

## Research Paper

# Impact of cyclone Amphan on the water, sanitation, hygiene, and health (WASH2) facilities of coastal Bangladesh

Nazifa Rafa, Abu Jubayer and Sayed Mohammad Nazim Uddin

### ABSTRACT

The vulnerability of the underfunded water, sanitation, hygiene, and health (WASH2) facilities, particularly in the developing nations, is exacerbated by natural disasters. This study assessed the impacts of Amphan on the WASH2 facilities of the affected coastal areas of Bangladesh via a structured questionnaire survey, key informant interviews, and direct observation. The study reported that Amphan destroyed WASH2 facilities, where only 20% of the respondents were receiving WASH2 services afterwards. Many respondents had to rely on unsafe water sources after the cyclone hit. While the respondents used different kinds of water treatment methods, three-quarters of the respondents reported issues related to odor, taste, color, and/or others. The majority had to practice open defecation due to damage done to sanitation facilities. Amphan has also resulted in an onslaught of several WASH2 diseases in the study area, primarily skin disease and diarrhea. The study has exhibited how intense natural disasters can completely render WASH2 facilities useless, causing the communities affected to switch to unsafe practices to meet their needs. The affected communities are in urgent need of adequate and sustainable WASH2 facilities.

**Key words** | Amphan, inequalities and insecurity, natural disaster, risks, hazards, and vulnerabilities, service delivery, water, sanitation, hygiene, and health (WASH2)

**Nazifa Rafa**

**Sayed Mohammad Nazim Uddin** (corresponding author)

Environmental Sciences Program,  
Asian University for Women,  
20 M. M. Ali Road, Chattogram,  
Bangladesh  
E-mail: [sayed.uddin@auw.edu.bd](mailto:sayed.uddin@auw.edu.bd)

**Abu Jubayer**

Center for Continuous Education, Consultancy and  
Research (CCECR),  
Stamford University,  
H#64, R#6/A, Dhanmondi Campus, Satmasjid  
Road, Dhaka,  
Bangladesh

### HIGHLIGHTS

- Very few people received adequate WASH2-related services both before and after the Amphan hit.
- Natural disasters compounding on underfunded and vulnerable WASH2 facilities can exacerbate social inequalities.
- This study illustrates the lack of attention given by the government and international humanitarian organizations in rural coastal communities.

### INTRODUCTION

Safe and adequate water, sanitation, and hygiene (WASH), or the more recently popularized, water, sanitation, hygiene,

and health (WASH2) facilities are crucial for human health and well-being, as their absence impacts the quality of life and undermines fundamental human rights. As of 2017, 2.2 billion people still lacked safely managed water, 4.2 billion lacked safely managed sanitation, and 3 billion lacked access to basic handwashing facilities (UN-Water/WHO 2019).

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Worldwide, in 2016, 1.9 million deaths and 123 million disability-adjusted life years could have been prevented with adequate WASH facilities (WHO 2019). Yet, significantly large funding gaps hinder the achievement of WASH targets around the world despite the increase in government WASH budgets (UN-Water/WHO 2019). WASH concerns can be heightened during emergencies or natural disasters, as facilities can be damaged.

At the emergence of the new millennium, the vulnerability of the WASH2 facilities, particularly in the developing nations, was exacerbated by the increasing frequencies and intensities of natural disasters, attributed to climate change. A flooding incident in Nepal that occurred between 11 August and 12 August 2017 destroyed water and sanitation infrastructures and caused power cuts, damage to roads, and the closure of local health centers (Gautam *et al.* 2017). The incident called for rapid interventions that targeted WASH in order to prevent water- and vector-borne disease outbreaks. The recent cyclone Idai, which hit Mozambique in March 2019, caused massive damage to houses and disruptions to vital infrastructure, including the electrical grid, communications, and water supply, and came to be known as one of the worst climate-related natural disasters on record in the Southern Hemisphere (Lequechane *et al.* 2020). The level of infrastructural damages, coupled with a high level of contaminated sources, poor sanitation, and living conditions, led to a rapid spread of infectious diseases and a cholera outbreak.

The densely populated Bangladesh experiences frequent disasters such as floods, droughts, cyclones, tidal surges, and salinity intrusion due to its low-lying topography, which causes great damage to human lives and properties every year. However, with its ranking 5th in the Global Climate Risk Index according to relative vulnerabilities to climate change (Kreft & Eckstein 2013), the frequency and intensity of the extreme events have increased significantly in Bangladesh, as has the vulnerability of the existing fragile WASH2 facilities in Bangladesh. Yet, the post-disaster WASH2 needs are scarcely addressed. For example, flooding is one of the most common disasters occurring in coastal areas. Bangladesh has around 54 trans-boundary rivers that have huge floodwater during the monsoon period, and approximately 80% of the total area of the country is prone to flooding, with a catastrophic flood occurring every 10–20 years on

average (Hasnat *et al.* 2018). The rural poor, which predominantly reside in the coastal regions of Bangladesh, experience increased difficulty in overcoming the aftermath of flood incidents due to their relatively low socioeconomic and health status, and thus, their poor adaptive capacity (Shimi *et al.* 2010). However, sustainable forms of adaptation are hardly perceived.

The most recent super cyclonic tropical cyclone, Amphan, caused widespread damage in West Bengal and Bangladesh. Amphan originated from a low-pressure area persisting a couple of hundred miles (300 km) east of Colombo, Sri Lanka, on 13 May 2020, and underwent rapid intensification to become an extremely severe cyclonic storm on 17 May. In Bangladesh, over a million people were affected across nine districts in the divisions of Khulna and Barisal, with the death of 26 people and damage caused to houses, infrastructures, livelihoods, as well as WASH facilities, where approximately 18,235 water points and 40,894 latrines were destroyed in most impacted districts (IFRC 2020).

As it is, information on post-disaster WASH2 assessments in Bangladesh is scanty, which makes visualizing and estimating community needs challenging. However, the current pandemic of COVID-19 could make humanitarian relief more unreachable to the affected areas due to the preventive measure of social distancing recommended by public health authorities. This study, therefore, attempts to not only assess the WASH2 facilities of some of the areas that were hit by the cyclone Amphan, but also evaluates how much support the affected areas are receiving from government and humanitarian agencies. It also looks into the affected communities' adaptation to the damaged WASH2 facilities and provides insights into the WASH2-related issues that affected communities are facing.

## METHODOLOGY

The study was conducted in two villages, Datinakhali and Burigoalini, in the Burigoalini Union of Shyamnagar Upazila in Satkhira District, Bangladesh, as illustrated in Figure 1(a). The villages are located on the northwestern fringe of the Sundarbans forest, which provides the locals with resources for their livelihoods. Fishing, agriculture,

and nonagricultural labor are the most widely practiced occupations in the community. With an area of 1,968.24 km<sup>2</sup>, Shyamnagar has a population of 318,254, according to the 2011 census (BBS 2011).

The study is based on data collected through a structured questionnaire survey. The data were collected during the period of May and June 2020, and the data collection was subjected to restrictions brought about by the ongoing pandemic crisis at the time of the study. Specific methods were used for local database collection, such as structured questionnaires, local people one to one interviews, direct observations, and critical incidents.

### Structured questionnaire survey

The structured questionnaires were administered among the respondents via simple random sampling. The questionnaire inquired into the respondents' drinking water sources, water treatment options, water quality issues, damage to WASH2 facilities, the burden of diseases, and sanitation facilities post-cyclone. The collection of field data was carried out by survey enumerators by using local transport (e.g., boat) during high tide and low tide. Microsoft Office Excel 2010 was used to analyze the data.

### Key informant interviews

A total of six key informant interviews were conducted with the local school teacher (1), Union Parishad members (2), youth leader (1), NGO personnel (1), and Union Parishad Chairman (1) to assess the existing issues and challenges faced by the cyclonic event in terms of WASH2 facilities.

### Observation

Various WASH2 infrastructural damages such as drinking water supply systems, sanitary facilities, and handwashing facilities were observed during the data collections and noted properly for analysis. Pictorial data have been collected to analyze them and incorporate them into the results. Ethical approval for the study was obtained from the Ethical Review Committee of Asian University for Women (AUW).

## RESULTS AND DISCUSSION

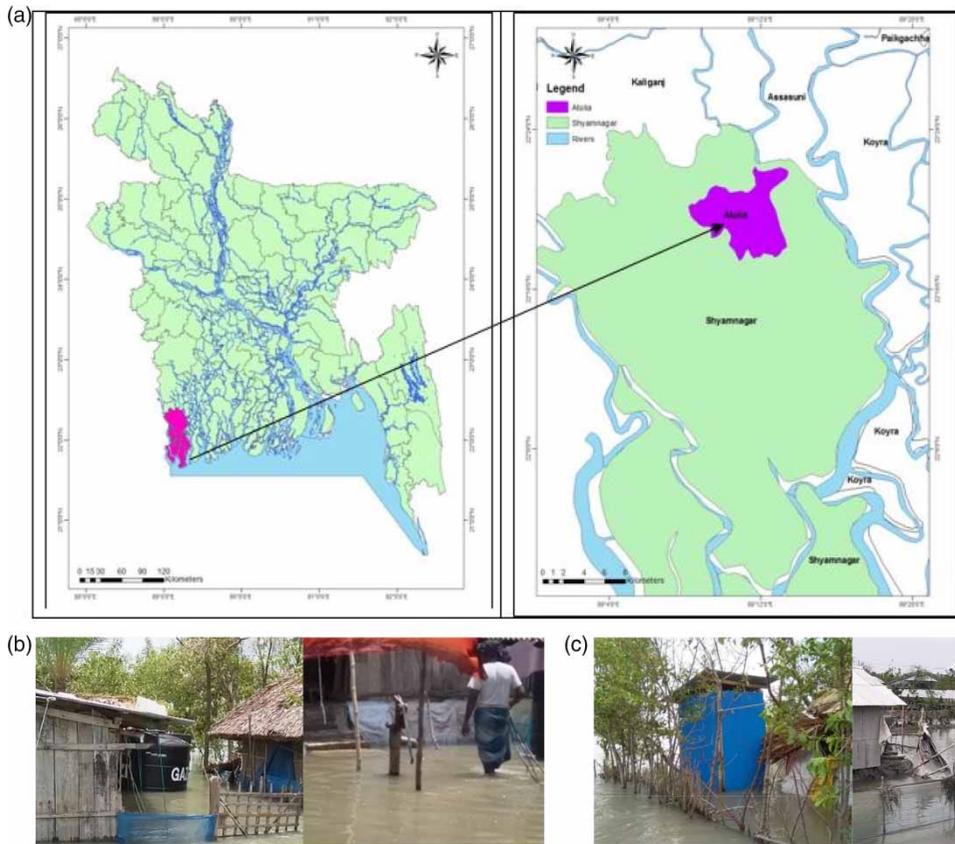
### Impact of Amphan on the overall WASH2 facilities

WASH2 facilities derive their vulnerability to disasters particularly due to the low budgets allocated by national governments. In Bangladesh, the government has allocated only 5 dollars per capita per year on WASH2 facilities (UN-Water/WHO 2019), an underfunding that contributes to 80% of the diseases (Shimi *et al.* 2010). After the Amphan hit in 2020, which affected approximately 70% of the population (~180,000 people), WASH2 facilities of affected communities suffered severely, as shown in Figure 1(b) and 1(c).

Respondents of this study were asked whether damage was done in the following WASH2 facilities: water sources, sanitation facilities, health facilities, bathing facilities, and handwashing facilities. Their responses have been recorded in Figure 2(a). Of the respondents, 75% notified that all the WASH2 facilities that they use were destroyed. For 22.5%, only the water sources, sanitation facilities, and bathing facilities were damaged. For one respondent (2.5%), only health facilities seemed to be accessible after the cyclone. Despite such large-scale damage to the WASH2 facilities, 80% of the respondents did not receive any WASH2-related services from the government or NGOs after Amphan, as shown in Figure 2(b). Most of the respondents of the study area seem to have been excluded from the services of humanitarian agencies that are currently operating there to provide disaster relief, such as the Nuabeki Gono Mukhi Foundation (NGF), Youth Development Unit (YDU), Leader, and several other volunteer groups. Only 17.5% of the respondents received services from NGOs, while only one respondent (2.5%) informed of having received WASH2-related services from the office Upazila Nirbahi Officer (UNO), the chief executive of an Upazila. In addition, many respondents have also expressed distress over having lost their homes to the cyclones – many were underwater – while semi-pucca housings were completely destroyed.

### Impact of Amphan on safe water availability and accessibility

The availability and accessibility of safe water have been consistently difficult to achieve in Bangladesh. Nearly half



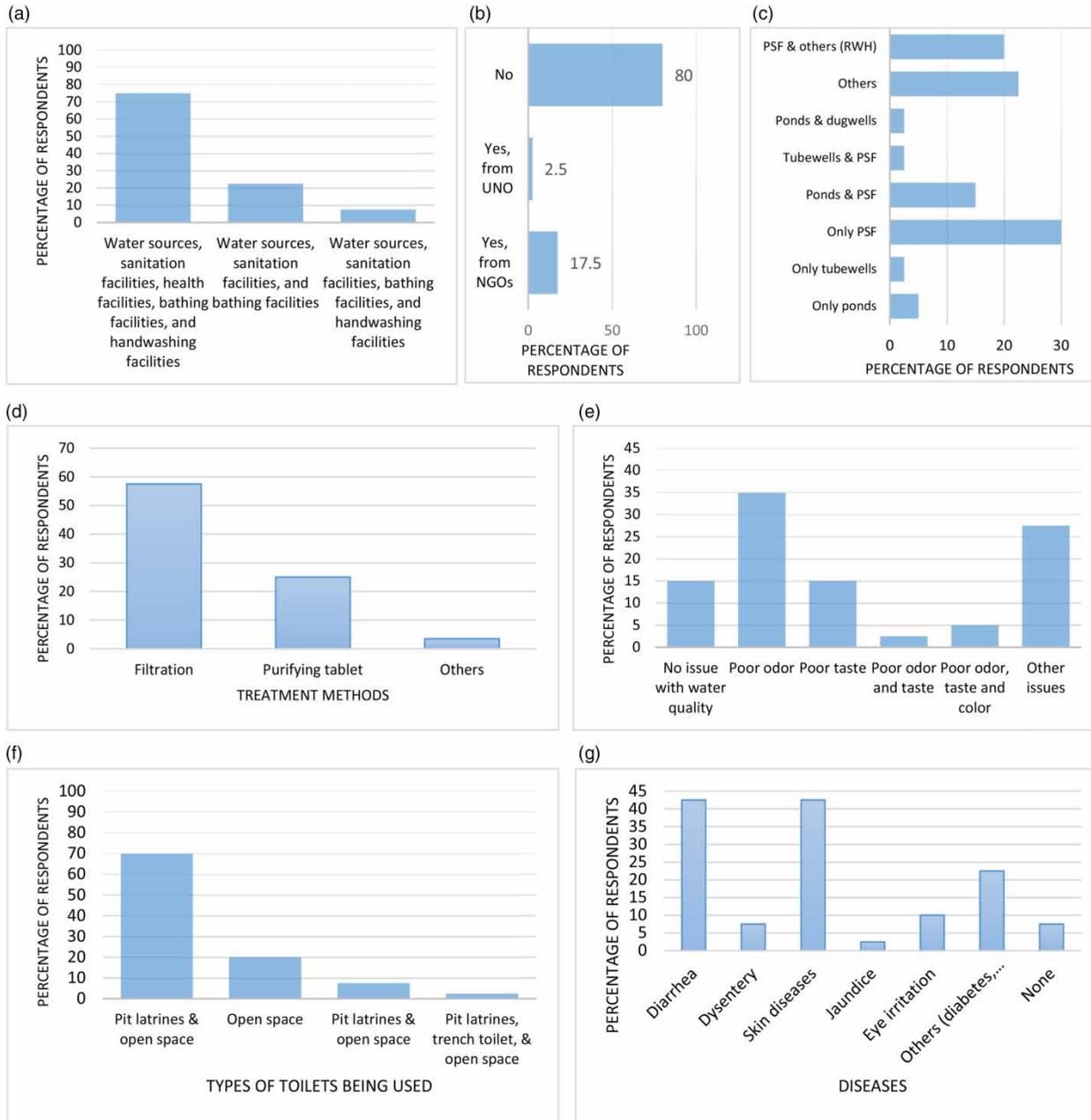
**Figure 1** | (a) Study area. (b) Impact of cyclone Amphan on water supply system in the study area. (c) Impact of cyclone Amphan on sanitation facilities in the study area.

of the population consumes water that does not comply with the Bangladesh standard for both arsenic and *Escherichia coli* (UNICEF 2018). Safe water scarcity is a growing problem in the coastal regions of Bangladesh, particularly due to saline water intrusion occurring in both surface water and groundwaters. Rural people experience the greatest hindrance to accessing safe water due to their socioeconomic standings, and the unavailability of safe drinking water, particularly due to natural disasters (McLean & Moore 2005), which exposes them to various health risks. Shyamnagar Upazila is one of the disaster-prone areas in Bangladesh, where safe water scarcity is increasing due to the continuous impacts of climate change.

Before the cyclone hit, the primary sources of water for the inhabitants of the study area were raw pond water, shallow tube wells (<90 ft), hand tube wells, NGO and government-supported deep tube wells, pond sand filters (PSFs), re-engineered PSFs that served as artificial aquifer

tube wells, desalination plants, which were often referred to as NGO water, and three systems of rainwater harvesting (RWH) system: personal, community, and cluster. However, after Amphan rendered much of the previous sources of water unsafe or nonfunctional, people had to shift to new sources. Figure 2(c) shows the combinations of key sources of water after the Amphan hit.

Respondents have reported using different combinations of mostly ponds, tube wells, dug wells, PSFs, and RWH systems. As illustrated in Figure 2, 5% of the respondents depended on only pond water, 2.5% depended on only tube wells, 30% depended on only PSFs, 15% on ponds and PSFs, 2.5% on tube wells and PSFs, 2.5% on ponds and dug wells, and 20% on PSF and RWH systems. Finally, 22.5% relied on other sources, primarily RWH systems. Of this 22.5%, 2.5% (one respondent) mentioned having received water from water supplies built by NGOs, and another 2.5% (one respondent) mentioned using water from a reverse osmosis (RO) water plant.



**Figure 2** | (a) Damage done by Amphan to WASH2 facilities, according to respondents. (b) Percentages of respondents who were receiving WASH2 services after the Amphan hit. (c) Key sources of water after Amphan. (d) Treatment methods after Amphan. (e) Water quality issues observed by respondents after Amphan. (f) Types of toilets being used by respondents after the Amphan hit. (g) Diseases being experienced by the respondents after the Amphan hit.

Respondents collected water from whichever facility was available and feasible to use at a particular time. About 100 PSFs have been constructed in every union after the cyclone Sidr in 2009 by different NGOs with donor funds, and local and national government organizations. Before 2018, NGOs had been conducting routine

maintenance and operational work of the PSFs, but due to a shortage of funds, NGOs stopped monitoring PSFs. Currently, the communities are responsible for the maintenance of PSFs, even though they cannot afford the cost of maintenance of these facilities. Many PSFs had been disabled before the cyclone hit, but others had been

destroyed during the cyclone due to the high surge and saline water intrusion.

Despite the higher usage of PSF compared to other sources, using PSF was criticized for having to consume too much time in case ponds are located too far. Since the task of water collection is mostly shouldered by women and children, PSF use can hinder women's pursuit of education or employment. On average, people need to travel 1.5–2.5 km to reach their nearest PSF in the study area. In addition, safety concerns entail the usage of PSF derived from design flaws. The efficiency of PSF in reducing total dissolved solids, potassium, and chloride is not enough to meet the standard prescribed by the WHO (Harun & Kabir 2013). The PSF also fails to completely rid the water of coliform, which can prove to be an alarming health hazard (Kamruzzaman & Ahmed 2006; Hossain *et al.* 2016). Thus, PSF is not appropriate for the ponds that contain high salinity, potassium, and chloride (Harun & Kabir 2013). Nevertheless, the treatment of pond water by PSF maintains the pH, ammonium, total hardness, total alkalinity, chloride, phosphate, sulfate, and nitrate value well with the WHO standards (Hossain *et al.* 2016). The removal of turbidity, color, and general bacteria provided by the PSF is appreciable, with the water obtained from it having been received favorably by users in Bangladesh (Kamruzzaman & Ahmed 2006; Harun & Kabir 2013). Contamination is reported to decrease by almost two-thirds via filtration by PSF (Mahmud *et al.* 2007). Therefore, in case RWH fails to meet the needs of the community, PSF can potentially be used simultaneously, provided that changes have been made to PSF designs. However, water obtained via rooftop RWH, which was the dominant type of the RWH system in the study area, can carry microbial risks (Karim 2010). Alarmingly, a total of 22.5% of the respondents use pond water. Pond waters are a type of unimproved water sources that are highly contaminated and tend to induce water- and vector-borne diseases within its users, if not treated sufficiently. In addition, respondents have been using tube wells, most of which are shallow, even before the cyclone hit. While the quality of water is significantly affected in shallow tube wells due to sewage seepage or arsenic contamination, disasters further worsen the quality.

It can be assumed that RWH systems and water supplies from NGOs and an RO plant are the best sources of water

available to the affected community, but ultimately the kinds of treatment methods used on point-of-use are significant, which if efficient enough, the source of the water should not matter. Figure 2(d) exhibits the kinds of water treatment options that were available to the respondents after Amphan. Filtration was used the highest, by a total of 57.5% of the respondents. Most of the filtration refers to the water obtained from the PSF. The PSFs used compose of three to four different layers of materials like a sand layer, followed by a stone layer, then a gravel layer, and finally, filter paper. 25% of the respondents used purifying tablets, much of which were provided by NGOs, and 20% employed other methods. Only one respondent was reported to have both the options of filtration and purifying tablets.

The efficiency of the water treatment methods used was assessed from the water quality issues perceived by the respondents. Figure 2(e) depicts the water quality issues identified by the respondents. According to the graph, 35% of respondents felt that there were issues with the odor, 15% found issues with taste, 2.5% with both odor and taste, 5% with odor, color, and taste, and 27.5% pointed out other issues with the water. 15% of the respondents were satisfied with the quality of water, which mostly came from the RWH tank or water supplies built by NGOs. Some reasons have been proposed for the water quality changes. In the case of RWH, because the tanks preserve water round the year, the prolonged containment causes the taste, color, and odor to change, particularly during the summer. In addition, high tide and low tide affect the water quality from tube wells and ponds at present by causing saltwater intrusion. Salinity has increased by around 26% in Bangladesh within the last 35 years, entering noncoastal areas as well (UNB 2019). Excess salt intake causes several health problems like hypertension, which is particularly harmful to pregnant women. Moreover, increased sodium consumption has immunological effects on the skin, intestine, and also causes infection, inflammation, and cardiovascular diseases (Shammi *et al.* 2019).

Water from the PSF undergoes quality changes when filters have not been changed in a long time or when the water has been subjected to filtration for an extended time. In fact, this is a recurring problem with PSFs. For the PSF to continue to work efficiently, its filters need to be routinely

cleaned to remove the stored contaminants, at least every 1–5 months, during which locals tend to depend on other, often unsound, options for water supply (Kamruzzaman & Ahmed 2006).

As a study found with the aftermath of Aila, residents require a water treatment plan and deep tube well services with piped-water supplies to meet the demands of the local community, funded by the government, civil society, and via a system of payments by the users (Jubayer & Mondal 2017).

### Impact of Amphan on sanitation facilities

Bangladesh is currently facing the challenge of meeting the gap between access and the quality of sanitation services. The universal access to safely managed sanitation is currently 31% in rural areas (WHO & UNICEF 2017), particularly due to the disparities in terms of financial resources in urban and rural areas (UN-Water/WHO 2019). Shymnagar Upazila is one of the rural areas where the average sanitation condition is poor. Most of the inhabitants of the study area used pit latrines before the cyclone. However, after the cyclone hit, most of the pit latrines have been submerged underwater, causing them to scramble for alternatives.

Figure 2(f) shows the kinds of toilets being used by the respondents after the cyclone. 7.5% of respondents reported having been using pit latrines. 70% of the respondents used both pit latrines and defecated in open space, while 2.5% used pit latrines, trench toilets, and defecated in open space. However, a significant number, 20% of the respondents, could not access any forms of toilet facilities and had to defecate in open space, as in the aftermath of Aila (Chakraborty *et al.* 2016). Disasters like this can hinder the elimination of open defecation, which Bangladesh had nearly achieved (WHO & UNICEF 2017).

Respondents were facing a number of issues because of insufficient and inadequate sanitation facilities. All of the respondents reported having been experiencing difficulties in accessing toilets during high tide, as they become submerged underwater during this time. They had to wait it out until there was low tide. This also meant that the people were unable to visit toilets on time, which was a problem that all of the participants faced. In addition, the toilets

have become unsuitable and uncomfortable for use, especially for women and the elderly. In fact, the damages caused to sanitation facilities brought about an onslaught of privacy problems for women, which was noted by nearly all (97.5%) of the participants. Thus, 67.5% of the participants pointed out that women had to wait until evening to be able to use the toilets, as they could only undertake defecation in open spaces. Women and children are often affected the most due to damage caused by disasters to WASH2 facilities. After the 2010 earthquake in Haiti, limited access to water and sanitation facilities was reported as a factor for the lack of security for women and children in internally displaced persons' camps (Ayalew & O'Connor 2013). The damage caused by the cyclone, coupled with the lack of attention from the government to the affected communities before and after the cyclone hit, have created conditions that violate several fundamental human rights and dignity.

The existing, ruined sanitation facilities have also been tracked to being the cause of water pollution by 5% of the respondents, as well as health problems by 7.5% of respondents, who have repeatedly mentioned suffering from stomach aches. Moreover, all the respondents complained about waste accumulation in open spaces, which tended to flow during periods of high tide. Observable wastes included human wastes, dead animals and fish, tree branches, and other debris.

### Impact of Amphan on health of the community

Developing countries like Bangladesh are disproportionately affected by natural disasters because they may lack resources, infrastructure, and disaster-preparedness systems. Risks of communicable disease outbreaks in affected populations are highly dependent on the availability of safe water, sanitation, and health-care facilities, the tolerance of the immune systems of the population, as well as the degree of crowding of the affected area (Watson *et al.* 2007). Some, if not all, is a matter of concern in the rural coast of Bangladesh.

Deaths from natural disasters, especially rapid onset ones, are often because of bodily injuries, and seldom due to communicable diseases (Watson *et al.* 2007). Among all respondents, 45% stated that they have been injured during the cyclone, but 52.5% incurred no such health injuries. However, the clearest form of threat caused by

damaged WASH2 facilities is perceived through the spread of communicable diseases. 42.5% of respondents stated that their communities were suffering disease outbreaks, primarily diarrhea, and skin disease, after the cyclone.

In fact, when specifically enquired into the kinds of diseases that the respondents were experiencing, 42.5% of the respondents were reported to be suffering from diarrhea and skin diseases, respectively. Figure 2(g) shows the disease burden of the community as a consequence of Amphan. The prevalence of diarrhea and skin diseases can be attributed to respondents' and the communities' frequent use of highly polluted pond water as their main drinking source, which does not undergo adequate treatment, as mentioned above, compounded with the fact that the area now suffers from a poor sanitation system. In addition, 7.5% were suffering from dysentery, 10% from eye irritation, and 2.5% from jaundice. 22.5% reported having been suffering from other diseases and ailments like weakness. Only 7.5% were not experiencing any diseases due to the cyclone. The lack of interventions from humanitarian and governmental agencies worsens their health conditions, as the communities are now in a dire need of medicines and treatment.

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## RECOMMENDATIONS

From the discussion above, it is evident that the communities affected by Amphan are in urgent need of adequate and sustainable WASH2 facilities, which can be ensured by addressing the technical, economic, and environmental aspects of the facilities (UNICEF 2006). While sustainable WASH2 facilities imply that WASH2 services can be provided throughout the facilities' useful lifetime, it is challenging for the facilities to be able to completely withstand the impacts of natural disasters, particularly in areas where they are frequent and intense. Therefore, risk management strategies serve to contribute to their sustainability (UNICEF 2006). Damage to lives and properties can be minimized with a comprehensive disaster-preparedness plan and proper post-disaster risk assessments. However, the facilities need to be able to provide a minimum level of services that can meet the local needs for consumption, hygiene, and well-being during the aftermath of natural disasters (UNICEF 2006).

The interruption of WASH2 services in areas affected by natural disasters exposes the population to disease outbreaks and prevents the communities from reaping the social benefits obtained from them (UNICEF 2006). Disaster-preparedness plans should anticipate potential outbreaks of diseases in affected areas, along with other health effects associated with inadequate access to safe water and sanitation facilities. Facilities that provide therapeutic and preventive interventions, such as the rapid delivery of safe water and the provision of rehydration materials, and antimicrobial agents, will need to be part of the interventions provided to those affected. If WASH2 recovery programs are to improve community health, sanitation, and resilience post-disaster, there needs to be more emphasis on health education, which addresses social norms, attitudes, and preferences for open defecation through community participation and interconnected approach (Krishnan 2019), along with hygiene promotion, the most favorable intervention in terms of its effectiveness to reduce the incidence of diarrheal disease (Parkinson 2009). In addition, vaccination campaigns, as well as strong government leadership and collaborative multisectoral engagements that link real-time surveillance data to the WASH interventions for immediate actions are necessary to improve how disaster aftermath are dealt with in the future (Lequechane *et al.* 2020).

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## CONCLUSION

While reducing the numbers of intense natural disasters demands the attention of a wider range of actors, ensuring the sustainability of WASH2 facilities so that they are able to withstand natural disasters or at least provide the minimum level of services is entirely reliant on the extent to which the government is willing to fund these facilities. The study area had already been relying on inadequate, unsafe, and poor WASH2 facilities before the cyclone hit. Due to preexisting vulnerabilities of the underfunded WASH2 facilities, three-quarters of the respondents of our study have reported that Amphan has destroyed the facilities in affected areas, but only one-fifth of the respondents received WASH2 services from government or humanitarian agencies post-disaster. Amphan has also exacerbated the safe drinking water scarcity issue on the coast, as it ruined much of the previous water sources that residents

relied on. RWH systems, water from RO plants, and NGO water supplies were the safest sources available to the inhabitants, but it was used by less than a quarter of the respondents while others relied on a combination of different and often unsafe water sources, such as ponds, dug wells, and shallow tube wells, or inconvenient sources, such as PSF. Even though water underwent treatment before consumption, significant degradation in water quality in terms of color, taste, and odor was observed particularly when water is obtained from PSF or RWH systems. Natural disasters also worsen existing inequalities, such as based on age or gender, in societies. Amphan's impact on sanitation facilities aggravated discrimination faced by women or the elderly, as they are suffering the most due to inadequate sanitation facilities.

This study aims to address the gap that exists in the understanding of the effect of Amphan on WASH2 facilities. The study has exhibited how intense natural disasters can completely render WASH2 facilities useless, causing the communities affected to switch to unsafe practices to meet their needs. A clear understanding of what kinds of WASH2 facilities that the affected community depended on is also required to provide insights into the previous vulnerabilities of the facilities that exposed the communities to the risks as a result of natural disasters. Therefore, there is a need for the pre- and post-disaster assessment of WASH2 facilities in order to better prepare for emergencies.

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## DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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