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Flood Risk Management in Bangladesh: Evaluating Health Impacts from 2020 Bangladesh Flood

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ABSTRACT:

Objectives: In 2020, Bangladesh faced severe floods from heavy rains, impacting health in rural areas, but information on risk factors was lacking. Thus, the study aims to assess the health effects in coastal areas due to environmental risk factors and inadequate disaster management systems.

Study Design: This study first reviews the existing disaster information management system, focusing specifically on how to collect health information from residents of Bangladesh. Second, a questionnaire survey and two focus group discussions were conducted in August 2021 in two subdistricts in the coastal area. Logistic regression analysis was then conducted to assess environmental health effects.

Methods: This study was developed using a combination of qualitative and quantitative research methods, making it a mixed-method study. Odds ratios with 95% confidence intervals of disease incidence from each environmental factor were calculated. Descriptive analysis and data visualization were conducted using Microsoft Excel for Focus Group Discussion data.

Results: Out of 168 participants, 82.73% were directly affected, with 44% evacuated. Water supply (60.43%) and sanitation (69%) were severely disrupted. Over half couldn't access drinking water (62%), food (59.71%), or medicine (72%). People without access to medicine during floods had more experiences of diarrhea [Odds ratio: 2.23 (95% CI: 1.10-4.48)], worsening their mental health [3.80 (95% CI: 1.56-9.26)] compared with people who could access it.

Conclusion: In remote coastal areas, floods disrupted sanitation, food, drinking water, and health. This study compared the effects of the 2020 floods on the physical and mental well-being of those who were directly and indirectly affected.

KEYWORDS: Risk factors, Coastal areas, Evacuation, Sanitation, Diarrhea, Mental health

I. INTRODUCTION

Floods are a prevalent natural disaster all around the world, and Bangladesh is one of the world's most flood-prone nations. Bangladesh is highly susceptible to floods due to the presence of 230 rivers and tributaries, forcing the country to drain heavy rainfall and river flow. This excess flow often overwhelms the river networks, making Bangladesh one of the most flood-prone countries in the world.[15] Floods have wreaked havoc on the country in the past, killing people and destroying property[7], and they continue to do so every year, killing over 5,000 people and destroying over 7 million dwellings.[12]

Floods not only destroy the land and property of the country but can also affect human health and well-being in a variety of ways. Some researchers, like Ramin & McMichael (2009) and Schwartz (2006) believe that floods cause long-term fatalities.[18,20] According to Shimi et al. (2010), in addition to various vulnerabilities during floods, water supply, sanitation and health problems became significant.[21]

In 2020, heavy rains and cyclone 'Amphan' caused major floods in Bangladesh. Tentulia and Agunmukha rivers in Galachipa and Payra river in Amtali flooded the entire upazila. A report dated August 19, 2020 from the Bangladesh Ministry of Disaster Management and Relief (MoDMR) states that over 5,000,000 people suffered injuries and over 50,000 people in 33 flood-affected areas developed illnesses like typhoid, dermatitis, diarrhea, and eye inflammation.[8] However, the exact health impacts are unknown due to communication disruptions and insufficient information management.

Estimating flood risk is crucial for managing floods and addressing health issues in flood-affected areas. Infectious disease risk increases with poor sanitation and contaminated water sources. Flood waters contaminate subterranean water sources.[10]

Due to the contamination of surface water by both organic and inorganic pollutants, flooding causes a shortage of drinking water.[14] Diarrhea, cholera, and other intestinal diseases increase significantly during and after floods in flooded and non-flooded communities.[19]

Much research has been done to assess the risk of flooding and related health effects on a spatial scale using risk mapping. Researchers have utilized geographic information systems to couple spatial data on risks[22] and vulnerabilities to quantify flood risk.[13] Despite existing literature, there is still a lack of information on flood risks in hard-to-reach coastal areas. The study aims to review flood management systems and identify environmental risk factors affecting health in rural coastal areas affected by the 2020 Bangladesh floods. Objectives include describing health impacts, evaluating causes of health risks, and offering recommendations to reduce disaster-related diseases. Findings will help clarify health risks and develop mitigation measures, assisting policymakers in identifying and mitigating risks in coastal areas.

II. METHODS

A. *Study Area*

Study areas in southern Bangladesh include Galachipa Upazila in Patuakhali District and Amtali Upazila in Barguna District. Galachipa is located between 21°48′ and 22°21′ N and 90°15′ and 90°37′ E,[17] while Amtali is situated between 22.14° N and 90.22° E.[11]

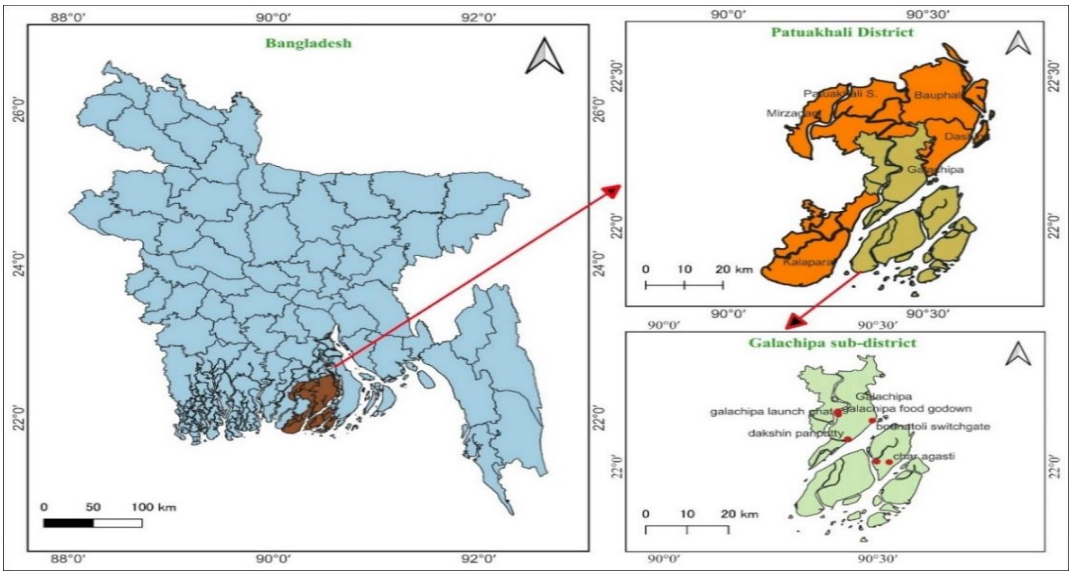

Figure 1. Map of the study area of Galachipa Upazila (Sub-district) in Patuakhali District

Source: GIS shape file obtained from DIVA-GIS (https://www.diva-gis.org/)

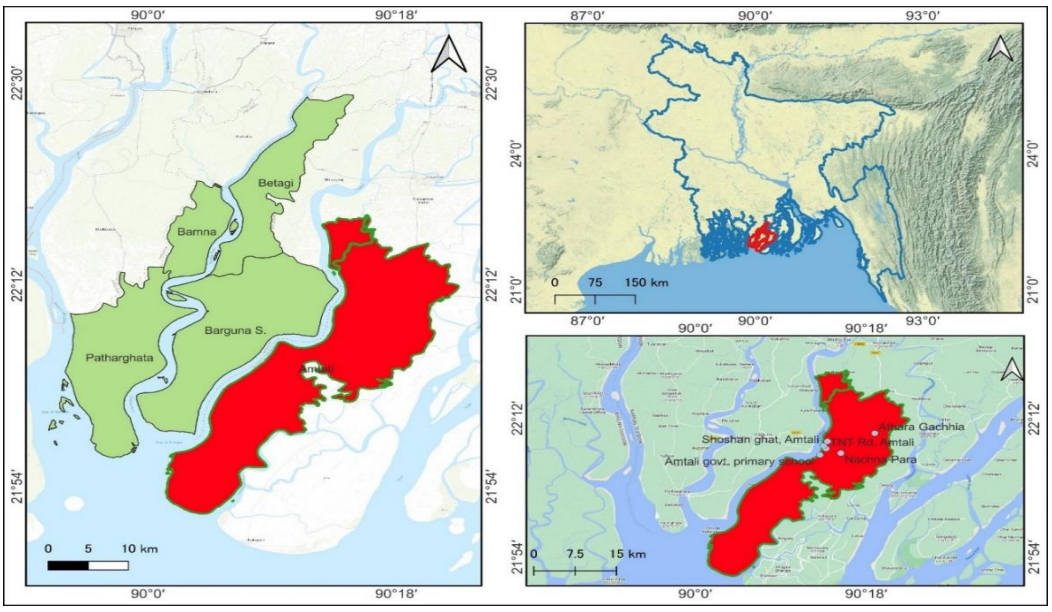

Figure 2. Map of the study area of Amtali Upazila (Sub-district) in Barguna District

Source: GIS shape file obtained from DIVA-GIS (https://www.diva-gis.org/)

The floods caused by cyclone 'Amphan' in 2020[3] and monsoon floods that year[9] affected residents of my chosen subdistricts. For the aforementioned factors, these coastal areas are ideal for researching disaster risk management in Bangladesh, focusing on health risks from flooding.

B. *Study design and data collection*

This study targeted 188 residents and local government officials in flood-affected areas. Data was collected from 168 adults through questionnaire surveys and 20 individuals through two focus group discussions, despite floods affecting people of all ages.

Table I: The participants, methods and tools used to collect data

Serial No.	Source of Information	Instrument
1	Residents of my selected areas	Questionnaire based face to face interview, Audio & video recording, Focus Group Discussion (FGD), Taking notes
2	Local officials of my selected areas	Same

In this study we used "Stratified Random Sampling". Also, using the following equation we have selected the respondent for the questionnaire survey and FGD.

Sample group = (sample size/population size) x stratum size.

Sample group: $\frac{217404}{498438} \times 188 = 82$

Table II : Selected participants through Stratified Random Sampling

Strata (Location)	Number of people in population	Number to be included in sample
Amtali Upazila	217404	82
Galachipa Upazila	228009	86
FGD (Char Kajal & Barabagi Union (small part of sub-district))	53025	20
Total	498438	188

This study is a mixed method study i.e., both qualitative and quantitative research methods were applied for the development of this study. This study explores the relationship between flood exposure and health outcomes in a cross-sectional research design approach. In the cross-sectional research, quantitative data were collected in August 2021 through a questionnaire survey and qualitative data were from the FGD method in the study area.

C. *Data Processing and analysis*

The collected data was analyzed using R-programming version 4.1.1 and RStudio version 22021.09.0. Logistic regression was used to calculate odds ratios with a 95% confidence interval for disease incidences related to environmental factors. The analysis focused on health challenges during and after floods, exploring each question individually. Descriptive analysis of Focus Group Discussion data was done using Microsoft Excel to prepare frequencies, percentages, tables, and graphs, providing insight into flood management and health risks.

III. RESULTS

A. *Flood Exposures*

The majority of the study participants were from two coastal subdistricts, and 82.73% of them were directly impacted by the 2020 floods.

Table III: Demographic and Socio-Economic Profile of Respondents in Selected Coastal Areas

Respondent Characteristic	Directly affected (%) (n = 139)	Indirectly affected (%) (n = 29)
Sex		
Male	44.60	65.51
Female	55.39	34.48
Age (years)		
≤20	7.19	0.00
21-30	22.30	17.24
31-40	26.61	24.13
41-50	24.46	20.68
51-60	9.35	17.24
>60	10.07	20.68
Schooling		
No Education	32.37	51.72
Primary (class1-class5)	37.41	17.24
Secondary (class6-class10)	9.35	13.79
Higher secondary (class11-class12)	13.66	3.44
Higher study (honours/master's)	7.19	13.79
Occupation		
Fisherman	32.37	37.93
Farmer	12.23	24.13
Small business	15.82	13.79
Day labour	10.07	6.89
Housewife	24.46	6.89
Others	5.03	10.34

Direct victims faced damage to their homes, with 61% completely submerged and 39% partially flooded. Most homes (72.7%) were completely destroyed. 44% of those affected were evacuated to shelters or other locations. The results also disclosed problems with long-term prescription shortages (65%), a lack of life-saving supplies, and poor sanitation (69%).

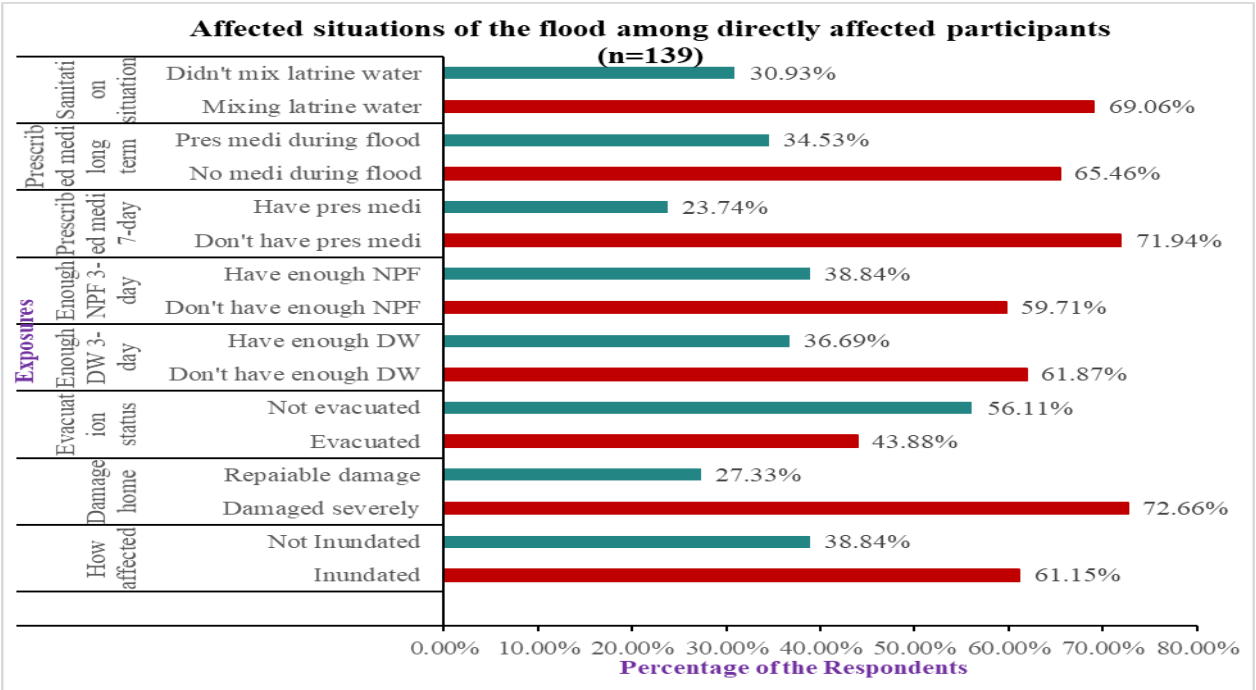

Figure 3. Affected situations of the flood (n = 168)

Directly affected = 82.73% (n=139), Indirectly affected = 17.27% (n=29)
Here, DW = drinking water, NPF = non-perishable food, MEDI = medication,
MIX = mixing of latrine water into flood water

B. *Health Outcomes Assessment*

Affected level and health outcomes: Fully submerged homes in floods were linked to higher odds of typhoid [OR: 1.75 (95% CI: 1.00-3.33)], worsened mental health [OR: 2.53 (95% CI: 1.05-6.10)], and increased child malnutrition [OR: 2.60 (95% CI: 1.37-4.93)] compared to partially submerged homes.

Table IV. Adjusted Odds Ratios And Their Confidence Intervals Of Increase In Outbreaks Of Various Physical And Mental Illnesses Based On How Were Affected By Floods

How affected	Diarrhoea	GI	Typhoid	Dengue	Mental	Hypertension	Diabetes	Chronic lung	Malnutrition
*	lackam	Inadeqdw	toilplabgl	Incmosqb	pooreco	riveropd	lackam	mixlw	fmshort
Inundated	0.68(0.35-1.32)	3.06(0.78-12.01)	1.75(1.00-3.33)	2.11(0.60-7.31)	2.53(1.05-6.10)	0.47(0.25-0.90)	1.40(0.58-3.37)	0.29(0.12-0.66)	2.60(1.37-4.93)
Not Inundated	ref	ref	ref	ref	ref	ref	ref	ref	ref

Here, GI = Gastrointestinal disease,
* Each OR was adjusted by-lackam = lack of adequate medicine, inadeqdw = inadequate provision of clean drinking water, toilplabgl = toilet placed below ground level of the homestead, incmosqb = increasing mosquito biting, pooreco = poor economic condition, riveropd = further poverty & displacement due to river erosion, lackam = lack of adequate medicine, mixlw = mixing of latrine water with flood water, fmshort = food and medication shortages, respectively.
On the other hand, people whose homes were destroyed during the floods had less experiences of diarrhoea [Odds ratio: 0.28 (95% CI: 0.10–0.73)] and typhoid [OR: 0.23 (95% CI: 0.10–0.52)].

Comparison of health problems between displaced and non-displaced:

Table V. Adjusted odds ratios and their confidence intervals of the incidence of various physical and mental health problems by comparing the flood-based evacuation status

Evacuation	Diarrhoea	GI	Typhoid	Dengue	Mental	Hypertension	Chronic lung	Malnutrition
*	toilplabgl	Inadeqdw	toilplabgl	Incmosqb	riveropd	pooreco	mixlw	fmshort
Evacuated	1.68(0.88–3.20)	0.45(0.14–1.49)	1.27(0.67–2.39)	0.37(0.09–1.42)	3.11(1.35–7.14)	2.60(1.37–4.90)	5.27(2.28–12.19)	1.34(0.72–2.51)
Not evacuated	ref	ref	ref	ref	ref	ref	ref	ref

Eviction due to flooding did not increase common infectious diseases but significantly worsened mental health [OR: 3.11 (95% CI: 1.35–7.14)]. Evicted individuals had higher rates of hypertension [OR: 2.60 (95% CI: 1.37–4.90)] and asthma problems [OR: 5.27 (95% CI: 2.28–12.19)] compared to non-evicted individuals.

Access to drinking water / food and medicine in the early emergency phase (within 3/7 days) and its effects on human health: The lack of safe drinking water within 3 days of a flood led to a notable increase in typhoid [OR: 4.66 (95% CI: 2.23–9.70)], hypertension [OR: 2.11 (95% CI: 1.08–4.14)], diabetes [OR: 7.76 (95% CI: 2.19–27.46)], malnutrition [OR: 2.45 (95% CI: 1.29–4.68)], and mental health issues [OR: 3.67 (95% CI: 1.37–9.83)] among victims.
Similarly, the absence of non-perishable food had comparable effects on health outcomes, with significant rises in typhoid [OR: 5.08 (95% CI: 2.46–10.51)], hypertension [OR: 1.86 (95% CI: 1.00–3.57)], diabetes [OR: 4.08 (95%) CI: 1.44–11.59)], malnutrition [OR: 2.84 (95% CI: 1.48–5.43)], and mental health problems [OR: 4.15 (95% CI: 1.55–11.10)].
Furthermore, individuals unable to access medication within 7 days experienced higher rates of typhoid [OR: 4.57 (95% CI: 1.94–10.78)], worsened mental health [OR: 3.19 (95% CI: 1.01-10.05)], diabetes [OR: 12.54 (95% CI: 1.63–96.25)], and child malnutrition [OR: 3.46 (95% CI: 1.68–7.10)].

Flood-affected sanitation situation and health problems:

Table VI. Adjusted odds ratios and their confidence intervals of the incidence of various physical and mental health problems based on the mixing of latrine water with flood water

Mixing latrine water	Diarrhoea	GI	Typhoid	Mental	Dengue	Hypertension	Diabetes	Malnutrition
*	lackam	lackam	Inadeqdw	pooreco	Incmosqb	riveropd	hypbf	gcrconsoi
Mixing latrine water	1.10(0.57-2.14)	1.56(0.51-4.74)	2.69(1.24-5.86)	1.42(0.58-3.47)	2.62(0.55-12.45)	1.58(0.81-3.10)	3.68(1.18-11.46)	1.04(0.55-1.99)
Didn't mix	ref	ref	ref	ref	ref	ref	ref	ref

This study focuses on the impact of combining flood water with latrine water on the sanitation situation. The incidence of typhoid [OR: 2.69 (95% CI: 1.24-5.86)] and diabetes [OR: 3.68 (95% CI: 1.18–11.46)] significantly increased among flood victims due to this pollution, but no significant correlations were found with other diseases.

The impact of floods human health based on the analysis of the focus group discussion: We have conducted FGD as a robust means to prove the reliability of the results obtained from the survey i.e., to show the significance of the relationship between the environmental risk of flooding and associated health issues.

C. ***FGD-1***

A focus group in Char Kajal union, Galachipa, discussed severe damage to homes and toilets from flooding, causing waterborne diseases. Residents were evacuated during floods, receiving meals but lacking clean water and medicine, leading to health issues. Participants reported lack of potable water, food or medicine during the initial emergency, leading to mental health problems, diabetes and high blood pressure. Prescription medicine supplies were disrupted, and flooded tube wells increased diseases.

D. ***FGD-2***

Another focus group discussion in Barabagi Union of Amtali subdistrict addressed the 2020 floods, lasting 1.15 to 1.45 hours. Participants shared how floods impacted homes, floodplains, crops, and fish farms, leading to diseases like diarrhoea, typhoid, and malnutrition. Loss of income from damaged crops and fish negatively affected mental health, causing anxiety, depression, and hypertension. Residents faced eviction twice a year due to flooding, leading to water shortages in evacuation centers. Poor flood management caused medicine shortages, worsening health issues. Fuel and communication problems delayed emergency aid.

IV. DISCUSSION

This study explores the effects of floods on coastal regions, emphasizing the scarcity of necessities like food, water, and medicine. It examines the physical and mental health impact on flood victims, noting differences in disease outbreaks among those fully submerged and partially submerged. The study demonstrates differences in disease prevalence between displaced versus non-displaced family members in Bangladesh, which is consistent with previous research by Haque et al. (2020)[6], and it also emphasizes the importance of sanitation in preventing disease in emergencies.

A. ***Impact on health due to home damage during floods***

The study compared infectious disease prevalence in family members from flooded and non-flooded homes, consistent with the findings of Alderman et al. (2012)[1]. Completely submerged homes had higher rates of mental health problems and malnutrition. Chronic diseases and respiratory issues increased due to shortages and economic challenges (see Table 2 & FGD 2). Du et al. (2010) support these findings.[4]

B. ***Impact of flood eviction on human health***

Diarrhea, typhoid, mental health issues, and malnutrition are more common among displaced families in coastal areas than non-displaced families. Chronic diseases like hypertension and asthma also show similar patterns. Displaced families face challenges with access to drinking water (see FGD 2) and incur high costs during displacement,[6] impacting their physical and mental health, which is also demonstrated in the study of Radosavljevic et al., 2017.[16]

C. ***Effects of food / clean drinking water / medicine accessibility on human health in the early stages of flood emergency (within 3/7 days)***

In the early stages of floods, lack of emergency services like food, water, and medicine worsens issues like diarrhea, typhoid, malnutrition, and mental health, which relates to the findings of Shimi et al. (2010).[21] Only 40% had access to non-perishable

food and 38% of clean drinking water, leading to increased illnesses among flood-affected families (see Figure 1 & FGD 2). This led to a rise in illnesses among flood-affected families, as shown in a study by Haque et al. (2020).[6]

D. ***Health problems caused by limited access to prescription drugs during floods***

Poor communication and high medication costs during floods resulted in only 35% of victims being able to collect prescribed medicines (see Figure 1 & FGD 1). This led to inadequate control of chronic diseases like hypertension and diabetes, increased risk of infectious diseases, malnutrition, and mental health issues. Previous research by Bich et al. (2011) also highlighted the negative impact of flood-affected communication systems on medication access, similar to this study.[2]

E. ***Sanitation related effects on health***

In coastal areas, toilets are often placed in low corners of houses, causing them to sink and contaminate floodwaters (see FGD 1). This leads to the growth of diseases like diarrhea and typhoid in crops grown in the affected soil. During the 2020 floods, only 31% of toilets were partially usable, leading to widespread direct defecation in water and the spread of diseases, as seen in the previous study of Shimi et al. (2010).[21]

V. RECOMMENDATIONS

Effective measures to reduce environmental risks of flooding and associated health problems are crucial in flood-prone areas of Bangladesh. Strategies like afforestation, sustainable embankments, and building houses above flood levels are recommended. Residents require financial aid and post-flood medical care (Bich et al., 2011).[2] Availability of clean water, food, and medicine is vital, along with introducing mobile and ecological sanitation systems. Bangladesh can learn from Japan's disaster management systems, such as SIP4D and J-ALERT to improve their strategies.[5]

VI. CONCLUSIONS

Floods are a prevalent element of natural disasters that strike coastal areas on a regular basis, practically every year. In this study, it has been observed that the residents of this area experience many flood-related harmful occurrences each year, including flooding of homes, destruction of sanitation systems, damage to communication systems, damage to crops, and inadequate access to food/safe drinking water/medicine in the early emergency stage (3/7 days). As a result, diarrhea, typhoid, malnutrition, mental health problems and even various chronic diseases increase with such incidents in Bangladesh, especially among those who were in frequent evictions and low sanitation conditions. Similar results were found in people without access to safe drinking water / food / medicine during floods. After identifying the factors that affect the physical and mental health of flood-affected people, it can be concluded that these factors not only increase the prevalence of short-term diseases, but also affect those suffering from chronic diseases.

In this study, a comparative analysis was conducted of the consequences of the 2020 floods on the physical and mental health of the directly and indirectly affected groups in the most isolated and coastal areas. I concluded that, in the isolated coastal areas, the disaster severely disrupted sanitation and access to adequate services and exaggerated the health conditions. It, however, is considering that there are a lot of unrecognized adverse health effects from the disaster in particular such type of isolated areas. I would suggest that government should plan further investigations immediately after the disaster should be conducted in rural areas.

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Participants were assured their personal information would be kept private in survey results, with only their pseudonym disclosed if shared.

REFERENCES

1) Alderman K, Turner LR, Tong S. Floods and human health: a systematic review. Environment international. 2012 Oct 15;47:37-47.https://doi.org/10.1016/j.envint.2012.06.003
2) Bich TH, Quang LN, Thanh Ha LT, Duc Hanh TT, Guha-Sapir D. Impacts of flood on health: epidemiologic evidence from Hanoi, Vietnam. Global health action. 2011 Dec 1;4(1):6356. https://doi.org/10.3402/gha.v4i0.6356
3) Chakma P, Akter A. Flood mapping in the coastal region of Bangladesh using Sentinel-1 SAR images: A case study of super cyclone Amphan. InJ. Civ. Eng. Forum 2021 Sep (Vol. 7, pp. 267-278). https://doi.org/10.22146/jcef. 64497

4) Du W, FitzGerald GJ, Clark M, Hou XY. Health impacts of floods. Prehospital and disaster medicine. 2010 Jun;25(3):265-72. https://doi.org/10.1017/s1049023x00008141
5) Fokaefs A, Sapountzaki K. Crisis communication after earthquakes in Greece and Japan: Effects on seismic disaster management. Sustainability. 2021 Aug 18;13(16):9257. https://doi.org/10.3390/su13169257
6) Haque R, Parr N, Muhidin S. Climate-related displacement, impoverishment and healthcare accessibility in mainland Bangladesh. Asian Population Studies. 2020 May 3;16(2):220-39.
7) https://doi.org/10.1080/17441730.2020.1764187
8) Hossain MA, Miah MG. Environmental disasters in history: Bangladesh perspective. International Journal of Social Development and Information System. 2011 Jan;2(1):31-7.
9) Kader A. Special Flood Situation Report. National Disaster Response Co-ordination Centre [Internet]. 2020 Aug 19 [cited 2021 Aug 1]; Available from: https://modmr.gov.bd/site/situationreport/4869c4b6-2ba1-4bf0-988f-4fc87f6a5838/
10) Hafiz H, editor. The coast is floating in water [Internet]. www.kalerkantho.com. The Daily Kalerkantho; 2021 [cited 2022 Feb 12]. Available from: https://www.kalerkantho.com/print-edition/firstpage/2020/08/23/948038.
11) Hunter PR. Climate change and waterborne and vector-borne disease. Journal of applied microbiology. 2003 May 1;94(s1):37-46. https://doi.org/10.1046/j.1365-2672.94.s1.5.x
12) Ibrahim M, Khan ME, Hasan MM, Khanam R. Livelihood condition of fishermen at Amtali Upazila, Barguna, Bangladesh. International Journal of Fisheries and Aquatic Studies. 2018;6(3):13-24.
13) Islam J. Flooding in Bangladesh: A Geographical Advantage & Disadvantage of Times. International Journal for Empirical Education and Research. 2019 Feb 28;31–41. https://doi.org/10.35935/edr/32.4131
14) Mondal MS, Murayama T, Nishikizawa S. Assessing the flood risk of riverine households: A case study from the right bank of the Teesta River, Bangladesh. International Journal of Disaster Risk Reduction. 2020 Dec 1;51:101758. https://doi.org/10.1016/j.ijdrr.2020.101758
15) Parvin GA, Fujita K, Matsuyama A, Shaw R, Sakamoto M. Climate change, flood, food security and human health: cross-cutting issues in Bangladesh. Food Security and Risk Reduction in Bangladesh. 2015:235-54.
16) Parvin GA, Shimi AC, Shaw R, Biswas C. Flood in a changing climate: The impact on livelihood and how the rural poor cope in Bangladesh. Climate. 2016 Dec 21;4(4):60. https://doi.org/10.3390/cli4040060
17) Radosavljevic V, Belojevic G, Pavlovic N. Tool for decision-making regarding general evacuation during a rapid river flood. Public health. 2017 May 1;146:134-9. https://doi.org/10.1016/j.puhe.2017.01.025
18) Md Rahman B, Md Sazedul Hoque Z, Md Rahman M, Nahar A. Exploration of fishing gear and fisheries diversity of Agunmukha River at Galachipa Upazila in Patuakhali District of Bangladesh. Iranian Journal of Fisheries Sciences. 2017 Jan 10;16(1):108-26.
19) Ramin BM, McMichael AJ. Climate change and health in sub-Saharan Africa: a case-based perspective. EcoHealth. 2009 Mar;6:52-7. https://doi.org/10.1007/s10393-009-0222-4
20) Reacher M, McKenzie K, Lane C, et al. Health impacts of flooding in Lewes: a comparison of reported gastrointestinal and other illness and mental health in flooded and non-flooded households. Communicable Disease and Public Health. 2004;71:1-8.
21) Schwartz BS, Harris JB, Khan AI, Larocque RC, Sack DA, Malek MA, Faruque AS, Qadri F, Calderwood SB, Luby SP, Ryan ET. Diarrheal epidemics in Dhaka, Bangladesh, during three consecutive floods: 1988, 1998, and 2004. The American journal of tropical medicine and hygiene. 2006 Jun;74(6):1067. https://doi.org/10.4269/ajtmh.2006.74.1067
22) Chanda Shimi A, Ara Parvin G, Biswas C, Shaw R. Impact and adaptation to flood: A focus on water supply, sanitation and health problems of rural community in Bangladesh. Disaster Prevention and Management: An International Journal. 2010 Jun 22;19(3):298-313. https://doi.org/10.1108/09653561011052484
23) Van der Sande CJ, De Jong SM, De Roo AP. A segmentation and classification approach of IKONOS-2 imagery for land cover mapping to assist flood risk and flood damage assessment. International Journal of applied earth observation and geoinformation. 2003 Jun 1;4(3):217-29. https://doi.org/10.1016/s0303-2434(03)00003-5