health Soc Care Community*. 2019;27(3):621–631. doi:10.1111/hsc.12674
- Masson T, Bamberg S, Stricker M, et al. “We can help ourselves”: does community resilience buffer against the negative impact of flooding on mental health? *Nat Hazards Earth Syst Sci*. 2019;19(11):2371–2384. doi:10.5194/nhess-19-2371-2019
- Song J, Li W. Linkage between the environment and individual resilience to urban flooding: a case study of Shenzhen, China. *Int J Environ Res Public Health*. 2019;16(14):2559. doi:10.3390/ijerph16142559
- Zhong S, Pang M, Ho HC, et al. Assessing the effectiveness and pathways of planned shelters in protecting mental health of flood victims in China. *Environ Res Lett*. 2020;15(12):125006. doi:10.1088/1748-9326/abc446
- Brockie L, Miller E. Understanding older adults’ resilience during the Brisbane floods: social capital, life experience, and optimism. *Disaster Med Public Health Prep*. 2017;11(1):72–79. doi:10.1017/dmp.2016.161
- Butler C, Walker-Springett K, Adger WN. Narratives of recovery after floods: mental health, institutions, and intervention. *Soc Sci Med*. 2018;216:67–73. doi:10.1016/j.socscimed.2018.09.024
- Mustaffa CS, Ahmad Marzuki N, Universiti Utara Malaysia, et al. Understanding Malaysian Malays communication characteristics in reducing

- psychological impact on flood victims. *J Komun: Malays J Commun*. 2018; **34**(1):20–36. doi:10.17576/JKMJC-2018-3401-02
42. **Shultz JM, McLean A, Herberman Mash HB**, et al. Mitigating flood exposure: reducing disaster risk and trauma signature. *Disaster Health*. 2013; **1**(1):30–44. doi:10.4161/dish.23076
43. **Buckner JC**. The development of an instrument to measure neighborhood cohesion. *American J Community Psychol*. 1988; **16**(6):771–791. doi:10.1007/BF00930892
44. **Kulig JC, Edge DS, Townshend I**, et al. Community resiliency: emerging theoretical insights. *J Community Psychol*. 2013; **41**(6):758–775. doi:10.1002/jcop.21569
45. **Creswell JW, Poth CN**. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications; 2016.
46. **Herrman H, Stewart DE, Diaz-Granados N**, et al. What is resilience? *Can J Psychiatry*. 2011; **56**(5):258–265. doi:10.1177/070674371105600504
47. **Saeed SA, Gargano SP**. Natural disasters and mental health. *Int Rev Psychiatry*. 2022; **34**(1):16–25. doi:10.1080/09540261.2022.2037524
48. **Engle NL, De Bremond A, Malone EL**, et al. Towards a resilience indicator framework for making climate-change adaptation decisions. *Mitig Adapt Strateg Glob Change*. 2014; **19**(8):1295–1312. doi:10.1007/s11027-013-9475-x
49. **Zhou H, Wang J, Wan J**, et al. Resilience to natural hazards: a geographic perspective. *Nat Hazards*. 2010; **53**(1):21–41. doi:10.1007/s11069-009-9407-y
50. **Jones N, Clark JRA**. Social capital and climate change mitigation in coastal areas: a review of current debates and identification of future research directions. *Ocean Coast Manag*. 2013; **80**:12–19. doi:10.1016/j.ocecoaman.2013.03.009
51. **Smith PW, Bennett G, Bradley S**, et al. SHEA/APIC guideline: infection prevention and control in the long-term care facility, July 2008. *Infect Control Hosp Epidemiol*. 2008; **29**(9):785–814. doi:10.1086/592416
52. **Adger W**. Social capital and climate change. *Published online November 1*, 2001.
53. **Chioma OC, Chitakira M, Olanrewaju OO**, et al. Impacts of flood disasters in Nigeria: a critical evaluation of health implications and management. *Jàmbá*. 2019; **11**(1). doi:10.4102/jamba.v11i1.557
54. **Tullos D**. How to achieve better flood-risk governance in the United States. *Proc Natl Acad Sci USA*. 2018; **115**(15):3731–3734. doi:10.1073/pnas.1722412115
55. **Priyanti RP, Hidayah N, Rosmaharani S**, et al. Community preparedness in flood disaster: a qualitative study. *Int Q Community Health Educ*. 2019; **40**(1):67–68. doi:10.1177/0272684X19853169
56. **Shariff NNM, Hamidi ZS**. Community-based approach for a flood preparedness plan in Malaysia. *Jàmbá*. 2019; **11**(1). doi:10.4102/jamba.v11i1.598
57. **Khalid MS, Mustaffa CS, Marzuki MN**, et al. Failure to react positively to flood early warning systems: lessons learned by flood victims from flash flood disasters: the Malaysia experience. *Published online April 2*, 2015. doi:10.5281/ZENODO.1100584
58. **Carmen E, Fazey I, Ross H**, et al. Building community resilience in a context of climate change: the role of social capital. *Ambio*. 2022; **51**(6):1371–1387. doi:10.1007/s13280-021-01678-9
59. **Smith JW, Anderson DH, Moore RL**. Social capital, place meanings, and perceived resilience to climate change*: social capital, place meanings, & perceived resilience. *Rural Sociol*. 2012; **77**(3):380–407. doi:10.1111/j.1549-0831.2012.00082.x
60. **North CS, Pfefferbaum B**. Mental health response to community disasters: a systematic review. *JAMA*. 2013; **310**(5):507. doi:10.1001/jama.2013.107799
61. **Hudson P, Thieken AH, Bubeck P**. The challenges of longitudinal surveys in the flood risk domain. *J Risk Res*. 2020; **23**(5):642–663. doi:10.1080/13669877.2019.1617339
62. **Bubeck P, Berghäuser L, Hudson P**, et al. Using panel data to understand the dynamics of human behavior in response to flooding. *Risk Anal*. 2020; **40**(11):2340–2359. doi:10.1111/risa.13548