CHAPTER

# 10

# Health impacts of rapid-onset event: 2022 flash flood in Bangladesh

*Dibakar Chakraborty*[a], *Krishna Prosad Mondal*[b], *Al Jubaer*[b], *Sheikh Tawhidul Islam*[b], *and Byomkesh Talukder*[c]

[a]National University, Dhaka, Bangladesh [b]Institute of Remote Sensing and GIS, Jahangirnagar University, Dhaka, Bangladesh [c]Dahdaleh Institute for Global Health Research, York University, Toronto, ON, Canada

## Abstract

Flash floods have become severe and frequent in the northeast wetland of Bangladesh due to climate change impacts. Flash floods seriously affect agricultural production, especially Boro rice, and socio-ecological systems and cause various health impacts. However, the health impacts of flash floods have not yet been documented well. To capture the health impacts of flash floods, this chapter identifies the health impacts of flash flooding in Bangladesh in 2022. Based on primary data obtained through a questionnaire survey and secondary data from published articles and grey literature, the health impacts are identified and categorized as: (i) scarcity of drinking and bath water; (ii) waterborne diseases; (iii) health service disruption; (iv) vulnerable people's health issues; (v) food insecurity; (vi) mental pressure; and (vii) drowning, injury, lightning, snake bites, and other. By analyzing the health impacts of flash floods using both primary and secondary data verified by key informants, this study proposes recommendations that could be very useful in managing the health impacts of flash floods in Bangladesh.

**Keywords:** Slow onset events, Flash floods, Health impacts, Bangladesh

## 1 Introduction

Climate change has increased the frequency of extreme weather events such as floods, droughts, and heat waves [1–3]. These extreme weather events are also known as rapid-onset hazards [4]. Among these rapid-onset events, flooding is the most common weather risk and the costliest and most widespread natural calamity worldwide [5]. Floods are often caused by heavy rainfall, rapid snowmelt, storm surge, or tsunami [6,7] and can be categorized into six categories: (i) pluvial floods, (ii) flash floods, (iii) river floods, (iv) groundwater floods,


https://doi.org/10.1016/B978-0-443-18515-1.00004-6
Copyright © 2024 Elsevier Inc. All rights reserved.

(v) surge floods, and (vi) coastal floods [8–10]. Flash flooding is one of the most dangerous natural events among these floods. It is often responsible for loss of life and severe failure of infrastructure and socio-ecological systems [11]. Flash floods happen when runoff from extreme rainfall triggers a fast rise in the height of a stream [12,13]. It can occur within minutes of the causative rain, reducing the time on hand to alert and guard the public [14]. Climate change increases the probability of extreme precipitation, leading to more disastrous flash floods [2,15] due to rising temperatures that increase evaporation, which puts more moisture into the atmosphere that can create intense, rapid rainfall. As a result, the timing of flash floods will accelerate while their magnitude grows [7,16].

Around the world, the number of flash floods has increased in recent years. In 2021–2022, Afghanistan, Australia, Bangladesh, India, Pakistan, Nepal, Sri Lanka, Thailand, Germany, Austria, Belgium, Croatia, Italy, Luxembourg, the Netherlands, Switzerland, Angola, Benin, Cameroon, Brazil, and more countries experienced flash floods [17]. Flash floods result in the highest average mortality per event [18,19]. For example, a 2022 flood in Pakistan inundated half of the country and killed 1000 people [20]. Flash floods cause health impacts in various ways. As in other types of floods, the population experiences varying levels of these impacts depending on their location and environmental and social vulnerabilities [21]. Although the health impacts of regular floods such as infectious diseases, food insecurity, mental trauma, drowning, injuries, hypothermia, animal bites, and so forth [22] are well investigated and documented around the world, the health impacts related to flash floods are yet to be documented thoroughly from the perspectives of developing countries even though understanding them will be vital for flash flood-related health impact management. To help fill this gap, the health impacts from a flash flood which occurred in 2022 in the northeast wetland regions (locally known as *Haor*) of Bangladesh are identified in this study.

## 2 A brief description of flash floods in the Northeast of Bangladesh

Bangladesh is vulnerable to floods, but its northeast *Haor* regions (wetlands, see Fig. 1) are particularly subject to frequent flash floods because of their geographical location [23]. The *Haor* region is situated in the Meghna Basin and commonly experiences flash floods due to heavy rainfall in the Indian states of Assam and Meghalaya, which lie upstream of rivers that flow into Bangladesh through hilly topographic terrain characterized by steep slopes [24]. The whole *Haor* regions are low-lying and bowl-shaped and inundated for 7–8 months of the year during monsoon season [25]. These regions account for 43% of the country's land area, 1.99 million hectares in the northeast. There are seven districts: (i) Sunamganj, (ii) Sylhet, (iii) Habiganj, (iv) Moulvibazar, (v) Netrokona, (vi) Kishanganj, and (vii) Brahmanbaria [26]. The deepest parts of the *Haor* regions are labeled with different names like *Tanguar Haor*, *Hakaluki Haor*, *Shanir Haor*, and *Kharchar Haor*. These *Haors* have immense importance due to its agricultural and ecological services benefits, although it is highly prone to monsoon flooding. It provides various livelihood options for its inhabitants, as shown in the *Tanguar Haor* cross profile depicted in Fig. 2.

In addition to regular monsoon flooding, the region is subject to substantial river and flash flooding, presenting challenges for the large population and bringing irreparable direct or indirect harm to the socio-ecological systems. For example, disastrous floods in 1954, 1955, 1974, 1987, 1988, 1998, 2004, 2007, 2014, 2016, and 2017 resulted in significant property damage and fatalities

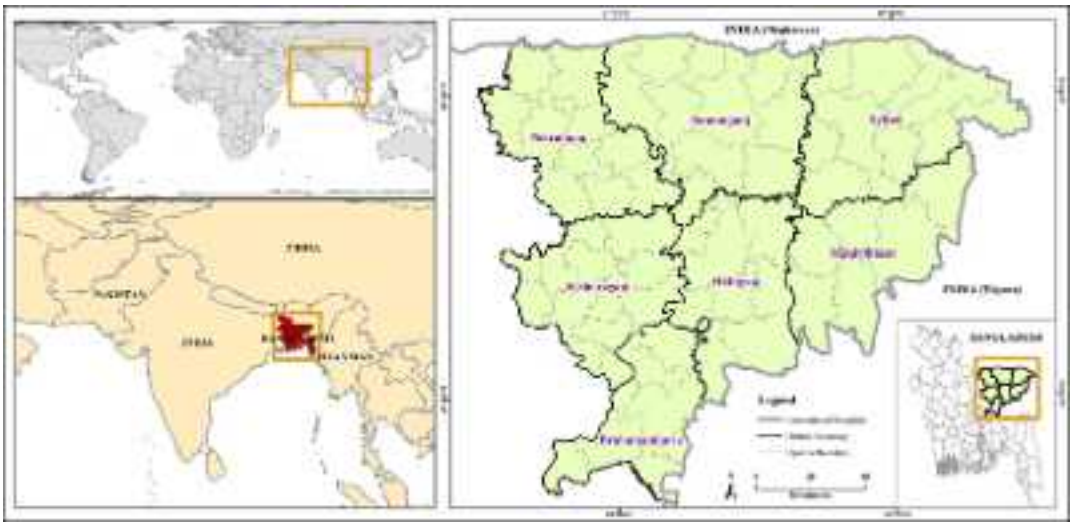


**FIG. 1** Flash flood-prone regions in the northeast *Haor* (wetland) area of Bangladesh.

[28]. The region faced the most devastating natural calamity of its history due to flash floods in 2017, with 49,244 out of 166,682 ha of Boro (Boro is a winter-season, photo-insensitive, transplanted rice cultivated with supplemental irrigation [29]) rice land in the Sunamganj District damaged [25]. The final estimated failure report for the rice harvest was about 400,000 tons worth 157 million USD. This failure resulted in local food insecurity as well as a crisis of food supplies for livestock. Farmers lost 308,000 metric tons of wet straw and 46,000 tons of grass, valued at about 1.1 million USD and 9.22 million USD, respectively [25]. In 2019, floods in Bangladesh killed 104 people and affected 2.1 million people across 24 districts [30].

In June 2022, the northeastern *Haor* region was hit by two severe flash floods within a 15-day interval, with the Sylhet and Sunamganj Districts most severely affected (see Fig. 2A). The ensuing floods affected 7.2 million people, with more than 4.8 million displaced in nine districts of northeast Bangladesh. About 450,000 people took refuge in flood shelters. The government arranged around 1605 flood shelters for the affected people [31]. An overview of the effects and damages of the 2022 flash flood in northeast *Haor* region is presented in Fig. 2B.

Climate change has increased the severity and frequency of the phenomenon, with more erratic rainfall causing more flash floods [32]. The incidences of flash floods have increased in the northeastern parts of Bangladesh due to unusually intense rains during the early monsoon season. In June 2022, Assam and Meghalaya received 2500 mm of rain over 3 days, with Mawsynram village in Meghalaya, the wettest place in the world, receiving 972 mm of rainfall in just 24 h on 17 June. This was the third highest (The highest was 1563.3 mm, recorded on 16 June 1995; the second highest was 973.8 mm on 5 June 1956 [27]) 24-h amount of rain in June in 122 years [27]. In addition to this heavy upstream rainfall, there was excessive rainfall in the Sylhet and Sunamganj Districts, with the latter recording 185 mm in 24 h [24]. Human encroachment in drainage channel areas resulting in low drainage capacity of local rivers/canals and unplanned development in the watershed areas has compounded the problem, blocking the quick runoff of excess water [33]. This situation has caused rising water levels in the rivers within a short period of time and created sudden flash flood conditions in the area (Fig. 3).

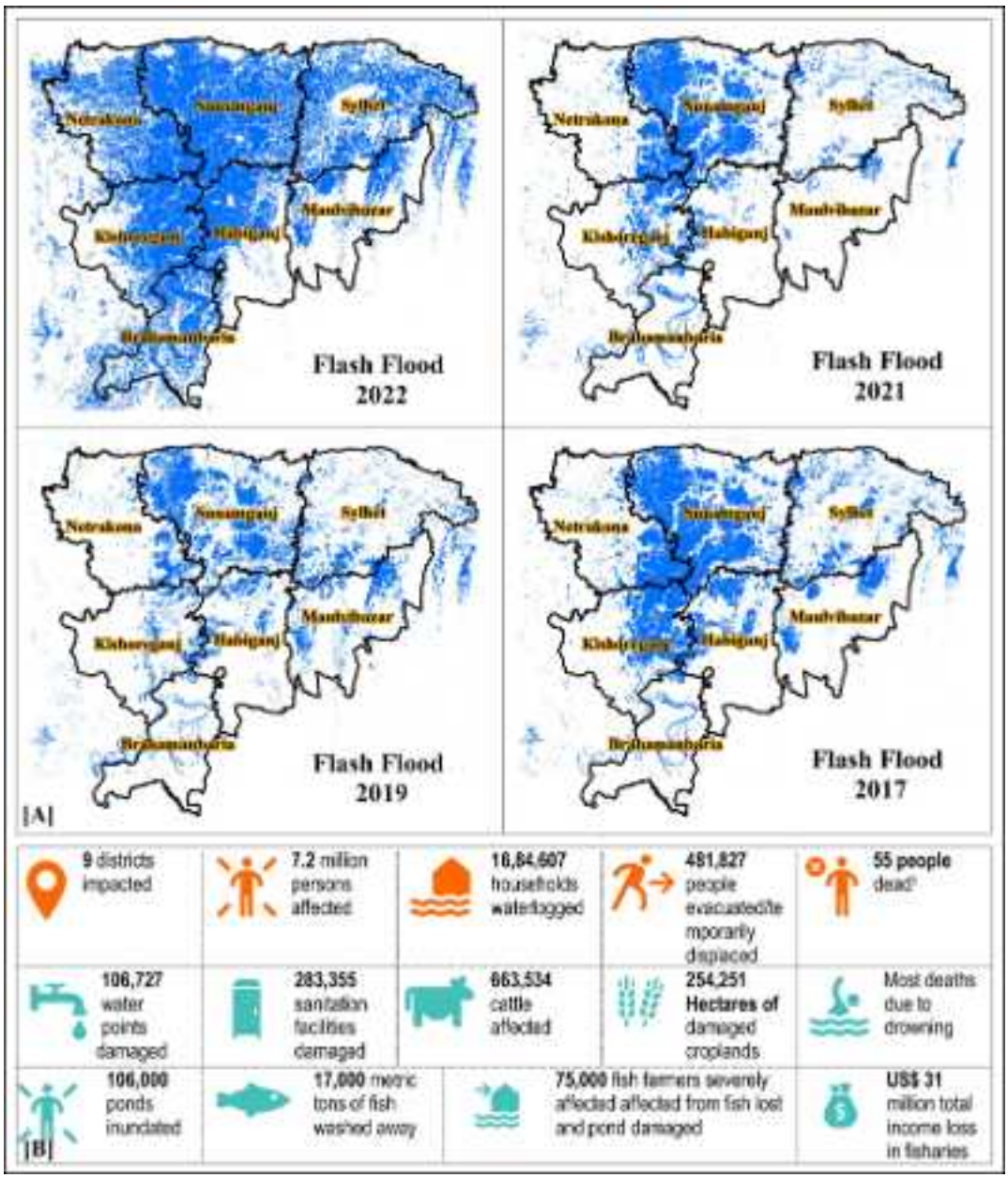



**FIG. 2** (A) Areas that experienced flash floods in 2017, 2018, 2021, and 2022 in northeastern *Haor* Region; (B) Overview of damages due to 2022 flash flooding in northeast Bangladesh [27].




**FIG. 3** A cross profile of Tanguar *Haor* in Sunamganj District of Bangladesh.

## 3 Methodology

The health impacts of the flash floods in 2022 in northeastern Bangladesh were captured in this work based on primary and secondary data. A closed-ended questionnaire survey was conducted to gather primary data from 116 respondents who were female students in grades XI–XII at the Sunamganj Government Women's College. Women college students were selected because they are associated with household activities and have good community-based social networks. All of the respondents' households were affected by the flooding. Secondary data were collected from various published papers and reports. Key informant interviews with health practitioners (such as Upazila medical officers, pharmacists, and nurses), local pharmacists, local community leaders, agricultural officer, local administrators, and NGO activities were conducted to verify the findings.

## 4 Results and discussion

The health impacts of flash floods are wide-ranging and can be categorized in several ways, such as direct and indirect, immediate crises and long-term consequences, impacts based on gender and age, and impacts in connection with the locations of communities (e.g., near or far from rivers/wetlands). In this investigation, the health impacts of the 2022 flash floods in the Sunamganj District of Bangladesh are categorized into seven types and discussed in the sections below. These are (i) scarcity of drinking and bath water; (ii) waterborne diseases; (iii) health service disruption; (iv) vulnerable people's health issues; (v) food insecurity; (vi) mental pressure; and (vii) drowning, injury, lightning, snake bites, and other.

### 4.1 Scarcity of drinking and bath water

The water supply is particularly vulnerable during flash flood events. Per the local administration, around 2 million people faced a freshwater crisis during the flash floods in the Sunamganj District. In their report titled "Flash Floods Humanitarian Response Plan 2022," the HCTT and MoDMR [27] also highlighted this effect. The respondents in this study reported that 80% of tube wells and other freshwater sources were submerged. In many localities, drinking water sources became contaminated due to contact with raw sewage, agricultural waste, and chemicals. The respondents noted that many localities lacked drinking water for one to two weeks. Bathing water was also affected, as the open fresh water was contaminated. More than 90% of respondents reported scarcity of drinking water and water for bathing (see Fig. 4D).

### 4.2 Waterborne diseases

During and after flash flooding, the water supply suffers from damaged sanitation systems or open defecation, accelerating the spread of waterborne diseases and triggering health risks. According to the HCTT and MoDMR [27] report, 3276 acute watery diarrhea cases and 236 skin diseases were reported in the northeast flash flood areas. According to the key informants, inhabitants also experienced waterborne diseases. Among respondents 75%, 56%,

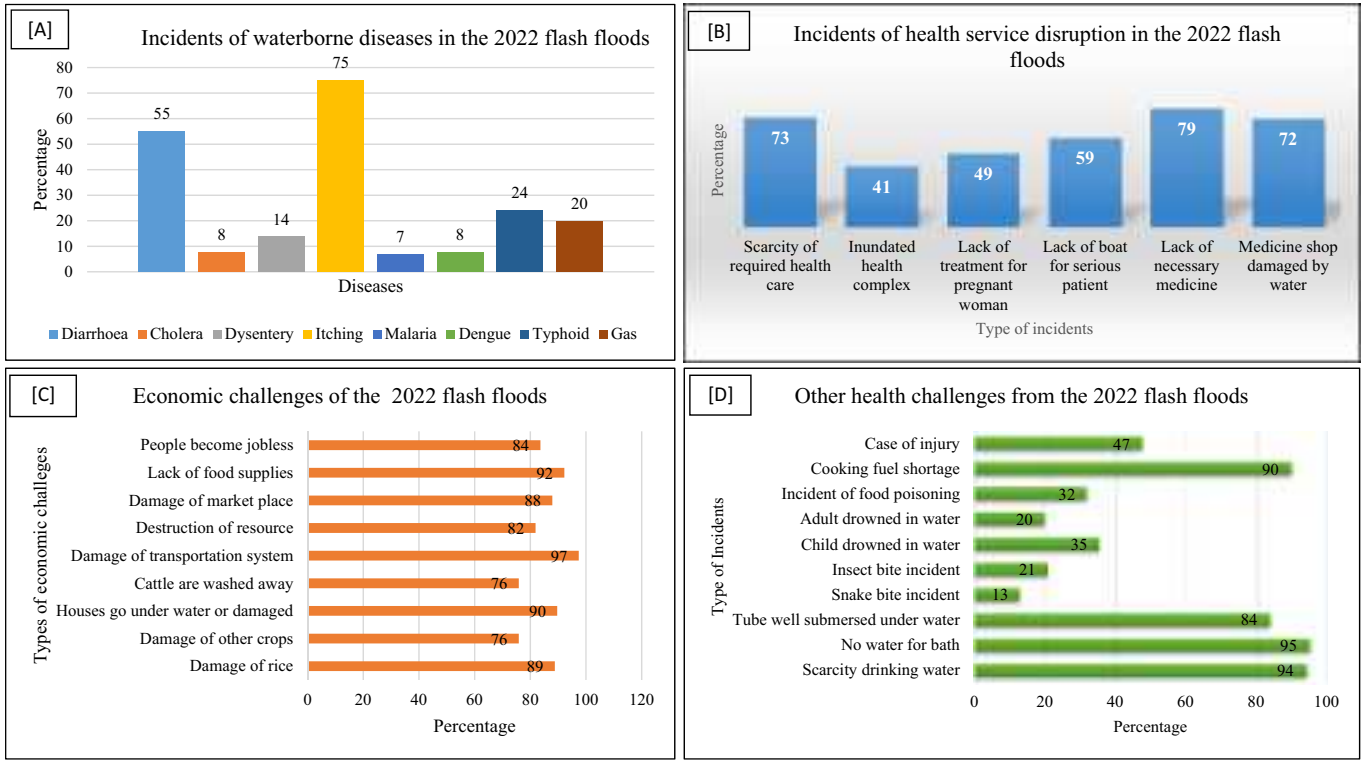



**FIG. 4** (A) Incidents of waterborne diseases. (B) Incidents of health service disruption. (C) Economic challenges. (D) Other health challenges.

24%, and 20% observed itching, diarrhea, typhoid, and gas problems, respectively, among people of the affected areas (see Fig. 4A). The local health authorities also reported an increased frequency of these diseases among inhabitants after the flooding subsided. Many inhabitants were food poisoned due to water contamination.

## 4.3 Health service disruption

Flash floods disrupt health services similar to other types of natural disasters. Health facilities at the Upazila level, such as the Upazila Health Complex, Community Clinic, and Union Health & Family Welfare Centre, were significantly affected [27]. Many health facilities were inundated, damaged, or destroyed by the floods (see Picture 1A–C). About 80% of respondents experienced scarcity of medicine during the flash floods. Around 70% of respondents reported that people were deprived of required health treatment and essential drugs, as the medical facilities and pharmacies were inundated by water. Access to and by healthcare providers was seriously hampered as people could not reach hospitals due to the destruction of the road network (see Picture 1D). The road networks and regular naval communications systems were disrupted, and the electricity supply and mobile network were cut off for 5 days, significantly impacting public health treatment. In addition, the impacts of the flash floods made the lives and work of healthcare providers more challenging than usual, raising the risk of burnout.

## 4.4 Vulnerable people's health issues

Sick children and pregnant women faced significant barriers to accessing medical facilities, and there was a lack of emergency treatment for them. The key informants observed that the elderly, disabled, and children suffered greatly during the flash flooding. According to the United Nations (UN), around 60,000 pregnant women were in the affected area in Bangladesh [24]. Almost 50% of respondents observed that pregnant women were deprived of proper treatment due to a lack of boats to take them to the hospital, and 60% of respondents reported the scarcity of vessels to transport severe patients (see Fig. 4B). Many pregnant women could not move to a flood shelter or safe place due to a lack of transportation and communication. Complications following birth and delays in getting to the hospital were responsible for maternal deaths. Many people prefer to call village doctors or kobiraj (a type of quack practicing traditional Ayurveda) when any serious maternal complication arises. Nevertheless, these practitioners do not have the appropriate skills to ensure proper treatment. The key informants and the respondents firmly believe that natural catastrophes like floods in the affected areas significantly impact maternal fatalities.

## 4.5 Food insecurity

Flash floods caused severe damage to crops, with 83,394 ha damaged, and to livestock, with losses worth 28.1 million USD (HCTT and MoDMR [27]). Around 2 million people faced a food crisis during and after the flash flooding [34]. Among the respondents in this study, 80% observed food insecurity among the affected area's inhabitants (see Fig. 4C).




**PICTURE 1** (A) Biswambharpur Upazila Health, (B) Derai Upazila Health Complex, (C) Complex Sunamganj Government Sadar Hospital, (D) Example of disruption of road network from Sunamganj to Tahirpur road, (E) Screenshot of Facebook post seeking insulin.

According to the Department of Agriculture Extension division, approximately 90% of the usual Boro harvest was damaged. Not only the Boro rice in the fields but also stored rice in the homes of farmers was damaged. Flash flooding primarily affected the availability of food stocks and agricultural produce, as both private and market food storage was inundated. Affected people were reportedly surviving on limited minimal stocks of dry foods. With average general inflation of 7.43%, food inflation of 8.30%, and the highest rate of increase in the prices of essential commodities in 8 years, cash distribution may increase the inflation and price hikes. Food safety is also a concern as food stored in private warehouses, households, shops, and chatals was damaged by flood water, but residents may still try to utilize it [27].

About 83% of respondents mentioned that day laborers lost their jobs as a result of the flooding. Most people in these districts depend on agriculture for livelihood and jobs, and their means of livelihood were heavily damaged during the crisis. In particular, poor people in rural areas face increased food insecurity due to reduced incomes, loss of employment in agriculture sectors, and asset losses. Significant sources of animal feed were destroyed, and the livestock, poultry, and fisheries sectors were affected heavily due to the lack of feed, forcing farmers to sell at a lower price and causing additional losses. Food supply chains have become non-functional, contributing to food insecurity.

The shortage of cooking fuel is a critical difficulty faced by the people during the flash flooding. According to the survey, about 90% of responders reported that people experienced a cooking fuel shortage resulting in the availability and acceptability of food. During the 2022 flash flooding, about 150,000 households in Sylhet and Sunamganj were without electricity due to the submersion of power plants [34], which also hampered the ability to cook and prepare food.

## 4.6 Mental pressure

In Sunamganj, 71% of areas were flooded, and approximately 50,000 people were evacuated to 1605 flood shelters isolated from neighbors and relatives, creating mental pressure among the evacuated people. Lack of drinking water, insufficient health facilities, food insecurity, and unemployment put a huge mental strain on poor people. The rapid gender analysis conducted by the Gender in Humanitarian Action Working Group (GiHA) found that 60% of women, who depend mostly on day labor and tending livestock for their livelihoods, lost their income, while 40% of affected women experienced damaged cooking utensils. With no food stock in most affected households, many rely on dry food relief to get half a meal per day [27]. This situation has created considerable mental pressure among women. Many children were deprived of education as floods damaged more than 870 educational facilities, primarily government primary schools, and they were closed [34], which is a massive blow to children's mental health. Per the respondents, 28.4% of schools and 75% of textbooks were damaged.

Other economic challenges such as (i) damage to rice, (ii) damage to other crops, (iii) submerged or damaged houses, (iv) cattle washed away, (v) damage to the transportation system, (vi) destruction of resources, (vii) damage of marketplaces, (viii) lack of food supplies, and (ix) job loss (see Fig. 4C) also created mental pressures in various dimensions among the people of Sunamganj. These pressures were reflected among the respondents; 89.7% reported that they felt social insecurity during the flood as there was a lack of relief activities (see Fig. 5).

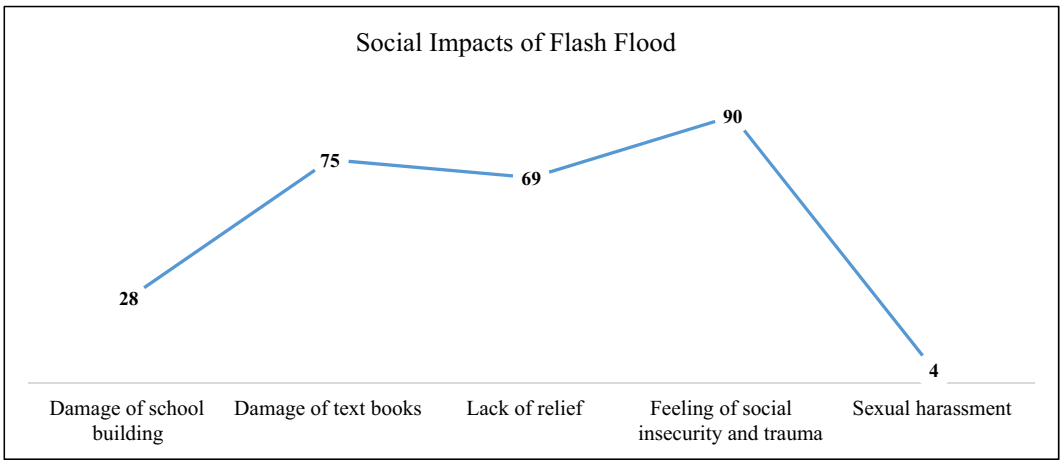



**FIG. 5** Social impacts of flash flooding.

## 4.7 Drowning, injury, lightning, snake bites, and other

According to the HCTT and MoDMR [27], 26 people died from drowning, lightning, snake bites, and other causes in Sunamganj. The respondents also noted these problems (see Fig. 4D) in their answers. People also faced acute respiratory infection, injury, eye infections, and near drowning. Another health problem was getting regular medicine related to many noncommunicable diseases such as diabetes, hypertension, kidney disease, and so forth. For example, as shown in Picture 1E (in Bengali language), someone requested insulin during the start of the flash flood when still electricity and Facebook were operational. The key informants also mentioned that many people who with noncommunicable diseases suffered from lack of access to medicine as suddenly all the pharmacies and hospital were closed, and people could not travel freely.

# 5 Conclusions

The 2022 flash floods caused various sudden health impacts among the inhabitants of the Sunamganj District. Nevertheless, health conditions receive less attention from government and nongovernment agencies than the food supply and temporary shelter, which are on the priority lists of relief activities. Water, sanitation, hygiene issues, treatment of injuries, and evacuation of people in serious emergencies (e.g., pregnant women, wounded aged people, those injured by poisonous animals, etc.) receive less attention from agencies engaged in providing support services during emergencies. Health issues are less prioritized even in predisaster preparedness planning. Based on the community consultations, the following recommendations are made to ameliorate the situation:

**(i)** Developing community-based early warning systems can be very useful in providing some warning to communities so they can evacuate in time to save lives.

**(ii)** Floating hospitals are a solution for providing primary and emergency health care facilities when the road and navigation systems are disrupted.

**(iii)** Ensure uninterrupted power supply for the flash flood areas. An uninterrupted power supply is crucial for communication, identifying the victims, and providing emergency health care facilities.

**(iv)** Establish a community-led rice bank initiative to provide food/rice during a crisis.

**(v)** Enhanced collaboration with the government and development partners requires holistically addressing health impacts and ensuring immediate food, water, and cash assistance to flood victims.

**(vi)** Managing the health impacts of flash floods has to be incorporated into national disaster management systems and included in all development activities in the flash flood-prone areas of Bangladesh.

**(vii)** Government agencies must protect the sources of the freshwater systems.

**(viii)** The overall health impacts and their management will have to be a part of the government Water, Sanitation and Hygiene program.

**(ix)** Houses, schools, medical facilities, and other establishments must be redesigned to be adaptive and resilient to frequent flash floods.

**(x)** The medical establishment must be equipped with facilities to address the specific health impacts of flash floods.

**(xi)** Innovative and adaptive agricultural systems should be introduced to make agriculture adaptive and resilient so that it can help to alleviate food insecurity related to flash floods.

**(xii)** The government should take steps to improve the infrastructure such as building stronger homes, improving road and bridge networks, and developing alternative water and sanitation systems to reduce the risk of damage and loss.

**(xiii)** Flash flood-related health education and awareness among communities will be helpful to prepare for flash flood-related health impacts and respond effectively to reduce the health risk.

**(xiv)** Emergency response plans should be designed to ensure that adequate resources are available to respond to the health needs of affected communities during and after flash floods.

**(xv)** Strengthening the capacity of existing healthcare facilities is essential to addressing the health impacts of flash floods.

## References

[1] D.G. Huber, J. Gulledge, Extreme Weather and Climate Change: Understanding the Link, Managing the Risk, Pew Center on Global Climate Change, Arlington, 2011.

[2] S.I. Seneviratne, N. Nicholls, D. Easterling, C.M. Goodess, S. Kanae, J. Kossin, Y. Luo, J. Marengo, K. McInnes, M. Rahimi, M. Reichstein, A. Sorteberg, C. Vera, X. Zhang, Changes in climate extremes and their impacts on the natural physical environment, in: C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, P.M. Midgley (Eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Cambridge University Press, Cambridge, UK, and New York, NY, USA, 2012, pp. 109–230. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC).

[3] P. Stott, How climate change affects extreme weather events, Science 352 (6293) (2016) 1517–1518.

[4] C. Zickgraf, Climate change, slow onset events and human mobility: reviewing the evidence, Curr. Opin. Environ. Sustain. 50 (2021) 21–30.
[5] Z.M. Taib, N.S. Jaharuddin, Z.D. Mansor, A review of flood disaster and disaster management in Malaysia, Int. J. Account. Business Manag. 4 (3) (2016).
[6] W. Kron, Flood disasters—a global perspective, Water Policy 17 (S1) (2015) 6–24.
[7] S.I. Seneviratne, X. Zhang, M. Adnan, W. Badi, C. Dereczynski, A. Di Luca, S. Ghosh, I. Iskandar, J. Kossin, S. Lewis, F. Otto, I. Pinto, M. Satoh, S.M. Vicente-Serrano, M. Wehner, B. Zhou, Weather and climate extreme events in a changing climate, in: V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, B. Zhou (Eds.), Climate Change 2021: The Physical Science Basis, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2021, pp. 1513–1766, https://doi.org/10.1017/9781009157896.013. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
[8] L. Andrade, J. O'Dwyer, E. O'Neill, P. Hynds, Surface water flooding, groundwater contamination, and enteric disease in developed countries: a scoping review of connections and consequences, Environ. Pollut. 236 (2018) 540–549.
[9] R.H. Falconer, D. Cobby, P. Smyth, G. Astle, J. Dent, B. Golding, Pluvial flooding: new approaches in flood warning, mapping and risk management, J. Flood Risk Manag. 2 (3) (2009) 198–208.
[10] M. Rahman, N. Chen, A. Elbeltagi, M.M. Islam, M. Alam, H.R. Pourghasemi, A. Dewan, Application of stacking hybrid machine learning algorithms in delineating multi-type flooding in Bangladesh, J. Environ. Manag. 295 (2021) 113086.
[11] H.A.P. Hapuarachchi, Q.J. Wang, T.C. Pagano, A review of advances in flash flood forecasting, Hydrol. Process. 25 (18) (2011) 2771–2784.
[12] H. Brammer, Floods in Bangladesh: geographical background to the 1987 and 1988 floods, Geogr. J. (1990) 12–22.
[13] M. Kelsch, Hydrometeorological characteristics of flash floods, in: Coping With Flash Floods, 2001, pp. 181–193.
[14] J.D. Creutin, M. Borga, E. Gruntfest, C. Lutoff, D. Zoccatelli, I. Ruin, A space and time framework for analyzing human anticipation of flash floods, J. Hydrol. 482 (2013) 14–24.
[15] P. Guhathakurta, O.P. Sreejith, P.A. Menon, Impact of climate change on extreme rainfall events and flood risk in India, J. Earth System Sci. 120 (2011) 359–373.
[16] E. Shao, How Is Climate Change Affecting Floods?, The New York Times, USA, 2022.
[17] Floodlist, Floodlist, 2022. https://floodlist.com/america/brazil-floods-santa-catarina-december-2022#:~:text=Brazil%20%E2%80%93%20Santa%20Catarina%20Floods%20andperiod%20to%2005%20May%202022.
[18] S.N. Jonkman, Global perspectives on loss of human life caused by floods, Nat. Hazards 34 (2) (2005) 151–175.
[19] WMO, GWP, Handbook of Drought Indicators and Indices Geneva, World Meteorological Organization (WMO) and Global Water Partnership (GWP), 2016.
[20] O. Milman, Nature Is Striking Back': Flooding Around the World, From Australia to Venezuela, The Guardian, UK, 2022.
[21] M. Ahern, R.S. Kovats, P. Wilkinson, R. Few, F. Matthies, Global health impacts of floods: epidemiologic evidence, Epidemiol. Rev. 27 (1) (2005) 36–46.
[22] W. Du, G.J. FitzGerald, M. Clark, X.Y. Hou, Health impacts of floods, Prehospital Disaster Med. 25 (3) (2010) 265–272.
[23] M.E. Huq, et al., Measuring vulnerability to flash flood of urban dwellers, in: T. Sumi, S.A. Kantoush, M. Saber (Eds.), Wadi Flash Floods. Natural Disaster Science and Mitigation Engineering: DPRI Reports, Springer, Singapore, 2022, https://doi.org/10.1007/978-981-16-2904-4_12.
[24] AH, Flash Floods in Bangladesh—and the Way Forward for the Anticipatory Action Community, The flash floods, Anticipation Hub (AH), 2022. https://www.anticipation-hub.org/news/flash-floods-in-bangladesh-and-the-way-forward-for-the-anticipatory-action-community.
[25] D. Chakraborty, K.P. Mondal, S.T. Islam, J. Roy, 2017 flash floods in Bangladesh: lesson learnt, in: I. Pal, R. Shaw, S. Shrestha, R. Djalante (Eds.), Disaster Resilience and Sustainability, Elsevier, 2021.
[26] CEGIS, Master Plan of Haor Area, Bangladesh Haor and Wetland Development Board (BHWDB), Summary Report, vol. II, Ministry of Water Resources, Government of the People's Republic of Bangladesh, 2012.
[27] HCTT, MoDMR, Humanitarian Coordinator Task Team (HCTT) In collaboration with the Bangladesh Ministry of Disaster Management and Relief (MoDMR), 2022, United Nations Bangladesh Coordinated Appeal July—December 2022 https://fscluster.org/sites/default/files/documents/final_hrp_flash_flood_humanitarian_response_plan_2022_updated_7th_july.pdf.

[28] M.N. Haque, S. Siddika, M.A. Sresto, M.M. Saroar, K.R. Shabab, Geo-spatial analysis for flash flood susceptibility mapping in the North-East Haor (Wetland) region in Bangladesh, Earth Syst. Environ. (2021), https://doi.org/10.1007/s41748-021-00221-w.
[29] U.P. Singh, Boro Rice in Eastern India, in: Rice-Wheat Consortium Regional Technical Coordination Committee Meeting. 10-14 February 2002, Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi, India, 2002.
[30] M. Uddin, Meyer, Operational flood mapping using multi-temporal sentinel-1 SAR images: a case study from Bangladesh, Remote Sens. 11 (13) (2019) 1581, https://doi.org/10.3390/rs11131581.
[31] UN, Joint Press Statement on Flash Flood—July 2022, 2022, Bangladesh https://bangladesh.un.org/en/189312-joint-press- statement-flash-flood-july-2022.
[32] F. Mahmud, Bangladesh Floods: Experts Say Climate Crisis Worsening Situation, Aljazeera, 2022. https://www.aljazeera.com/news/2022/6/22/bangladesh-floods-experts-say-climate-crisis-worsening-situation.
[33] A. Siddique, More Research About Relationship Between Flash Floods and Climate Change Needed, UNDRR, 2022. https://www.preventionweb.net/news/more-research-about-relationship-between-flash-floods-and-climate-change-needed#:~:text=Unusually%20heavy%20rains%20during%20thequick%20run off%20of%20excess%20water.
[34] Care. (2022). Needs Assessment Working Group (NAWG): Situation Analysis North Eastern Flash Flood 2022 (Version-1). https://www.humanitarianresponse.info/en/operations/bangladesh/document/20220521 flashfloodsav3 (Accessed 08/17/2022, 2.19 am).