

*Review Article*

# The Long-Term Health Impacts of Repeated Flood Events: A Review

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## Abstract

Global flood events over the last thirty years have affected over 2.8 billion people and claimed an astounding 200,000 lives. Flood victims experience long-lasting effects on their physical and mental well-being that last for an uncertain amount of time after the incident. Secondary stressors that are indirectly related to the flood event have the capacity to worsen and prolong the health effects on impacted individuals and communities, even after the initial aftermath. These secondary stressors include social stressors like extended isolation from flooding and economic difficulties like income loss. Notably, there is a significant research vacuum regarding the effects of recurrent flooding and how it affects people's vulnerability to these secondary stressors. This thorough analysis explores research on periodic flooding, highlighting the secondary stressors that result from these occurrences. It also examines the study populations' awareness, readiness, and resilience in order to estimate the possible effects of secondary stressors on these communities. The review's conclusions highlight the substantial effects that secondary stressors in the economic, social, and psychological domains have on communities in both developed and developing countries, both rural and urban. Even though the majority of communities are fundamentally aware of the risk of flooding, many residents do not take this risk seriously, which leads to a lack of proactive measures. Research has indicated that there is greater community resilience in developing country urban and rural areas as well as in developed country rural areas. Subsequent investigations ought to thoroughly examine the various secondary stressors that impact communities and investigate tactics to mitigate their effects, with the ultimate goal of augmenting community resilience.

**Keywords:** Flooding, recurrent flooding, resilience, awareness, preparedness, urban, rural, health, secondary stressors.

## Introduction

Flooding is now the most common major disaster in the world, affecting both developed and developing countries [1]. According to data from the World Health Organization (WHO), flooding has affected over 2.8 billion people globally and resulted in over 200,000 deaths over the previous three decades. These figures highlight how widespread flooding is as a worldwide occurrence and demonstrate how unquestionably it is a cross-border problem. Although there is ample evidence to support the immediate physical effects of flooding, such as injuries and drownings, there is mounting evidence that the health effects of flooding go well beyond these initial effects. The unprecedented monsoon rainfall in Pakistan, spanning from mid-June to late August 2022, resulted in extensive flooding and widespread damage. The Indus River, running through the country, overflowed, submerging large areas and causing urban flash floods, landslides, and Glacial Lake Outburst Floods (GLOFs) [29]. The southern provinces of Sindh and Balochistan were particularly hard-hit, with a 100 km wide lake forming due to the overflowing Indus. The recorded rainfall in August for Sindh and Balochistan was exceptionally high, reaching 726% and 590%, respectively, of the usual totals since 1961 [30]. The severity of the

flooding underscores the urgent need for coordinated disaster response and climate resilience measures in the affected regions. A growing body of knowledge highlights that following extreme occurrences such as floods, secondary stressors that are not directly related to the event may prolong and worsen the health effects on impacted people and communities [1]. These secondary stressors include social stressors like enforced isolation during protracted flood events, as well as economic factors like the effect on property values [2]. While many secondary stressors associated with extreme events have been identified, more research is necessary to determine the effect of recurrent flooding on the degree to which these stressors affect communities. Additionally, it is imperative to ascertain whether these stressors have comparable effects on various community types, including rural and urban areas.

The following goals are the focus of this paper:

- Find and look into research that have looked at the long-term effects of frequent flooding.
- Write a summary and critical analysis of the most recent research on secondary stressors that affect populations that are vulnerable to flooding in both urban and rural areas.
- Assess the degree of awareness, preparedness, and resilience in communities that frequently flood in order to ascertain how susceptible these communities are to additional stressors.
- Determine the gaps in the current body of knowledge about the long-term health effects of frequent flooding on communities. By pursuing these goals, this paper hopes to advance our knowledge of the complex interplay between recurrent flooding, secondary stressors, and the various effects these have on communities.

### **Methods**

Proquest, Science Direct, Medline, and Web of Science were used to conduct an extensive literature search to find pertinent peer-reviewed articles published in English [31]. The search was designed to concentrate on research that looked at the effects of recurrent flooding on health and secondary stressors [32]. The search strategy used in this investigation is described in Table 1, which includes a combination of keywords linked to exposure, health outcomes, flooding susceptibility, and the location of the flood event. Articles that did not specifically address the health impacts or secondary stressors of flood events were excluded. The first author critically reviewed the full texts of the remaining articles that met the inclusion criteria, and this paper summarizes the main conclusions from that review. Additionally, studies that focused only on the immediate effects of flooding, like mortality and diarrheal diseases, were excluded. Papers that only addressed the health impacts of individual flood events were also disregarded. Finally, studies that included sample populations that did not permanently reside in areas that had experienced repeated flooding, like those that focused on caravan sites, were discounted.

### **Results and discussion**

Potentially 4,970 pertinent references that matched the search strategy's key terms were found in the first search. 118 articles were chosen for a thorough review after the inclusion criteria were applied; those that did not primarily address the effects of floods on human health were excluded. After a more thorough review, ninety-three articles were removed because they did not satisfy all of the requirements, particularly those related to recurrent flood incidents. The first author critically examined the complete texts of the remaining 25 studies, classifying them as case studies, where appropriate, into urban and rural areas. A breakdown of the 25 important articles that were selected for inclusion showed that 16 of the studies were conducted in rural areas, 8 in urban areas, and 1 study combined case studies from both urban and rural areas. In addition, four of the rural studies were carried out in developed nations, whereas twelve were carried out in developing nations. Of the urban studies, four were located in developing nations and four in industrialized nations. The one study that looked at both urban and rural areas was carried out in a developed nation.

### **Secondary stressors impacting flood affected populations**

An upsetting and difficult sequence of events may be experienced by flood victims, with the possibility that their health may suffer long after the floodwaters have subsided. This is especially significant for people who are affected by frequent floods because they are frequently faced with these health issues and don't have enough time to heal from past flood experiences. One of the most pressing issues facing flood victims is the potential for secondary stressors to arise following floods, which may be just as harmful to health as flood-related injuries and illnesses.

Table 1: Revised Search Strategy for Identifying Studies for Inclusion

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Key Words Relating to Repeated Flood Events (Exposure)	Flood* OR "repeated flood*" OR "frequent flood*" OR "successive flood*" OR "continuous flood*" OR "reoccurring flood*" OR "regular flood*" OR "habitual flood*" OR "intermittent flood*" OR "recurring flood*" OR "constant flood*" OR "repetitive flood*" OR "continual flood*" OR "perpetual flood*" OR "routine flood*"
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Key Words Relating to Health Outcomes (Outcome)	Health OR "secondary stressors" OR "health impacts" OR "mental health" OR stress OR anxiety OR depression
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AND/OR

Key Words Relating to Susceptibility to Flooding	Resilience OR awareness OR "flood risk" OR vulnerable*
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AND/OR

Key Words Relating to Location of Flood Event	Urban OR rural
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**Economic stressors**

**Loss of income, disruption to livelihoods and debt**

The investigation revealed that flooding has a significant impact on livelihoods, leading to a significant loss of income [2, 3]. This is one of the most notable secondary stressors. There were several different reasons for respondents' loss of income, such as property damage, road infrastructure damage, or difficulties getting to their place of employment [4]. Concerns about losing income were common in developed and developing nations alike, whether they were in urban or rural settings. For example, Braun and ABheuer discovered that following flooding, 70% of urban Bangladeshi households saw a notable decline in income [5]. According to a Vietnamese rural study, people experienced flooding for two to six months out of the year, which led to a significant loss of income [6].

Traditional rural livelihoods were also threatened by flooding [1,7]. The major cause of flooding has mainly been considered to be the climate change. As articulated by Khoso et al. [8], that, climate change has impacted the rural health at greater extent resulting flooding, increasing temperature, that not only loss the human settlements but also the main cause of migration. According to Sillar et al. [9] migration was prompted by the disruption that frequent flooding in Vietnam caused to rice farmers, as there was no other means of subsistence. Families affected by flooding in Vietnam frequently used seasonal migration as a way to increase their income [6].

In this review Nguyen et al. [10] debt surfaced as an additional source of economic stress. Flooding frequently forced low-income households to take out high-interest loans due to the disruption of their income. These loans were especially difficult for low-socioeconomic groups to repay, which increased stress and anxiety [10].

It is important to recognize that, after flood events, business owners experienced similar stresses as homeowners, which had a substantial negative influence on their livelihoods. Hoggart and colleagues discovered that company owners faced serious issues with flooding, such as physical damage to goods, interrupted delivery routes, limited access for customers and staff, and the possibility of power outages [11].

Across the studies included in this review, the majority of flood victims identified income loss as a common challenge. Significantly, neither geography nor socioeconomic standing lessened its effects; however, recovery was more difficult for people in developing nations, where many lacked the savings necessary to support themselves after a flood [1, 12].

### **Damage to property and possessions**

When flood victims experience damage to their properties and lose sentimental items in addition to valuable assets, the emotional toll on them is especially great [1, 3]. This study brought attention to another effect of property damage, highlighting the potential for damage to assets like cars to have far-reaching effects. For example, it might make it more difficult to get to work, which mean losing money, and it would might also make social interaction less frequent [13]. Additionally, the possibility of property damage can affect lifestyle decisions, limiting the furniture or appliances that flood victims can afford to buy, especially in light of the likelihood of future floods [1]. It is difficult to return properties to their pre-flood condition because state compensation is frequently insufficient, and many people do not have enough savings for an immediate restoration of their homes [10, 11]. Flood victims experience severe trauma when their property and possessions are damaged. This is because they often lose important and priceless items as a result of frequent flooding. The review emphasizes that damage to property and possessions is a common source of stress that affects both urban and rural areas in both developed and developing nations. But according to the study, its effects are noticeably more severe in developing nations where people don't have the money to replace everything they've lost [1].

### **Insurance and house prices**

Restoring a property to its pre-flood state is the top priority for homeowners following a flood event. But getting enough flood insurance coverage is becoming increasingly difficult due to the increasing frequency of flooding [14]. According to a representative UK study by Lamond et al. [15], 13% of respondents had their insurance quotes rejected because of the risk of flooding, and 3% more had their policy renewals denied for the same reason. Due to the increased frequency of flooding in developed nations, homeowners must purchase flood insurance. On the other hand, in developing nations, flood insurance is frequently non-existent, forcing victims of flooding to use their savings to pay for the related expenses. In developed nations, getting insurance for places that are vulnerable to flooding presents more and more of a challenge. Even though most homeowners eventually obtain insurance, it is important to recognize the impact that flooding-related stressors have on people who are already dealing with trauma [14].

### **Social stressors**

#### **Fear of reoccurrence**

Those who have flooded in the past are fearful of future flooding because of the long-lasting stress and anxiety associated with flood memories [3, 14]. An ongoing concern related to the fear of flooding recurrence was highlighted by a study done in Guyana, South America, which found that 58% of respondents voiced concerns each time there was heavy rainfall. [1, 12]. Due to the absence of official flood warning systems, households in developing nations are more likely to personally monitor signs of flooding, particularly during periods of prolonged rainfall, as a result of increased fear of a recurrence. This continuous source of stress has a major negative influence on day-to-day living; it strains family ties, discourages homeowners from taking vacations, and frequently causes people to leave work early when it starts to rain [3].

This study emphasizes that fear of recurring flooding is common in both rural and urban areas, with developing country urban areas receiving special attention. This fear may be exacerbated by additional secondary stressors like property damage and lost income. It is very difficult to reduce this stressor because the only ways to do so are either moving to a less flood-prone area or decreasing the frequency of floods [12, 14].

### **Migration and displacement**

During flood events, temporary evacuation is a common practice used to reduce mortality, injuries, and the negative health effects of living in a flooded or damp home [1, 12, 3]. Research from Bangladesh revealed that 50–95% of participants were forced to leave their homes due to frequent floods; this presents special difficulties for small children and the elderly, who may experience anxiety when they are taken out of their familiar environment [15]. When people experience flooding on a regular basis, moving becomes their only practical choice. According to a study conducted in New Orleans, 23% of participants were thinking about, trying, or had already sold their homes as a result of ongoing flood-related problems [13]. Migration may be prompted by recurring property damage or flooding that affects crops [16]. But migration itself can be a secondary stressor because it can be extremely upsetting to be uprooted from one's familiar surroundings and to cut off connections with family and neighbours [15]. Many flood victims, who frequently turn down relocation offers, want to stay in their homes despite their ongoing fear of flooding. But eventually, the overwhelming fear of recurrent flooding may force migration as the only option [3].

It is important to understand that moving does not always mean that stress will go away because there is always the possibility of financial problems [14]. These problems can include difficulties selling a home or increased housing costs in non-flood risk areas. Government funding can also be a major barrier to migration because moving villages can be extremely expensive [13]. The government resettlement decision-making process may become more stressful for property owners if they do not always receive what they believe to be their property's true value [10]. In certain instances, government resettlement leads to households obtaining a five-year loan for the purpose of purchasing a housing plot; this turns resettlement into a financial strain that may cause people to incur debt [10].

In both developed and developing nations, temporary evacuation is a common practice to protect the health of flood victims, whether in rural or urban areas. Moving permanently to urban areas thought to have a lower flood risk, however, is a more common phenomenon in rural settings [1, 16]. Migration and resettlement can lessen physical exposure to the negative health effects of frequent flooding, but they can also increase social and economic vulnerabilities. This highlights the dual nature of migration as a stressor and a solution.

### **Physical and psychological stressors**

#### **Long-term malnutrition**

Food shortages during floods are a result of both the devastation wrought by the floods and the difficulties in reaching stores or transporting supplies because of damaged roads. Flood victims frequently have to cut back on the number of meals they eat as a survival tactic [16, 13]. According to White et al. [7], children from flooded homes had a higher likelihood of being underweight and underdeveloped than children from non-flooded homes. Given that undernutrition in children is linked to underdevelopment, subpar academic performance, and even early mortality [3], this is a serious concern.

Long-term malnutrition is a serious problem, especially in developing nations and mainly in rural areas where it is more difficult for non-profit and governmental organizations to reach flood victims and provide assistance. In order to avert the emergence of chronic health issues, government organizations must step up their assistance to flood victims in rural areas of developing nations [14, 7].

#### **Stress, anxiety and depression**

Due to social and economic factors, communities and individuals experience extreme stress and anxiety when floods occur frequently [13, 15]. Research by Biswas et al. [16] shows the psychological effects of stress and anxiety on human behavior; during flood events, 40% of fathers and 70% of mothers abused their children. Early childhood abuse may have long-term health consequences, such as an increased risk of depression and eating disorders. The heightened influence of repeated events on mental health was highlighted by a 2013 study by Wind et al. [13] that found that mental health symptoms, such as anxiety and depression, were significantly higher in cases of repeated flood events compared to other natural disasters.

Studies conducted in both urban and rural areas have found that flooding causes stress, anxiety, and depression; people in developing nations are especially vulnerable because there aren't enough resources for recovery [7]. In



order to lessen the negative effects of recurrent flooding on mental health, it is important to gain a better understanding of the role that secondary stressors like property damage play in these psychological effects.

### **Isolation**

Repeated floods can cause isolation by making it difficult for people to get to work or school. As a result, families or individuals may experience protracted periods of isolation until the floodwaters subside [13]. This review has shown that isolation can lead to increased levels of stress and anxiety, which is a serious problem in both urban and rural environments. While flood victims in urban areas might be forced to stay inside their homes until the waters subside, isolation in rural areas is exacerbated by remote locations [13].

### **Awareness and preparedness for flood events**

The review emphasizes the difference between flood preparedness and awareness. People may not take preventative action even though they are aware of the risks of flooding, as shown by 16 of the 25 studies in this review [1, 12]. In certain developing nations, problems like low levels of education and inefficient warning systems make lack of awareness a serious. Flood preparedness has become a significant issue in both urban and rural areas, as well as in developed and developing nations [13]. A common problem was reactive rather than proactive preparation, which was linked to a lack of knowledge about mitigation strategies, a lack of funding, a lack of experience, and a short period of time between flood events [14]. Many times, even though residents thought they were ready, they discovered that their actions were insufficient and that flood events were not covered by their insurance [13]. Homeowners and business owners in developed nations have occasionally written off flood preparedness as the exclusive province of the state [14]. Most flood-prepared people were found in developing nations, where people believe that mitigation and preventative measures are their responsibility, while people in developed nations expect more help from the government [2, 18]. Residents with generational ties to a location were found to be more likely to take mitigation action to protect their heritage, indicating that place attachment was a significant factor influencing flood preparedness [19].

In summary, all studies showed a basic level of flood awareness, but little knowledge of mitigation strategies or the effects of flooding on health. Both developed and developing nations experienced significant shortages of preparedness, with communities in the former particularly vulnerable to the effects of secondary stressors because of inadequate flood preparation. Emphasizing the potential escalation of long-term health impacts associated with secondary stressors in unprepared communities, it is imperative to raise awareness about the consequences of inadequate flood preparation [20].

### **Community resilience: adaptation and mitigation**

It is becoming more and more common to support communities in strengthening their ability to recover from flooding together, frequently with little help from the government. Community resilience, which is especially important in developing nations, depends on neighbours and family members offering both emotional and practical support during flood events.

According to this review, there is a strong sense of community spirit in flood-affected areas, which helps during floods and shortens the recovery time [21]. Surprisingly, some research indicates that flooding may improve neighbour relations and increase community resilience [20]. Despite their harsh economic circumstances, people in developing nations are willing to lend money and provide shelter to neighbours during floods [22]. In developing nations, where people created coping mechanisms like building barriers around homes, utilizing creative building materials, and seeking safety on higher ground during floods, both individual and community resilience were especially strong time [23]. Particularly farmers showed resilience by implementing creative strategies, like switching to alternate sources of income during flood seasons—a move that developed nations might also take into account time [24].

The review does stress, though, that a person's resilience is frequently hampered by a lack of financial resources. People can become more resilient by upgrading their properties to lower the risk of flooding, but both developed and developing nations still struggle with financial viability [25]. Due to their higher income status, owner-occupied households are more likely to implement risk reduction measures, which is why housing tenure has emerged as a significant factor influencing flood mitigation [26]. The assessment also noted problems like short-

term, Band-Aid solutions, ignorance and indoctrination, and mitigation initiatives that are more focused on the individual or the business than on the group [27].

### **Community resilience: adaptation and mitigation**

This review emphasizes how community resilience is more prevalent in developing nations overall—this holds true for both urban and rural areas—but it is especially noticeable in developed nations' rural areas. Financial limitations or a reliance on temporary mitigating measures may pose obstacles to the development of community resilience. To lessen the long-term effects of secondary stressors on health, it is imperative to improve community resilience, particularly in urban areas of developed nations [28].

### **Conclusion**

The review comes to the conclusion that secondary stressors have a substantial negative impact on both rural and urban communities in developed and developing nations, with property damage and income loss being almost universal. However, developed countries are primarily affected by some secondary stressors, such as housing costs and insurance. Many communities, especially in developed nations, lack the seriousness and preparedness required for flood events, even though they are aware of the basic risk of flooding. It is noteworthy that flood victims in developing nations are more inclined to take preventative measures, highlighting the necessity for developed nations to take note of these strategies. There are differences in community resilience: it is higher in developing country urban and rural areas as well as in developed country rural areas, but it is lower in developed country urban areas. Innovative adaptation strategies were demonstrated by farmers in developing nations. Future research should concentrate on reducing particular secondary stressors in urban and rural areas in order to improve resilience, according to the review. It is essential to teach communities about proactive, low-cost measures, particularly in urban areas. More studies in the developed world are required to help policymakers comprehend secondary stressors that are unique to communities during the flood recovery process.

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