

# Chapter 6

## A Survey on Disaster: Understanding the After-Effects of Super-Cyclone Amphan, the Helping Hand of Social Media



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### 1 Introduction

Super-cyclonic storm “Amphan” hit Eastern India, specifically the state of West Bengal, Odisha and parts of Bangladesh in May 2020. Amphan was a very powerful tropical cyclone—technically, a super cyclone (CAT 5) (Balasubramanian and Chalamalla 2020)—that caused widespread damage.<sup>1</sup> In fact, CNN<sup>2</sup> reported that Amphan-caused damages amount to around US \$13 billion, which makes it the costliest cyclone ever recorded in the North Indian Ocean. The cyclone made landfall in West Bengal on May 20, 2020.

The meteorological offices in India gave early warning of the development of Amphan. Consequently, state as well as central governments made an effort prior, during and after this natural disaster to contain the devastation. However, it is not well understood how, from a collective societal point of view Amphan affected the lives of *normal* citizens, and if novel digital mediums like online social media platforms (e.g., Facebook, WhatsApp, Twitter) helped the citizens to cope better with this disaster. Note that *cyclone Amphan happened at a time when the state of West Bengal (and the whole of India) was under strict lockdown restrictions due to the COVID-19 pandemic*. Since physical movement of people was severely restricted, digital platforms such as online social media are likely to have played an especially important role in coordinating relief efforts.

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<sup>1</sup> <https://www.bbc.com/news/world-asia-52734259>

<sup>2</sup> <https://tinyurl.com/CNN-amphan>

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Thus, in this work, we attempted to understand this collective view via self-reported data from a sample of Amphan-affected population who resides in West Bengal, one of the worst affected states due to Amphan. Specifically, we conducted an *online survey* to get an estimate of the damages and impact of the cyclone on people. In this report, we will present our insights gained from the survey.

Some of the key takeaways from the survey are listed below. Details can be found in later sections.

- People were most affected due to disruption of services such as electricity, phone and internet than due to physical damages like uprooting of trees (this observation might have been affected by (i) the COVID19-induced lockdown which meant most people were indoors and (ii) the bias in our survey participants towards students and academicians residing in urban areas).
- Among the two most popular electric suppliers in West Bengal, it seems that CESC managed to restore a significantly higher fraction of connections (over 60%) within a day after the cyclone, as compared to WBSEDCL. However, for both suppliers, there were a comparable fraction of hard-to-repair connections whose restoration took more than 4 days.
- Among the popular phone service providers, Jio seems to have performed the best, with about 52% of the connections being disrupted, compared to almost 89% of Vodafone connections and 79% of Airtel connections being disrupted.
- The districts of Howrah and South 24 Parganas seem to have been the most affected, with very high fractions of participants saying they were severely affected by multiple factors associated with the cyclone. Though, it is to be noted that our sample sizes from these two districts are relatively small.
- It is seen that Online Social Media (OSM) is being used by the affected population in several important ways, including inquiring about safety of others, informing others of one's own safety, organizing donation campaigns, and so on. However, the authorities are *not* using OSM sufficiently to connect to people, which should be considered by the authorities for the future. There will always be the risk of fake news/biased opinions spreading through OSM (as also observed to some extent after Amphan), but the benefits of mass communication through social media clearly outweigh the downsides.
- Participants have given mixed ratings to the preparedness of the authorities in dealing with the disaster—the number of people who opined that the authorities were highly prepared to deal with the disaster almost equals the number of people who felt that the authorities were poorly prepared. We observed that people tend to give higher ratings to the authorities if they received helpful responses from the authorities, and if their services were restored earlier.

The insights obtained from this study can help the authorities to better understand the evolving information needs of people and to improve how they connect with people during disaster situations in future.

**Organization of the Chapter:** The rest of this chapter is organized as follows. We discuss some related work in Sect. 2, followed by the description of our survey methodology in Sect. 3. We then analyze the responses to the survey in subsequent

sections, starting with the demographics of the participants in Sect. 4. We then get an estimate of the damages caused by the cyclone to various localities and districts (Sect. 5), followed by how much the damages affected the people (Sect. 6). Then we discuss the use of OSM platforms by the people affected by the cyclone (Sect. 7). We also analyze how well the authorities were prepared to deal with the crisis (Sect. 8). Further, we discuss some implications/takeaways from the survey that can help better handling of disasters in future (Sect. 9). We conclude the study in Sect. 10.

## 2 Related Work

**Studies on Similar Disasters:** The frequency of super-cyclones has been predicted to have increased in recent past due to climate change and other man-made interventions, and this phenomenon has been studied across the globe (Nott and Hayne 2001; McCabe et al. 2001). These events pose serious threat to public health, livelihood and civil infrastructure in general (Majra and Gur 2009; Iwasaki et al. 2009). In this context, researches have pointed towards the growing needs of the adaptive capabilities of developing nations towards these extreme events especially with the surge in frequency and intensity (Mirza 2003). Several studies have also been conducted accessing the vulnerabilities in the process of disaster management in India (Kawiytri and Shekhar 2020; Mazumdar and Paul 2016; Yadav and Barve 2017).

**Importance of Participation of Population During Disasters:** The public opinion towards authorities during a disaster has been studied previously in O’Sullivan et al. (2012), OECD (2013), Eiser et al. (2012). Such studies have shown that proper communication in both directions (authorities and the public) is important in helping to prepare the population before a disaster (Grothmann and Reusswig 2006), which can greatly reduce the damages caused (Mahdavian et al. 2020; Ardaya et al. 2017). How the authorities choose to communicate can also affect the co-operation of the people with them (Coombs 1995). This brings forward the importance of participation of the local population on matters related to disaster risk mitigation, and the importance of authorities to communicate effectively with them. Especially in the context of developing nations like India, the importance of public participation in disaster management and planning for short-term crisis management and long-term risk management has been ascertained (Bhattacharyya 2015; Kala 2014; Raju and Becker 2013). Studies have shown that public communication during disaster plays a crucial role in mitigation of the effects of disasters (Diwanji et al. 2020; Doyle et al. 2019). This can be done in several ways, ranging from traditional television/radio broadcasts to the emerging use of online social media.

**Use of Social Media in Disaster Mitigation:** Online social media has been found to be an effective method of communication with the population during disasters over one-way communication channels (Saroj and Pal 2020; Houston et al. 2015; Alexander 2014; Gao et al. 2011). Firstly, social media can be used to raise disaster awareness for increasing preparedness of the population (Anson et al. 2017; Rogstadius et al. 2013). Social media can also be used in estimating the demand and supply

scenarios of infrastructure, emergency supply of food, water and medicine (Reuter and Kaufhold 2018a; Kryvasheyev et al. 2016; Imran et al. 2013; Cameron et al. 2012). Quite a few studies focus on mitigation of the after-effects in post-disaster phases (Kankanamge et al. 2020; Kim and Hastak 2018; Basu et al. 2017), while some studies are based on monitoring and assessment of the crisis as a whole (Shan et al. 2019). Research has been done to use social media as a platform to connect people to help each other during disasters (Li et al. 2019; Purohit et al. 2014). Some progress has been made in integrating the data from authorities with that from social media to better help disaster management (Schempp et al. 2019). Social media such as Whatsapp are also known to be used by responding authorities for coordinating relief efforts (Resource Mapping During a Natural Disaster: A Case Study on the 2015 Nepal Earthquake 2017).

A surge of posts on social media occur during any major events including disasters, which cover a variety of topics such as reporting of first-hand information or seeking of help/information from officials (Stowe et al. 2016). However, people often make posts relating the event which are not relevant to the process of disaster mitigation. The challenge lies in extracting useful information from the huge amount of social media posts being made and several researches have been conducted in this regard (De Albuquerque et al. 2015; Middleton et al. 2013; Kumar et al. 2011). Another major challenge in the process of utilizing social media is the spread of misinformation/fake news, which causes panic among the population and deters authorities from effective disaster mitigation (Kwanda and Lin 2020; Krishnan and Chen 2018).

### 3 Survey Methodology

We deployed the survey on May 30, 2020, i.e., 10 days after the cyclone. We chose to wait for 10 days after the cyclone due to several reasons—(i) the internet connectivity of many people was disrupted by the cyclone for several days (as will be evident from the results of the survey discussed in later sections). Since our survey would be conducted online, we wanted to ensure that internet connectivity would be restored for most people and (ii) to allow people time to recuperate from the effects of the cyclone.

The survey was disseminated through mailing lists of a few educational institutes in and around Kolkata, West Bengal, and through social media posts by the authors. Consequently, as can be seen in Sect. 4, most of the participants of the survey were students and faculty members of educational institutes in and around Kolkata. We collected data using our survey over a duration of 2 weeks, i.e., between May 30 and June 16, 2020. In total, 201 participants responded to the survey.

As part of the survey, a participant was mostly asked about the effects of the cyclone in his/her “locality”, which was described as the region approximately within 500 meters in all directions from the participant’s home.<sup>3</sup> Among the participants,

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<sup>3</sup> The exact questions asked during the survey are listed in the Appendix.

**Table 1** Gender distribution of survey participants and people in West Bengal. The gender ratio of the participants is slightly biased towards males

|                                | Male (%) | Female (%) |
|--------------------------------|----------|------------|
| Survey participants            | 58.2     | 41.8       |
| Population of West Bengal (WB) | 51.3     | 48.7       |

90.6% said they were themselves in the locality for which they were answering during the cyclone, while the rest were responding on behalf of others who were in affected localities.

Note that *cyclone Amphan occurred during the COVID-19 pandemic, when West Bengal (and the whole of India) was under strict lockdown protocols*. This exceptional situation might have affected some of the observations in the survey. For instance, our survey indicates that people were much more adversely affected by factors such as disruption to phone and Internet services, than by physical damages such as uprooting of trees and waterlogging in their locality (as detailed in later sections)—the difference between the effects may have been larger due to the fact that the lockdown forced a lot of people to work from home, without venturing out into streets. However, it is also possible that the authorities required more time to repair the damages (e.g., remove uprooted trees, repair damaged electricity cables) due to the ongoing pandemic (and resultant lockdown), than they would have under normal circumstances. Also note that our online mode of survey deployment was the only feasible option during a nation-wide lockdown (as opposed to approaching citizens’ offline).

## 4 Demographics of Participants

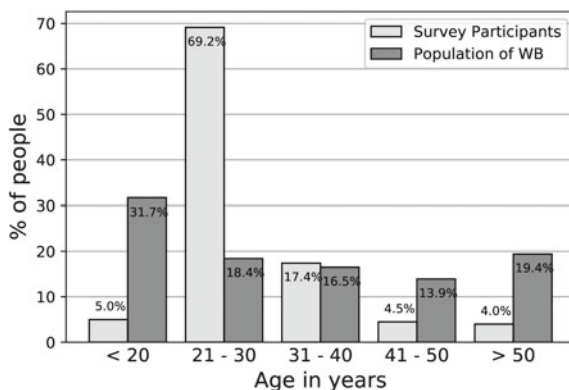
In this section, we study the demographics of the 201 participants who responded to the survey, in terms of their gender distribution, age distribution and occupation distribution. We also compare the distribution of the participants with the overall population distribution of the state of West Bengal, to check how representative our set of participants is of the overall population of the state.

**Gender Distribution:** Table 1 shows the distribution of gender of the survey participants.<sup>4</sup> We also compare it to the distribution of gender in the overall population of the state of West Bengal according to 2011 census 2011.<sup>5</sup> As we can see, the gender ratio of the survey participants is slightly biased towards males, with males consisting of 58% of the participants compared to 51% in overall population of West Bengal.

<sup>4</sup> We also had “Others” as an option (apart from “Male” and “Female”) in our survey. However, no participant selected it.

<sup>5</sup> [www.census2011.co.in/census/state/west+bengal.html](http://www.census2011.co.in/census/state/west+bengal.html)

**Fig. 1** Age distribution of survey participants and the overall population of West Bengal (WB). Our sample is heavily biased towards the age group between 21 and 40



**Age distribution:** Fig. 1 presents the age distribution of our participants. We again compare the age distribution to that of the overall population of West Bengal according to the 2011 census.<sup>6</sup>

Evidently, the age distribution of our participants is heavily biased towards people aged between 21 and 30 years (69% among survey participants, compared to 18% in WB population). In fact, 85% of the survey participants are aged between 21 and 40 years (compared to 35% in WB). This bias towards younger participants is mainly a result of our methodology of distributing the survey via mailing lists of educational institutions, whereby the survey was mostly taken by university students. However, this might even be beneficial for our study since people in this age group are generally well aware of the situation in the localities and their families. In fact, 90% of the participants in this age-group were themselves in the localities for which they reported the damages.

**Occupation distribution:** The distribution of occupation of the participants is given in Fig. 2. Our sample is biased towards more students, teachers and engineers, with students making up about 53% of our sample. As in the case of age distribution, this bias stemmed from our recruitment procedure that relied heavily on the students and faculty members of educational institutes, and users of social media, who are more likely to use the internet (and take our survey).

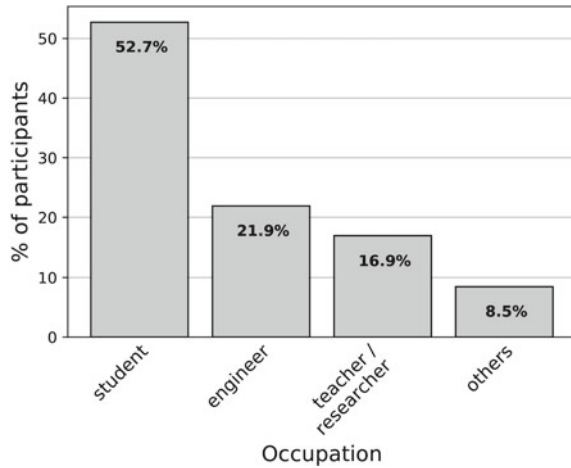
**Geographical distribution:** During the survey, participants were asked to state the pin code of their locality. Responses were obtained from a total of 124 distinct pin codes. We mapped the pin codes to the various districts of West Bengal. The distribution of the pin codes among the districts of West Bengal is shown in Fig. 3a. According to the Wikipedia,<sup>7</sup> and the newspaper “Hindustan Times”,<sup>8</sup> the districts North 24 Paraganas (N24P), South 24 Parganas (S24P), Kolkata (KOL), Hooghly (HGLY) and Howrah (HWH) were the ones mostly affected by cyclone Amphan. These are also the five districts from where most of the responses were received.

<sup>6</sup> <http://statisticstimes.com/demographics/population-of-west-bengal.php>

<sup>7</sup> [https://en.wikipedia.org/wiki/Cyclone\\_Amphan](https://en.wikipedia.org/wiki/Cyclone_Amphan)

<sup>8</sup> <https://tinyurl.com/HT-amphan>

**Fig. 2** Occupation distribution of survey participants. The participants are mostly students



We have considered these top five districts individually and grouped the rest as “Others”, as in Fig. 3b. It can be noted that, although the majority of the survey participants were from urban areas, some of them were from semi-urban areas.

### Summary of Section

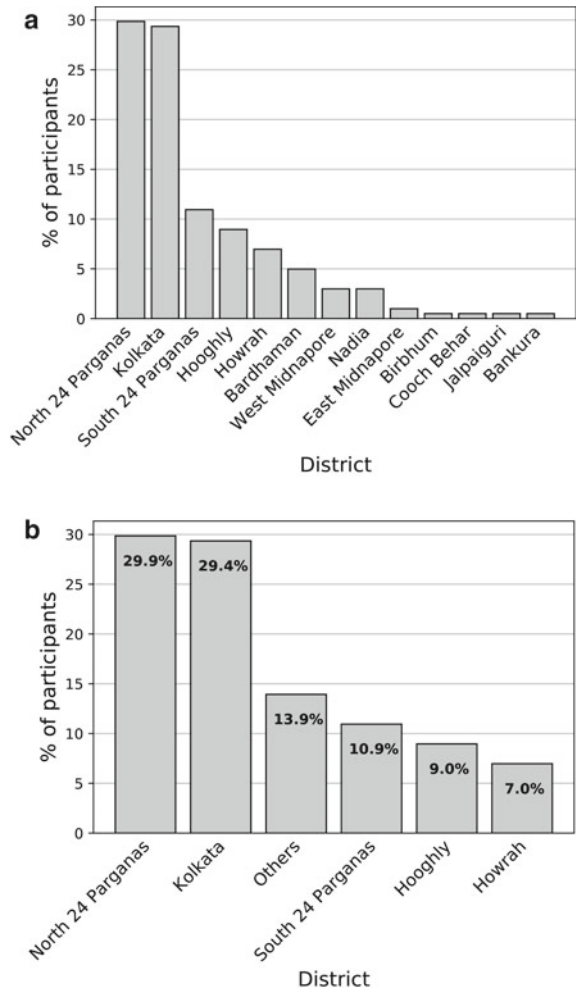
We found that our sample population is biased towards a younger population (age group of 21–40), and towards students. This bias is inherent in our recruitment procedure (via email list of educational institutions, social media).

However, we note that this biased population is still suitable for our study due to two reasons: First, our sample covers a wide range of cyclone-affected localities and provides a wide coverage over age groups as well as gender. Moreover, this bias might even facilitate parts of our exploration—one of the aims of this study is to understand the perceptions about digital media usage during disasters; since our survey respondents are well versed with digital media usage, it is possible to gain valuable insights about this aspect from the survey (see Sect. 7).

## 5 Measuring Extent of Damages

In this section, we study the damages caused by the cyclone to the various localities of the participants. We first analyze the physical damages caused to the localities (for example, damages to trees and buildings) in Sect. 5.1, followed by an analysis of how services like electricity supply were disrupted in Sect. 5.2.

**Fig. 3** Geographical distribution of survey participants. Most of the participants were from N24P and KOL. **a:** Distribution of participants among all districts in WB. **b:** Considering the top five districts and grouped rest as “Others”



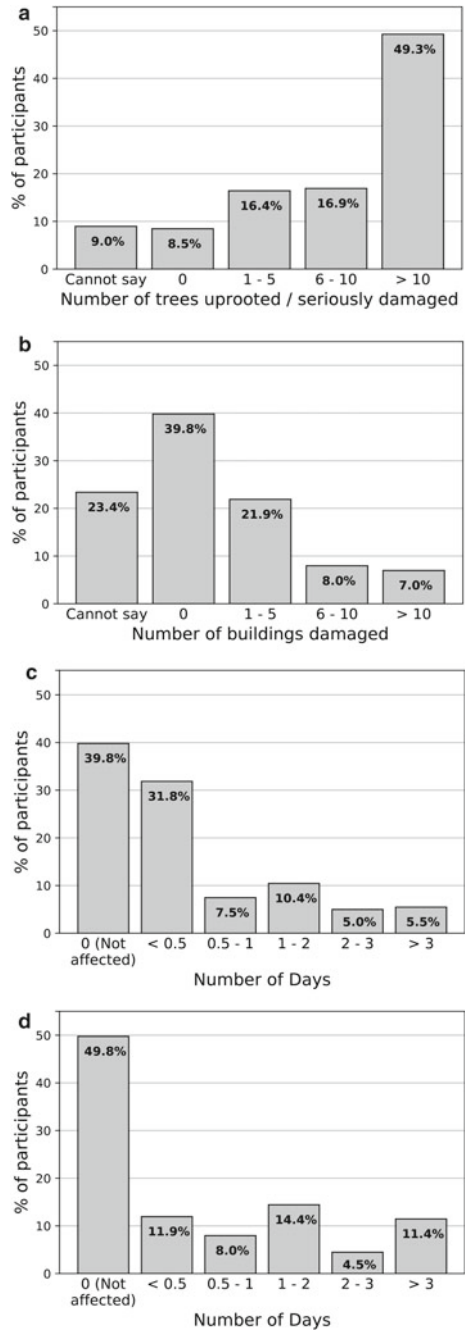
### 5.1 Physical Damages to Localities

We asked participants to give an estimate of the damages caused by Amphan to their localities in terms of (i) number of trees uprooted, (ii) number of buildings damaged, (iii) number of days for which one’s locality was waterlogged. We had specified that “locality” refers to the region approximately within 500 m in all directions from the participant’s home. The distribution of responses by the participants is shown in Fig. 4. We have also calculated the district-wise distribution of heavily damaged localities, and tabulated them in Table 2.

**Trees uprooted:** The number of trees that were uprooted or seriously damaged by the cyclone is shown in Fig. 4a. Uprooting of trees was prevalent in a large majority



**Fig. 4** Measuring the extent of damages in the localities of the survey participants. A lot of trees were damaged in many localities, but there was not much damage to buildings in the localities of the participants (mostly urban). Waterlogging and disruption to drinking water supply have also been relatively less. **a:** Number of trees uprooted in participants' locality. **b:** Number of Buildings damaged in participants' locality. **c:** Number of days for which participants' locality was waterlogged. **d:** Number of days for which participants' locality faced disruption of supply of drinking water



**Table 2** Distribution of heavy damages to different districts, where “heavy damage” is as described in the first column

| Participants who said their locality was damaged heavily in terms of: | N24P (60) (%) | KOL (59) (%) | S24P (22) (%) | HGLY (18) (%) | HWH (14) (%) | Others (28) (%) |
|---|---------------|--------------|---------------|---------------|--------------|-----------------|
| Trees uprooted (More than five trees)                                 | 65.0          | 66.1         | 86.4          | <b>88.9</b>   | 85.7         | 28.6            |
| Buildings damaged (More than five buildings)                          | 10.0          | 13.6         | 18.2          | <b>27.8</b>   | 21.4         | 14.3            |
| Waterlogging (More than 1 day)  | 21.7          | 27.1         | 18.2          | 5.6           | <b>35.7</b>  | 10.7            |
| Drinking water supply disrupted (More than 1 day)                     | 35.0          | 22.0         | 27.0          | <b>44.4</b>   | 42.9         | 21.4            |
| Electricity supply disrupted (More than 1 day)                        | 56.7          | 25.4         | <b>81.8</b>   | 61.1          | 64.3         | 28.6            |
| Phone service disrupted (More than 1 day)                             | 61.7          | 72.9         | <b>81.8</b>   | 61.1          | 64.3         | 25              |
| Internet service disrupted (More than 1 day)                          | 68.3          | 88.1         | 81.8          | 83.3          | <b>100</b>   | 25              |

The percentages represent the fraction of participants from that district who said their localities were damaged heavily. The numbers in brackets below each of the district names represent the count of participants from that district. The highest percentage in each row is highlighted in boldface. Note that “Others” refer to all the districts that were not affected much by cyclone Amphan.

of localities. In 66.2% of the localities, more than five trees were uprooted. In 49.3% localities, more than 10 trees were uprooted.

The district-wise distribution of heavy damage to trees is given in the first row of Table 2. As expected, damages to trees affected the other districts (“Others”) quite less (28.6% participants reported more than five trees uprooted), whereas for each

of the five districts that were most affected by the cyclone, over 65% of participants reported more than five trees uprooted. The fractions are especially high in South 24 Paraganas, Hooghly and Howrah, where more than 85% of participants from these districts reported more than five trees uprooted in their locality.

**Buildings damaged:** The number of buildings damaged in Fig. 4b. Damages to buildings were relatively less in the localities of our survey participants. Only in 15% of the localities, more than five buildings were damaged. From Table 2, we see that the fraction of participants who reported more than five buildings damaged is 10% in North 24 Paraganas, 13.6% in Kolkata, slightly more (27.8%) in Hooghly. These low fractions are somewhat expected due to these being urban areas.

**Waterlogging:** The distribution of the duration for which the localities were waterlogged is shown in Fig. 4c. About 21% of all localities of the participants faced waterlogging issues for more than 1 day. As seen in Table 2, waterlogging affected Howrah the most (35.7% of participants reported waterlogging for more than one day) and Hooghly the least (5.6% participants reported waterlogging for more than one day).

The relatively low severity of waterlogging in some localities indicates good drainage facilities in those localities. The areas where waterlogging was more severe could have improper drainage that tends to flood even with normal rains. In fact, 31.2% of the survey participants said that their locality was waterlogged due to cyclone Amphan but is not usually waterlogged during normal rainfall. Whereas, 23.8% of participants said that their locality gets regularly flooded every time there is heavy rainfall. The authorities should attempt to improve the drainage facilities in these localities.

## 5.2 *Disruption of Services*

We asked the participants if their drinking water, electricity, phone and internet services had been disrupted due to the cyclone Amphan, and if so, how long it took for these services to be restored back. We now analyze the disruption of various services.

**Disruption of drinking water supply:** The duration for which the supply of drinking water was disrupted is given in Fig. 4d. About 30.3% of the participants faced problems with drinking water supply beyond one day. The district-wise distribution is given in Table 2. Drinking water problems were faced by all districts more or less evenly, with Hooghly and Howrah facing the most problems, with 44.4% and 42.9% of the participants from these districts saying they faced irregular drinking water supply beyond one day.

It can be noted that disruption of drinking water supply may be correlated with electricity services being hampered for a long time (as discussed below), which rendered electric water pumps inoperable.

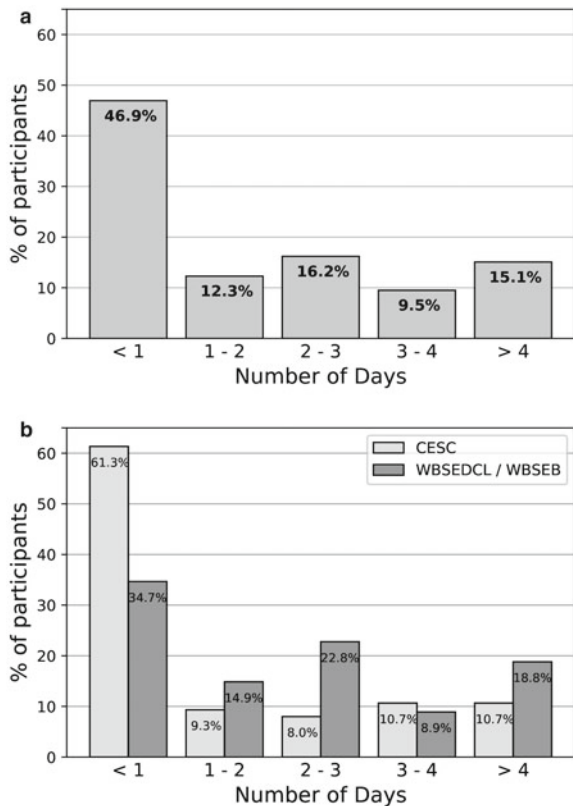
**Disruption of electricity supply:** There are two primary electricity supply providers in West Bengal—(i) CESC that primarily supplies Kolkata and parts

of Howrah and other districts neighboring Kolkata and (ii) WBSEB/WBSEDCL that supplies the other regions. In total 91 of our survey participants reported they were supplied by CESC, and 106 participants reported they were supplied by WBSEDCL/WBSEB (while only 4 reported some other supplier).

In total, as many as 89.1% of our survey participants reported disruption of electricity in their locality. Specifically, 82.4% out of the 91 participants supplied by CESC and 95.3% out of the 106 participants supplied by WBSEDCL/WBSEB faced disruption of electricity supply. Thus, it seems that people supplied by WBSEDCL/WBSEB were disrupted more than those by CESC (95.3% versus 82.4%).

The distribution of time taken for restoration of electricity supply is given in Fig. 5. The overall trends are given in Fig. 5a whereas Fig. 5b gives a comparison between the two major electricity suppliers CESC and WBSEDCL/WBSEB. In case of CESC, the majority of the connections were restored within a day (61%), whereas WBSEDCL/WBSEB took longer to restore supplies. However, for both providers, a considerable fraction of connections took longer than 3 days to restore (21.4% for CESC, and 27.6% for WBSEDCL/WBSEB).

**Fig. 5** Time taken (in days) for restoration of electricity supply. We present (a) overall results, and (b) a comparison between the two major electricity suppliers—CESC and WBSEB/WBSEDCL. The percentages in the bar charts are calculated based on the number of participants for whom services were disrupted (91 participants supplied by CESC, and 106 by WBSEDCL/WBSEB; 82.4% and 95.3% participants respectively faced disruption for them). **a:** Number of days taken for restoration of electricity (for all 201 participants). **b:** Comparison of electricity restoration time between CESC and WBSEDCL/WBSEB



The district-wise distribution of disruption of electric supply is given in Table 2. As we can see, a significantly less number of participants from Kolkata (25.4%) faced disruption beyond 1 day. The “Others” were not affected too much by the cyclone, hence most of the participants from these regions had electricity restored in under a day. However, the districts of North 24 Parganas, South 24 Parganas, Hooghly and Howrah saw heavy disruption of electricity services.

It can be noted that a large majority of electricity connections of Kolkata and Howrah are supplied by CESC. There is a huge difference in the fraction of connections in these two districts that were disrupted for more than a day—25.4% for Kolkata and 64.3% for Howrah. This difference indicates that CESC may have prioritized fixing connections in Kolkata since it is a major city.

We had also asked the participants (who said they faced disruption of electricity supply) *if their locality had some public utility whose operation could have been disrupted due to lack of electricity*. About 11.7% of participants answered there were *hospitals/nursing homes* in their localities, 26.1% said there were *water pumping stations*, and as many as 67.8% of participants said there were *mobile towers* in their locality. The mobile towers not getting electricity supply for long could have depleted their backup power source, which led to further disruption of phone and internet services (as discussed below). The same goes for the water pumping stations, whose disruption could have led to unavailability of drinking water in certain localities for a long duration.

**Disruption of phone and Internet Services:** Next we asked about the disruptions to phone and internet services. For the phone connections, we asked survey participants to mark which service providers they used, and which of them were disrupted, and how long it took for at least one service to be restored. For internet connections, we asked which media they used to access the internet (like mobile internet or broadband), and if they faced disruption of internet services.

It can be noted that there are four primary mobile service providers in the state of West Bengal—Vodafone, Airtel, BSNL and Jio. Out of the 201 survey participants, 114, 103, 53, and 132, respectively, reported using these services. Note that many participants reported to be using more than one mobile service providers simultaneously. For internet connectivity, there are two popular choices—mobile internet (used by 168 participants) and broadband internet (used by 111 participants). Again, several participants reported to be using both.

**Table 3** Number of participants who avail different network providers for phone and percentage of participants who experienced disrupted phone services

| Network Provider | Total | Disrupted (%) |
|------------------|-------|---------------|
| Overall          | 201   | 85.1          |
| Vodafone         | 114   | 88.6          |
| Airtel           | 103   | 78.6          |
| BSNL             | 53    | 66.0          |
| Jio              | 132   | 52.2          |

**Table 4** Number of participants who avail internet via different technologies, and percentage of participants who experienced disrupted internet services

| Internet technology | Total | Disrupted (%) |
|---------------------|-------|---------------|
| Overall             | 201   | 88.6          |
| Mobile              | 168   | 89.9          |
| Broadband           | 111   | 90.1          |

**Fig. 6** Time taken for phone services to be restored

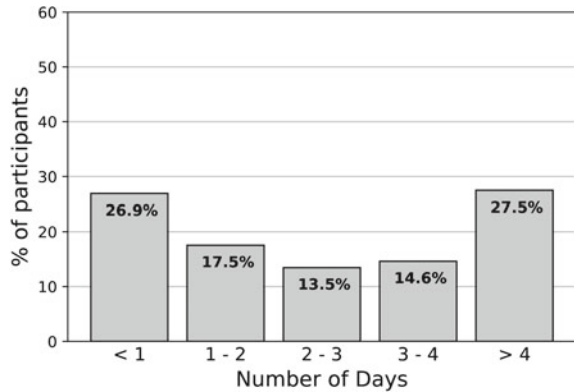


Table 3 shows the fraction of mobile connections that were disrupted. Overall, a huge number (85%) of phone connections seem to have been disrupted, with even more (88.6%) internet connections being disrupted. Among phone service providers, Vodafone seems to have been disrupted the most (88%), followed by Airtel (78.6%), while Jio connections were disrupted quite less relatively (52%). These observations in our survey corroborate with reports in the news media. For instance, The Indian Express reported<sup>9</sup> on May 22, 2020 (i.e., 2 days after the cyclone)—“indian-express.com reached out to some people in Kolkata, and most of them told us that only Jio and BSNL services are working somewhat decently, whereas, Vodafone and Airtel services are not working at all”.

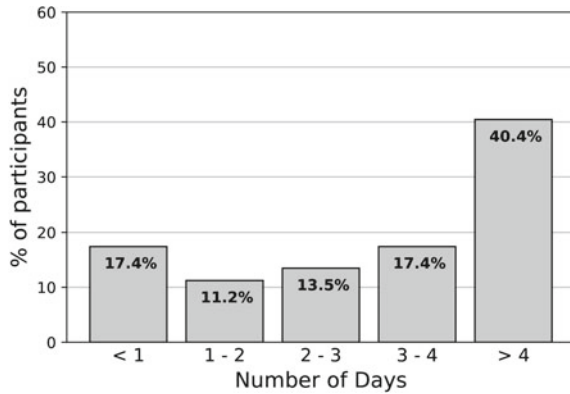
Table 4 shows the fraction of disrupted internet connections. Internet connections were also heavily disrupted, where close to 90% of both mobile internet connections as well as Broadband Internet connections were disrupted.

The distribution of *restoration times* of the phone services is given in Fig. 6 where it is seen that a large fraction of phone connections (42.1%) took more than 3 days to be restored. The distribution of restoration time of internet services is given in Fig. 7, and a significant fraction of them (57.8%) took more than 3 days to be restored.

The district-wise distributions of phone and internet connections that were disrupted for more than a day are shown in Table 2. It seems the phone and internet services were disrupted for over a day for a large majority of participants in all the five districts that were mostly affected by Amphan. The districts of Kolkata, South 24 Parganas and Howrah (especially for internet service disruption) seem to have

<sup>9</sup> <https://tinyurl.com/IE-amphan>

**Fig. 7** Time taken for internet services to be restored. Note that restoration of internet services took more time than restoration of phone services, for a substantial fraction of participants



been severely affected (though our sample size from Howrah and South 24 Parganas is quite small).

It can be noted that phone connections were disrupted slightly less than internet connections. Several participants indicated that, even though they could not access the internet through their mobile connections, they could use their phones for calling (especially the ones using the service provider Jio).

**Summary of Section**

The major physical damage (in the localities covered by our survey participants) was uprooting of trees, whereas the damage to buildings seemed less (since most of the participants were from urban areas). There was not too much damage in terms of waterlogging and disruption of supply of drinking water, even though some participants faced disruption of drinking water supply beyond 3 days. The district of Hooghly seems to have faced the most damage; however, the number of participants from here is quite less.

Importantly, a huge fraction of participants faced disruption of electricity, phone and internet services; even worse, a huge fraction of these services took more than 3 days to be restored (this delay in restoration could have been higher due to the ongoing COVID19-induced lockdown). Among the two most popular electricity suppliers, it seems that CESC managed to restore a significantly higher fraction of connections within a day after the cyclone, as compared to WBSEDCL. Among the popular phone service providers, Jio seems to have faced relatively less disruption.

**6 Effect of These Damages on the Population**

In this section, we attempt to study how severely the population was affected by the damages caused to their localities. We considered the seven factors discussed in Sect. 5 and tried to find to what extent the participants were affected by each factor.

To this end, for each of the seven factors, we asked participants to rate the extent to which they/their family were affected, on a *Likert scale* of 1–5, where level “1” indicates “not affected at all”, and level “5” indicates “extremely severely affected”. The distributions of the responses for all seven factors are shown in Fig. 8a–g.

We consider a participant to be “*severely affected*” if he/she selected levels 4 or 5 on the Likert scale. We have sorted the factors based on the decreasing order of number of people saying that they were severely affected by a certain factor. We also calculated which factors affected people severely (participants who selected levels 4 and 5) from each of the districts, and have tabulated the district-wise distributions in Table 5.

**Electricity, phone, internet and drinking water services:** A staggering 72.8% of the participants were severely affected (i.e., selected levels 4 or 5 on the Likert scale) by disruption of internet services (see Fig. 8a). As many as 67.3% of the participants were severely affected by disruption in phone services (Fig. 8b), while 48.5% of the participants were severely affected by disruption of electricity supply (Fig. 8c).

There can be two potential factors leading to such high fractions of people getting severely affected by disruptions of these services. First, as stated earlier, the cyclone occurred during the COVID19-induced lockdown which forced a lot of people to work from home. Second, our sample population mostly consisted of students, faculty and engineers (as given in Sect. 4). These services were particularly crucial for our sample population while working from home. These two factors might explain why the disruption severely affected so many of the survey participants.

The district-wise distribution of these participants is given in the first three rows of Table 5. It seems that people from Howrah and South 24 Parganas were most severely affected overall (though the number of participants from these districts is only 14 and 22, respectively).

Also 24.7% of the participants were severely affected by drinking water shortage (Fig. 4d), with the highest fraction being from Howrah.

**Physical damages to localities:** For the three physical damage factors (uprooting of trees, damage to buildings, and waterlogging), the number of people severely affected follows the same pattern as the amount of damages caused. Figure 8d shows that 30.3% of the participants were severely affected due to uprooting of trees. Figure 8f shows that not too many (16.3%) were affected severely by waterlogging and even fewer (10%) by damages to buildings as shown in Fig. 8g. The probable reason for these low fractions is that the participants were from urban areas mostly.

The district-wise distribution of these participants is given in Table 5. Uprooting of trees seems to have affected people more or less equally from all the districts, except for South 24 paraganas where a lot more people (50%) seem to have been affected, which is expected because of the huge amount of trees present in this district. Waterlogging seems to have been a problem mostly in Kolkata, North 24 Paraganas and Howrah. North 24 Paraganas seems to be most affected by damage to buildings, but still only a few participants (10) said they were affected severely.



**Fig. 8** Severity of participants affected by disruption of various factors on a scale of 1 (least severe) to 5 (most severe). Participants were affected much more by disruption of services than physical damages to their localities. **a:** Self-reported severity for disruption of internet services. **b:** Self-reported severity for disruption of phone services. **c:** Self-reported severity for disruption of electricity supply. **d:** Self-reported severity for uprooting of trees. **e:** Self-reported severity for disruption of supply of drinking water. **f:** Self-reported severity for to waterlogging. **g:** Self-reported severity for damages to buildings

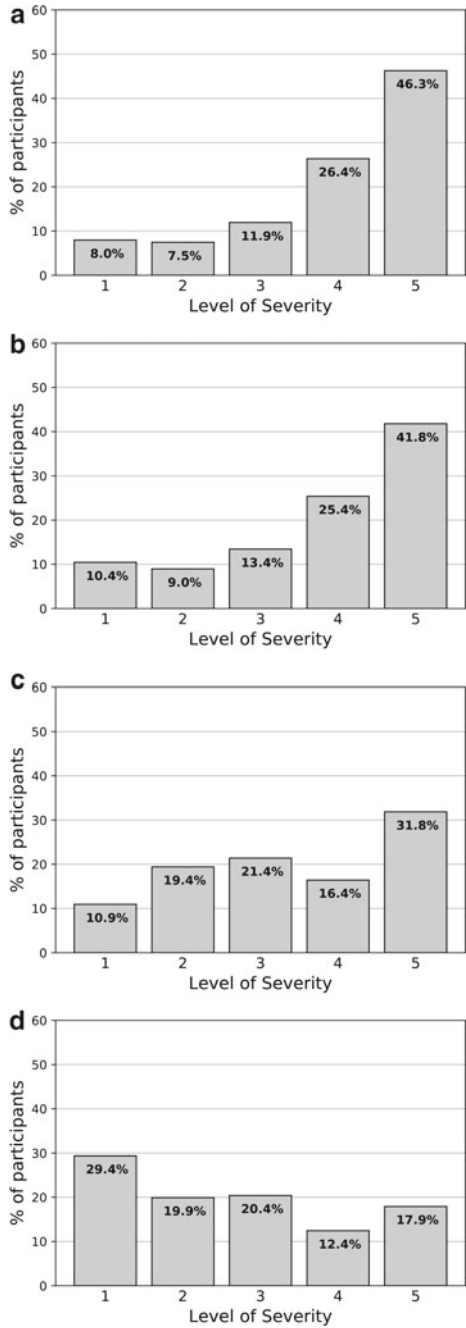
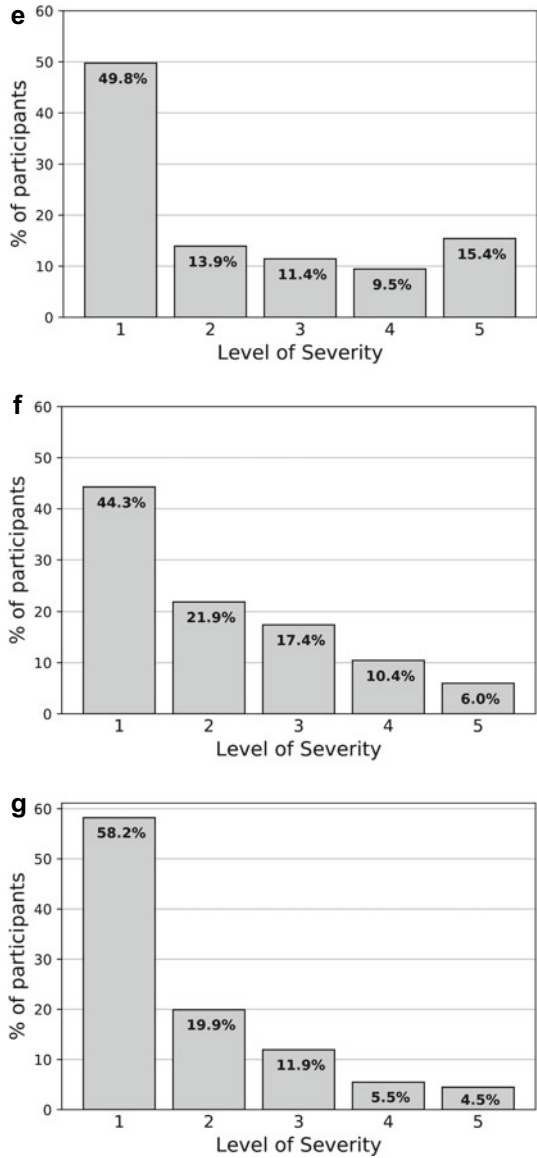


Fig. 8 (continued)



### Summary of Section

The population was affected much more by disruption of electricity, phone and internet services than by physical damages such as uprooting of trees and water-logging (which may be because of the COVID19-induced lockdown and the bias in our survey population). All districts seem to have been more or less equally affected due to disruption of internet and phone services (except for “Others” which were

**Table 5** Distribution of participants who were severely affected (i.e., selected one of the highest two levels 4 or 5 on Likert scale of being affected) by various factors, across the different districts

| Participants who said they were heavily affected (levels 4 and 5) due to | Overall (201) (%) | N24P (60) (%) | KOL (59) (%) | S24P (22) (%) | HGLY (18) (%) | HWH (14)(%) | Others (28) (%) |
|--|-------------------|---------------|--------------|---------------|---------------|-------------|-----------------|
| Disruption of internet connectivity                                      | 72.8              | 81.7          | 69.5         | 86.4          | 77.8          | <b>100</b>  | 32.1            |
| Disruption of phone connectivity   | 67.3              | 73.3          | 67.8         | <b>86.4</b>   | 72.2          | 78.6        | 28.6            |
| Disruption of electricity supply   | 48.5              | 60.6          | 27.1         | 77.3          | 50.0          | <b>78.6</b> | 28.6            |
| Uprooting of trees   | 30.0              | 33.3          | 23.7         | <b>50.0</b>   | 33.3          | 35.7        | 17.9            |
| Disruption of drinking water supply                                      | 24.7              | 30.0          | 20.3         | 31.8          | 22.2          | <b>42.9</b> | 10.7            |
| Waterlogging/flooding  | 16.3              | 20.0          | <b>22.0</b>  | 9.1           | 11.1          | 21.4        | 3.6             |
| Damage to buildings  | 9.9               | <b>16.7</b>   | 6.8          | 9.1           | 5.6           | 7.1         | 7.1             |

The percentages represent the fraction of participants who were severely affected from that district. The numbers in brackets below each of the headers represent the count of participants from that district. The highest percentage in each row is highlighted in boldface. The seven factors (rows) are arranged in decreasing order of the overall fraction of participants who said they were severely affected by a certain factor (second column).

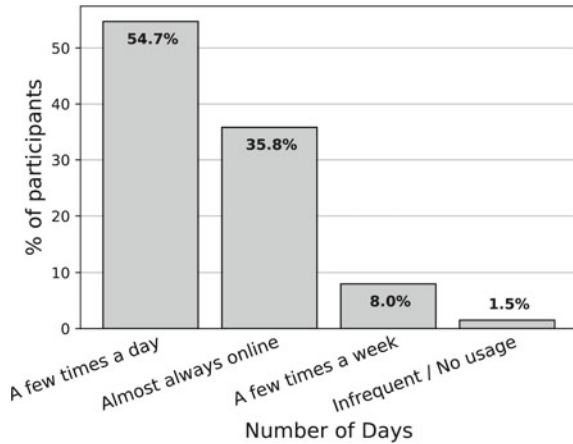
anyway affected less by the cyclone). South 24 Paraganas and Howrah seem to have been affected more by disruption of electricity supply. Participants from South 24 Paraganas seem to have been affected significantly more due to uprooting of trees, whereas Kolkata and North 24 Paraganas seem to have been affected more due to waterlogging.

## 7 Impact of Social Media

Online Social Media (OSM) is being increasingly used in post-disaster times both within India and abroad (Nazer et al. 2017; Imran et al. 2015; Niles et al. 2019; Reuter and Kaufhold 2018b). In this section, we analyze the impact of OSM on people during the days immediately after the Amphan cyclone. We also try to analyze how effective the authorities were in utilizing social media to reach people during the disaster.

**OSM usage of participants in general:** Out of the total of 201 survey participants, 198 said that they use social media, and the frequency of usage is as given in Fig. 9. Our survey participants mostly consist of people who frequently use social media, with 90.5% participants using social media every day. This high social media usage is expected as our survey population is biased towards people who frequently use social media and are thus more likely to respond to our survey (as discussed in Sect. 4).

**Fig. 9** Frequency of social media usage of our participants



**Table 6** Different social media used by participants

| Twitter (%) | Instagram (%) | Facebook (%) | Whatsapp (%) |
|-------------|---------------|--------------|--------------|
| 22.9        | 46.8          | 85.1         | 95.5         |

We also asked the participants that social media apps/sites they use, with a lot of them using Facebook and Whatsapp as shown in Table 6.

**OSM usage of participants within 7 days after Amphan:** We asked three primary questions to the survey participants to find out the impact of social media during and after the disaster—(i) whether they posted any information related to cyclone Amphan on OSM, (ii) whether they received any useful information related to Amphan from OSM and (iii) whether they observed any undesirable/harmful information related to Amphan on OSM. All these questions specified that the participants should consider a time window of *7 days after the cyclone* while answering these questions (e.g., whether they had posted/received any information relevant to Amphan from OSM within 7 days after the cyclone).

In each of the three questions described previously, we had also kept an option stating “I did not use social media within 7 days after Amphan”. A total of 22 participants selected this option for all three questions. We tried to find the reasons for these people not using social media. Two potential reasons could be (i) they are generally infrequent users of OSM, or (ii) their internet/electricity services were disrupted after the cyclone, thus preventing them from using OSM. It is interesting to see that, out of the 22 participants who did not use OSM in 7 days after Amphan, most of them (81.8%) are frequent users of OSM. Among them, about 72.7% faced internet connection problems and 63.6% faced electricity problems beyond 2 days after the cyclone, which might have been the reason for them not being able to use social media. It is difficult to guess why the rest did not use OSM for those few days. It is possible that they were recuperating from the effects of the cyclone and/or the COVID pandemic.

The rest 179 (89%) of our survey participants used OSM during the period of 7 days after Amphan. We refer to these participants as “active users”. In the rest of this section, we analyze the information posted/received by these active users on OSM over the 7 days immediately after cyclone Amphan.

**Information posted on social media:** We first asked *if the participants themselves had posted information related to Amphan on social media* during the 7 days immediately after the cyclone. The responses have been tabulated in Table 7. Quite a lot of the participants (46.4% of the active users) used social media but did not post anything related to Amphan. However, the rest actually posted various information related to Amphan on OSM, e.g., described the situation in their locality (14% of active users), or posted images of damages in their locality (20.1%), posted their opinion on issues related to Amphan (13.4%), and so on. An important usage of OSM seems to be that a sizable fraction of people are using OSM to inquire about safety of others (27.9% of the active users) and to inform others about their own safety (26.8%). The use of OSM for inquiring about safety of others and informing others of one’s own safety has been observed during other disaster events as well (Reuter and Kaufhold 2018b). Around 15.6% people also posted information to help others. A small fraction of participants (5.6%) specifically connected to social media accounts of the Government agencies or service providers and asked for help.

**Useful information received from social media:** We then asked *what kind of useful information they received from OSM related to Amphan*. The responses are summarized in Table 8. Among the participants who used social media within 7 days after Amphan, 18.4% did not get any useful information related to Amphan. The rest 81% of participants received various useful information, including 33% of them receiving useful updates from government and/or service providers. As many as 43% of active participants received information about safety of others, 31.3% received important updates from their own locality, and 49.2% received important updates from other regions. We also asked the participants to briefly describe some social media posts which they felt contained important information on Amphan. Some of the responses by the participants are shown in Table 10. From this table, we observe another important usage of OSM in organizing online donation campaigns.

These numbers show that OSM is more popularly used to consume information than produce information. Also, it can be noted that the engagement by the authorities is quite low after the cyclone, as compared to before the cyclone—while 62.7% of all the survey participants received advance warning *before* the cyclone via OSM, only 29.4% received useful updates from authorities in the 1-week period *after* the cyclone. This big difference between the two fractions shows that Government and other authorities can use social media to reach out to more people after a disaster, as shown also shown in studies (Nazer et al. 2017; Imran et al. 2015). Especially, online social media is even more beneficial since the authorities can do both—broadcast information to everyone, and engage with personal user accounts individually—which is not possible with traditional media like television or newspapers.

**Harmful/undesirable information received from social media:** Finally, we also asked if the participants observed any undesirable/harmful content on social media, which are known to often circulate on social media after a crisis (Zubiaga et al.

**Table 7** Experience of posting information on online social media (OSM), as reported by the survey participants

| Experience with posting information on OSM by participants                 | #  | %    | % active |
|--|----|------|----------|
| Connected to Government accounts/NGOs/service providers and asked for help | 10 | 5.0  | 5.6      |
| Posted my opinion on issues related to Amphan                              | 24 | 11.9 | 13.4     |
| Generally described the situation in my locality                           | 25 | 12.4 | 14.0     |
| Posted information that can help others (e.g., helpline numbers)           | 28 | 13.9 | 15.6     |
| Posted images of the damages in my locality                                | 36 | 17.9 | 20.1     |
| Informed others about safety of myself/my family                           | 48 | 23.9 | 26.8     |
| Inquired about safety of others  | 50 | 24.9 | 27.9     |
| I used social media, but did not post any information related to Amphan    | 83 | 41.3 | 46.4     |

“#” (%) represents the number (percentage) of participants. “% active” is the fraction of participants who said they were active on social media within the 7 days following Amphan. The rows are ordered in increasing number of participants.

**Table 8** Information received by the participants from social media

| Experience with information received by our participants from OSM                 | #   | %    | % active |
|---|-----|------|----------|
| I used social media, but did not receive any useful information related to Amphan | 33  | 16.4 | 18.4     |
| Received important updates from my own locality                                   | 56  | 27.9 | 31.3     |
| Received useful updates from Government accounts/NGOs/service providers           | 59  | 29.4 | 33.0     |
| Received information about safety of others                                       | 77  | 38.3 | 43.0     |
| Received important updates from other regions                                     | 88  | 43.8 | 49.2     |
| Received advance warning about the cyclone (from social media)                    | 126 | 62.7 | 70.4     |

The columns are same as that in Table 7. The rows are ordered in increasing number of participants.

2018; Rajdev et al. 2015). The responses to our question are summarized in Table 9. Among the participants who used social media within 7 days after Amphan, 48% said they observed some undesirable/harmful posts—19.6% said they observed fake news/rumors, 21.2% said they saw too much useless posts, 34.1% observed too much of political arguments, and 7.8% saw too much of superstitious/religious posts. We also asked the participants to briefly describe some social media posts that they thought had a negative impact on the situation. Some of their responses are shown in Table 11.

### Summary of Section

As discussed earlier, our sample of survey participants is biased towards frequent social media users; but this bias actually makes the analysis in this section more credible. We found that people use OSM in many different ways in the aftermath of the disaster. Importantly, out of the “active” survey participants who used OSM during the

**Table 9** Undesirable/harmful content observed by participants on social media

| Experience of undesirable/harmful information on OSM                            | #  | %     | % active |
|---|----|-------|----------|
| Observed too much of religious/superstitious posts                              | 14 | 7.0%  | 7.8%     |
| Observed many posts about other regions, but not enough coverage of my locality | 30 | 14.9% | 16.8%    |
| Observed fake news/rumours  | 35 | 17.4% | 19.6%    |
| Observed too much useless posts   | 38 | 18.9% | 21.2%    |
| Observed too much of political arguments  | 61 | 30.3% | 34.1%    |
| I used social media, but did not observe any negative effect of social media    | 86 | 42.8% | 48.0%    |

The columns are same as that of Table 7. The rows are ordered in increasing number of participants.

7 days immediately after Amphan, 81.6% said they received some useful information related to Amphan from OSM, while 52% said they observed undesirable/harmful content on OSM. Hence, *a much larger fraction of users (who actively use social media) seem to find useful information via OSM, than the fraction of users who find OSM propagating harmful content.*

Also, our study indicates that Government agencies and service providers should engage more with people via OSM in the aftermath of a disaster, to give them localized and personalized updates on the situation.

## 8 Preparedness of Authorities

In this section, we study how vigilant the authorities (including government and private service providers) were to mitigate the damages caused by the cyclone.

**Warning people about the cyclone in advance:** We asked the participants if they had received advance warning about the cyclone, and if so, via which medium. The responses are given in Table 12. The authorities were effective in informing a large majority of people via news media (94.5%), but relatively less through direct communication (31.3%). A large fraction (62.7%) also received warning from social media.

In fact, one of our participants from a remote region of West Bengal commented—“The Govt. of West Bengal warned us through SMS that those who were not staying in *pukka* houses should find some place safe and stay there for the next few days. It also specifically warned residents near coastal areas”. Hence, the authorities were very much effective in warning people about the cyclone.

**Responses received from authorities after the cyclone:** We asked the participants if they had tried to contact any of the authorities for assistance immediately after the cyclone. About half of the participants said that they did *not* attempt to contact any authority. To the other half of the participants (who tried to contact authorities

**Table 10** Sample responses (excerpts) by participants when asked to describe “social media posts that you found to contain important information on Amphan”

| Category                                 | Responses   |
|--|---|
| Situational information                  | – Updates on the speed and movement of the cyclone  |
|  | – Updates on the measures taken by the State and Central Government   |
| Useful contacts                          | – Essential phone numbers for connecting CESC, Water Department, Government of WB Facebook Page, etc  |
|  | – Instagram and WhatsApp stories with helpline nos and CM relief fund donation details  |
|  | – I came across phone numbers where I could address my problems regarding the disruption of electricity, and NGOs helping the needy   |
| Attempts to collect donations and relief | – I could see many relief activities going in social media and people posting activity pictures and asking for donation to help more. This is a very positive thing I have seen   |
|  | – Social media prompted to help bring in donation drives from people much faster than other media in these conditions   |
| Inquiring about safety of others/self    | – Social media gave more important updates since TV was not working, and even with less internet connectivity, at least text communication was to some extent helped to assure about relatives                          |
|  | – On Facebook there appeared a button after the cyclone to mark whether I was safe during the cyclone which helps my friends to know about my situation after the cyclone   |
| Other benefits of social media           | – The hashtags (#PrayForBengal, #FightBackbengal, etc.) expressing togetherness of Bengal were influencing enough   |
|  | – I feel that the posts, stating the devastating condition of worst-hit area Sundarban due to Amphan are helpful in reality. Many can contribute to the funds that are shared through social media (generally Facebook) |

**Table 11** Sample responses (excerpts) by participants when asked to describe “social media posts that you think hindered/worsened the situation”

| Responses   |
|---|
| – Posts vilifying little efforts of people trying to donate from selling artwork, trolling unnecessarily for difference of opinions, fake news about politics around relief work, etc. But overall negative effect was less than positive |
| – Fake news and propaganda by political parties   |
| – The posts that tried to add a political angle even to a natural disaster like Amphan  |
| – Negativity spreading regarding Electricity disruption   |



**Table 12** Communication medium through which our participants received warning about the cyclone

| Medium of communication                             | %    |
|---|------|
| Did not receive any warning                         | 2.0  |
| Via communication from Government (SMS/phone/email) | 31.3 |
| Via announcements on news media (TV, newspaper)     | 94.5 |
| Via word of mouth from friends and relatives        | 36.8 |
| Via social media (Facebook/Twitter/Whatsapp)        | 62.7 |

for help), we asked whether they received helpful responses from the authorities. This is the distribution of their responses:

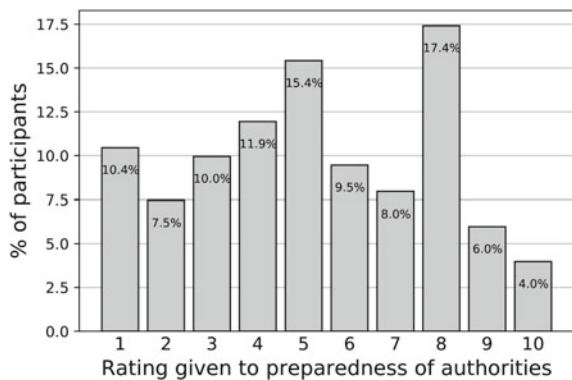
- Could not contact authorities (or no response): 53%
- Could contact but did not receive helpful response: 12%
- Could contact and received helpful response: 35%

It is alarming that as much as 65% of the participants who tried to contact authorities could not actually contact them or did not get any helpful response. This high fraction may be because (i) the cyclone damaged the helplines as well and (ii) due to the ongoing lockdown situation, the authorities could deploy a reduced number of personnel (compared to non-pandemic situations). Overall, these statistics show that authorities should improve their responsiveness after a disaster.

**Rating the preparedness of authorities:** Finally, we asked the participants to rate the preparedness of the authorities serving their localities on a Likert scale of 1–10, where level “1” means “authorities were not prepared at all” and level “10” means “authorities were excellently prepared”.

The distribution of the ratings by our survey participants is shown in Fig. 10. The mean preparedness rating (averaged across all participants) is 5.25, while the median preparedness rating (across all participants) is 5.0.

**Fig. 10** Preparedness of authorities as perceived by our participants



**Table 13** Rating given to authorities (eg, government, service providers) on their preparedness

| Participants who said authorities were | N24P<br>(60) (%) | KOL<br>(59) (%) | S24P<br>(22) (%) | HGLY<br>(18) (%) | HWH<br>(14) (%) | Others<br>(28) |
|--|------------------|-----------------|------------------|------------------|-----------------|----------------|
| Highly Prepared (Rating $\geq$ 8)      | 40.0             | 20.3            | 18.2             | 11.1             | 21.4            | 35.7           |
| Poorly Prepared (Rating $\leq$ 3)      | 23.3             | 37.3            | 27.3             | 27.8             | 28.6            | 17.9           |

The numbers in brackets below each of the headers represent the actual count of participants from that district.

We consider the authorities to be *highly prepared* (from the point of view of a participant) if they were rated greater than or equal to 8. On the other hand, we consider the authorities to be *poorly prepared* (from the point of view of a participant) if they were rated less than or equal to 3. Out of the 201 participants, almost an equal number said authorities were highly prepared (55 participants) and authorities were poorly prepared (56 participants).

Table 13 shows the district-wise fractions of participants (i) who said authorities were highly prepared and (ii) who said authorities were poorly prepared. Interestingly, across all districts, there are both participants who said authorities were highly prepared, as well as participants who said authorities were poorly prepared. The authorities seem to have been best prepared in North 24 Paraganas—40% of the participants from this district said authorities were highly prepared, and much fewer participants (23.3%) said authorities were poorly prepared. On the contrary, in Kolkata, only 20.3% said authorities were highly prepared but 37.3% said authorities were poorly prepared. Apart from North 24 Paraganas and “Others” (districts that were not affected much by the cyclone), in all other districts, a larger fraction of participants felt the authorities were poorly prepared (as compared to the fraction who felt authorities were highly prepared).

Note that the preparedness of the authorities was most probably hampered by the ongoing COVID19-induced lockdown, which made it difficult for the authorities to deploy sufficient manpower in many regions.

**Reasons for good and bad ratings:** We wanted to identify some probable factors that could have affected the preparedness ratings given by participants. Obviously, the actual reason behind a participant’s rating can only be found through personal interaction. Since such interaction was not feasible, we checked if some specific factors are correlated with the ratings given by participants.

Our hypothesis is that a person’s rating of the preparedness of authorities can be affected by factors such as whether he/she received helpful responses from the authorities, how long he/she had to tolerate disruptions in electricity/phone/internet services, and so on. We now investigate these hypotheses.

Table 14 shows the correlation between the preparedness rating given by a participant, and whether the said participant received helpful responses from the authorities. We see that 72% of the participants who received helpful responses said that the authorities were highly prepared, while 88.9% of those who did not receive any helpful response said that the authorities were poorly prepared. These figures seem to corroborate our hypothesis that participants who received helpful responses would

**Table 14** Response received from authorities versus rating given to preparedness of authorities

| Among those who tried to contact authorities | People saying authorities were |                 |
|--|--------------------------------|-----------------|
|  | Highly prepared                | Poorly prepared |
| Total count                                  | 25                             | 36              |
| Received helpful response                    | <b>72.0%</b>                   | 11.1%           |
| Received no/unhelpful response               | 28%                            | <b>88.9%</b>    |

Total count consists of only the participants who tried to contact the authorities.

tend to say authorities were highly prepared, whereas those who did not receive helpful responses, would tend to say that the authorities were poorly prepared.

Similarly, Tables 15, 16 and 17, respectively, show the correlation between the preparedness ratings given by participants, and the time taken for restoration of electricity supply, phone services, and internet services for those participants. All the three tables showed a common trend (that agrees to our hypothesis)—people who faced disruption of these services for less than 1 day mostly opined that the authorities were highly prepared (fractions shown in blue-colored text). Whereas, people facing disruption of these services for more than 2 days have mostly said authorities were poorly prepared (fractions shown in red-colored text).

**Table 15** Time for restoration of electricity supply versus rating given to preparedness of authorities

| Among those facing disruption, electricity supply was restored in | People saying authorities were |                 |
|---|--------------------------------|-----------------|
|   | Highly prepared                | Poorly prepared |
| Total count   | 49                             | 51              |
| Less than 1 day   | <b>57.2%</b>                   | 45.1%           |
| Between 1 and 2 days  | 16.3%                          | 5.9%            |
| More than 2 days  | 26.5%                          | <b>49.0%</b>    |

Total count consists of only the participants who faced disruption in electricity supply.

**Table 16** Time for restoration of phone connection versus rating given to preparedness of authorities

| Among those facing disruption, phone connection was restored in | People saying authorities were |                 |
|---|--------------------------------|-----------------|
|   | Highly prepared                | Poorly prepared |
| Total count   | 44                             | 49              |
| Less than 1 day   | <b>45.5%</b>                   | 20.4%           |
| Between 1 and 2 days  | 29.5%                          | 8.2%            |
| More than 2 days  | 25.0%                          | <b>71.4%</b>    |

Total count consists of only the participants who faced disruption in phone services.

**Table 17** Time for restoration of internet connection versus rating given to preparedness of authorities

| Among those facing disruption, internet connection was restored in | People saying authorities were |                 |
|--|--------------------------------|-----------------|
|  | Highly prepared                | Poorly prepared |
| Total count  | 46                             | 50              |
| Less than 1 day  | <b>30.4%</b>                   | 8.0%            |
| Between 1 and 2 days   | 17.4%                          | 4.0%            |
| More than 2 days   | 52.2%                          | <b>88.0%</b>    |

Total count consists of only the participants who faced disruption in internet services.

### Summary of Section

While the authorities did a very creditable job of warning people of the cyclone in advance, the performance of the authorities *after* the cyclone was not equally impressive. A large majority of people who tried to contact authorities for help after the cyclone either could *not* contact the authorities or did not get helpful responses from the authorities. Regarding preparedness of authorities, an equal number of participants rated the authorities to be highly prepared and poorly prepared to deal with the effects of the cyclone. Notably, in four out of the five districts that were majorly affected by cyclone Amphan, more people judged the authorities to be poorly prepared. These overall poor preparedness ratings of authorities seem to be correlated with factors such as whether participants received helpful responses, or how long it took for restoration of essential services.

## 9 Implications

Finally, in this section, we present our synthesis on how, taking lessons from this disaster, the authorities can better handle future disasters. Specifically, we present our insights across two fronts. First, as part of the survey, we asked the participants—“*If you have any suggestions that will help to better prepare for future disaster events, please list them here*”; we will present our findings from the participant’s responses to this question. Second, we will discuss how our survey results strongly indicate the efficacy (as well as pitfalls) of using social media to help people in the times of disaster.

### 9.1 Suggestions to Better Prepare for Future Disasters

We identify a few key themes from the general responses of the participants when asked to give suggestions that will help to better prepare for future disaster events.

We present those themes as well as a few verbatim user responses in Table 18. Specifically, the participants expressed ideas to better handle future disasters in terms of the after-effects.

**Continuous maintenance:** Our participants pointed out ways to minimize damage due to uprooting of trees via continuous maintenance (e.g., cutting and trimming the trees regularly).

**Advance planning to employ more resources:** The participants opined that, since a major disaster like Amphan can be expected to disrupt services such as electricity, mobile and internet, the authorities need to have a better “preparedness planning” so that more manpower and backup infrastructures can be quickly called upon to ensure functioning of these services. For instance, power back generators can be kept ready, and army personnel can be kept prepared to help with cleaning uprooted trees. In fact, similar suggestions also came up while solving the problem with lack of drinking water and food in certain areas (e.g., “*water should be kept in store from beforehand in adequate amount*”).

**Improving co-ordination:** An important point that was mentioned was the improvement of co-ordination among various authorities (e.g., between municipality and electricity supplier), e.g., “*Need to have synchronized effort all the related departments and Govt Agencies*”. It seems that lack of such co-ordination really hindered the efforts of the authorities. For example one participant mentioned that “*Before restoring electricity supply, it should be checked whether the locality is still water-logged. The waterlogging resulted in “electric fires” on several electricity poles when power supply was restored.*” So, more information sharing between different authorities (e.g., those who are helping with solving water-logging and those who are fixing affected electrical lines) is crucial for a swifter response.

We note that most of the suggestions discussed above were a direct response (from the participants) to the situation at hand and aimed at addressing the specific problems faced by them in spite of the best efforts of authorities. Additionally, we further analyzed communication between the authorities and citizens via novel mediums like social media—an avenue that helped some people to avert the worst in this disaster and could be further improved by developing more systematic mechanisms for communication.

## 9.2 Utility of Social Media in Post-disaster Scenario

We note in Table 18 that some participants pointed out the value of communication between authorities and affected populace. One participant mentioned that “*A toll free number should be given prior to such natural calamity and a quick response team must be on standby in every locality*”. However, given the huge spread of the affected area and the rarity of such disaster events, such a centralized approach might be too costly to build for authorities. To that end, our data, however, point out a few very interesting observations on how to improve the efficacy of two-way communication between authorities and affected citizens.

**Table 18** Sample responses (excerpts) by participants when asked to give “suggestions that will help to better prepare for future disaster events”

| Themes                                 | Responses from participants   |
|--|---|
| Uprooting of trees                     | – Army must be kept ready to take care of the cleaning of uprooted trees.   |
|  | – The trees in localities could be trimmed before so that uprooting can be avoided.   |
|  | – Trees are not regularly cut and maintained. No pruning is done even before the monsoons. If regularly cut and pruned they would, even if uprooted, caused less damage.  |
| Electricity, mobile, Internet supplies | – Electricity dept should be more adequate and engage more people when the workload is so huge.   |
|  | – Have power backup generators ready.   |
|  | – Using underground cables for power distribution in clustered places like here in Kolkata. Using underground optical fibre for data transmission.  |
|  | – Targeting electricity to mobile towers and communication mediums so that news can travel and authorities can be contacted and people can be helped out.   |
|  | – Before restoring electricity supply, it should be checked whether the locality is still waterlogged. The waterlogging resulted in “electric fires” on several electricity poles when power supply was restored. |
|  | – If main line electric supply wire take down from electric post before storm came then electric supply does not damage that much.  |
| Drinking water and food                | – I think proper drinking water should be kept in store from beforehand in adequate amount, so that it can be supplied to people lacking drinking water, later in a systematic manner.                            |
|  | – Those who are severely affected by the cyclone need to be served with food for at least a few days.   |
|  | – Drinking water tankers should be ready to supply after disaster.  |
| General disaster response              | – Frequent mock drills within the disaster response teams and frequent maintenance of the tools/machines used by them.  |
|  | – Need to have synchronised effort all the related departments and Govt Agencies  |
|  | – The Corporation, electric supply and other authorities should be well prepared before with lots of manpower and equipment for disaster.   |

(continued)

**Table 18** (continued)

| Themes | Responses from participants   |
|--------|---|
|        | <ul style="list-style-type: none"> <li>– It’ll be better that if we can provide an idea to those people who are staying in village about the severeness of the storm on the basis of the estimated speed, so that they can take preparation in a much better way. Not only do’s. Tell the reason why to do..</li> </ul> |
|        | <ul style="list-style-type: none"> <li>– Improve drainage system, increase forest more specifically Sundarban, make concrete structures in safe distance from the sea.</li> </ul>   |
|        | <ul style="list-style-type: none"> <li>– When is such natural calamity is forecasted, I feel the roadside dwellers or homeless people and animals must be shifted to nearby schools, colleges, or any vacant and safe buildings so that they don’t face the nature’s wrath and be safe.</li> </ul>                      |
|        | <ul style="list-style-type: none"> <li>– A toll free number should be given prior to such natural calamity and a quick response team must be on standby in every locality</li> </ul>  |

**The increasing reach of social media:** Recall that Table 12 identified that traditional broadcast mediums such as newspaper and television fared the best in warning people of the impending disaster—94% of our participants received advance warning through these mass communication mediums. However, these mediums have two problems—they are costly, and they provide one-way communication (i.e., they do not provide any simple way for the common people to reach the authorities with their questions or concerns). On the other hand, online social media (OSM) can reach the populace at a minimal fraction of the cost, and also provides a simple way for citizens to reach authorities (i.e., two-way communication). One key finding from Table 12 is that, as many as 62.7% of the participants received warning via OSM, which is second only to the mass communication mediums. Additionally, even though Amphan led to severe disruption of Internet connectivity, more than 80% of our survey participants received useful information about Amphan via social media in the 7 days after the cyclone (as seen from Table 8). In fact, a major utility of social media seems to be in inquiring about safety of friends/relatives and informing others about one’s own safety (as reported by 30%–40% of the participants). These numbers underline the increasing outreach of this medium, at least among the urban population who are conversant with use of such novel mediums.

**Lowering the cost of disseminating and receiving information:** OSM provides a *low-cost* and *real-time* medium for the authorities to reach the citizens, as well as for the citizens to express their worries to the right people. Furthermore, OSM can often help (due to the low cost and ubiquity of mobile Internet) to receive information about the affected remote places which are often *not covered* by traditional mediums. For instance, one participant mentioned that *“I feel that the (social media) posts, stating the devastating condition of worst-hit area Sundarban (a remote region in West Bengal) due to Amphan are helpful in reality. Many can contribute to the funds*

*which are shared through social media*”. So, our results identify that developing mechanisms to timely disseminate information on easily-accessible social media can tremendously help the affected populace to cope up with their loss.

It can be noted that recent research works have developed mechanisms for using digital media in spite of disruptions in internet connectivity (Paul et al. 2020, 2019). Such mechanisms can be set up during major disasters to ensure connectivity among the people, which will increase the access to social media and other digital media in post-disaster scenarios.

**Enabling citizens to get responses from authorities:** We note from Table 14 that the event of receiving responses to Amphan-related queries is highly positively correlated with the favorable perception of people about preparedness of authorities. However, it is very hard for people to receive responses to their queries via traditional mechanisms like phone. To that end, our survey results demonstrate a need for authorities to be more proactive in reaching out and answering queries to help the affected populace via digital media (including social media). To this end, novel Artificial Intelligence (AI)-driven chatbots may provide a scalable and automated way to pave this two-way communication during or after future disasters.

**Facilitating trustworthy and useful news on OSMs:** OSM have a severe pitfall today—often, they are *not* a reliable medium to connect with general populace due to misinformation, abuse and in general, lack of trustworthy information (Rajdev et al. 2015). Additionally, there is often lot of “conversational chatter” on OSM (such as political propaganda) which does not help post-disaster relief operations, and in fact, obscures the critical information. Table 11 identified some types of misinformation that worsen the situation. Often such misinformation (e.g., rumors) is just a side-effect of lack of good, authentic information. Thus, we strongly prescribe the authorities to disseminate more useful information from trustworthy official accounts to drown such misinformation. Additionally, recent AI-based techniques can be employed to extract critical information from social media that would help post-disaster relief operations (Basu et al. 2019; Dutt et al. 2019; Rudra et al. 2015), as well as to identify and counter rumors and other misinformation (Rajdev et al. 2015; Rudra et al. 2018). Thus, creating AI-based automated systems to aggregate useful information from OSM and disseminate trustworthy information on OSM will quite possibly help people to better cope with natural disasters in future.

## 10 Conclusion

In this report, we analyzed the responses to an online survey (by 201 participants) to get insights about the damages caused by the super-cyclone Amphan, and its impact on people. We saw that our participants were severely affected by disruption of internet, phone and electric services. In fact, more than 40% of our participants responded that these services took more than 4 days to be restored. We also found that people have rated the authorities highly if they were responsive and vigilant enough to repair the damages caused within a day. Furthermore, our exploration



revealed that communication (or lack thereof) between the authorities and affected citizens strongly influenced public perceptions about preparedness of the authorities. Then we synthesized our findings into policy implications for better handling future disasters. The survey results strongly suggest that authorities can better handle such situations using social media and AI-driven techniques over digital mediums that are low-cost, personalized alternatives of traditional communication media.

This study points towards the current extent of damages such as uprooting of trees and consequent disruption of electricity and telecommunication services, damage of buildings and needless to mention, waterlogging. While preparedness of the authority post-disaster is important, the extent of damage mapping that could be assessed through the OSM data especially in cases of developing nations could be valuable for building resilience through adaptive measures. Studies pointed out that there could be relationships between trees, cyclones and house damage (Van der Sommen et al. 2018). The future studies could look into the scenarios and sensitivity of planning and design of resilient urbanscapes. Additionally this study points towards the importance of the ability of people to reach out to the authority during and post-disaster; which instills confidence among the people at large. The current analysis of the perception of the people would aid the local disaster management teams to prepare for warning modules together with aid responses as well.

As stated earlier, some of the observations from the survey can be affected by the ongoing COVID19-induced lockdown situation, as well as by the bias of our survey participants towards students residing in urban areas. As a result, some of the micro-level findings might not generalize in another sample and another time. However, we believe that the broad findings (e.g., communication from authorities is a necessary aspect, how people use social media during a disaster, what affects people the most) should generalize across various disaster events.

We believe that this work will pave the way forward in better understanding of the impact of disasters like Amphan on the general populace, and also help to build novel mechanisms for authorities to cope with the after-effects of such disasters.

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## Survey Questionnaire

We state below the exact questions asked in the survey.

### Some details about you and your locality

In this survey, you will be asked questions about the effect of cyclone Amphan on your LOCALITY. For purpose of this survey, consider your “locality” to be the region within approx. 500 m from your home in all directions.

PIN code of your locality: \_\_\_\_.

A more specific identifier for your locality (e.g., street name, specific name of area): \_\_\_\_.

Were you yourself in the said locality during the cyclone, or are you filling in the survey on behalf of someone else who was in that locality (e.g., your family or relatives)? I was myself in the said locality during cyclone Amphan  I am filling in the survey on behalf of someone else who was in that locality  Other \_\_\_\_.

What is your age group?  < 20 years  21–30 years  31–40 years  41–50 years  > 50 years  Would prefer not to say

What is your gender? Male  Female  Other  Would prefer not to say

What is your occupation? (E.g., student, teacher, businessman, doctor, engineer, software professional, ...) \_\_\_\_.

### Before the cyclone

How did you receive advance warning about cyclone Amphan? You can select one or more options. Did not receive any advance warning  Via announcements on news media (TV/newspaper/radio)  Via social media (e.g., Facebook/Twitter/WhatsApp)  Via word of mouth from friends/relatives  Via specific communication from Government (SMS/WhatsApp/phone/email, etc.)  Others

Were any services disrupted even BEFORE cyclone Amphan struck your locality? You can select one or more options. No service was disrupted before the cyclone  Electricity was disrupted  Mobile connectivity was disrupted

Were you asked to evacuate your locality before the cyclone struck? Yes  No  Cannot say

### Damage in your locality due to Amphan

Approximately how many trees were uprooted/seriously damaged in your locality due to Amphan? Cannot say  No tree was uprooted/seriously damaged in my locality  Between 1 and 5 trees  Between 6 and 10 trees  More than 10 trees

Approximately how many buildings were damaged in your locality due to Amphan? Assume “damaged” means anything more severe than breaking of glass windows. Cannot say  No building was damaged in my locality  Between 1 and 5 buildings  Between 6 and 10 buildings  More than 10 buildings

Approximately for how long was your locality waterlogged/flooded due to Amphan? My locality was not waterlogged  Less than 6 h  Between 6 and 12 h  Between 12 h and 1 day  Between 1 and 2 days  Between 2 and 3 days  Between 3 and 4 days  More than 4 days  My locality is still waterlogged

Approximately for how long was drinking water supply irregular in your locality? Drinking water supply was not affected in my locality  Less than 6 h  Between 6 and 12 h  Between 12 h and 1 day  Between 1 and 2 days  Between 2 and 3 days

- Between 3 and 4 days
- More than 4 days
- Drinking water supply not regular till now
- 

**Disruption of Electricity**

Which electricity supplier are you served by? CESC ○ WBSEDCL/WBSEB ○ Other ○

Was electricity disrupted in your locality due to cyclone Amphan? Yes ○ No ○ Cannot say ○

Approximately how long after the cyclone did normal electricity service resume in your locality? Within 6 h ○ Between 6 and 12 h ○ Between 12 h and 1 day ○ Between 1 and 2 days ○ Between 2 and 3 days ○ Between 3 and 4 days ○ More than 4 days ○ Normal electricity service not resumed till now ○

Were electric poles/cables/transformers damaged in your locality due to the cyclone? Yes ○ No ○ Cannot say ○

Are there any PUBLIC UTILITIES in your locality, whose operations were hampered due to disruption in electricity? You can choose one or more options. No public utility in my locality ○ Hospital/nursing home ○ Water pumping station ○ Mobile tower ○ Other ○

**Disruption in phone connectivity**

Which phone service provider do you use? You can select more than one option, e.g., if you or your family members use multiple service providers. Airtel mobile ○ BSNL mobile ○ Jio mobile ○ Vodafone mobile ○ Landline phone ○ Other ○

Was phone connectivity disrupted in your locality due to Amphan? Yes ○ No ○ Cannot say ○

Which of these phone services were disrupted? You can select one or more options. Airtel mobile ○ BSNL mobile ○ Jio mobile ○ Vodafone mobile ○ Landline phone ○ Other ○

Approximately how long after the cyclone did normal phone connectivity resume in your locality? [In case different services resumed at different times, please specify for that phone service which resumed the earliest] Within 6 h ○ Between 6 and 12 h ○ Between 12 h and 1 day ○ Between 1 and 2 days ○ Between 2 and 3 days ○ Between 3 and 4 days ○ More than 4 days ○ Normal phone connectivity not resumed till now ○

**Disruption in internet connectivity**

How do you connect to the internet? You can select one or more options. Through mobile phone ○ Through landline ○ Cable internet ○ Other ○

Was internet connectivity disrupted in your locality due to Amphan? Yes ○ No ○ Cannot say ○

Approximately how long after the cyclone did normal internet connectivity resume in your location? Within 6 h ○ Between 6 and 12 h ○ Between 12 h and 1 day ○ Between 1 and 2 days ○ Between 2 and 3 days ○ Between 3 and 4 days ○ More than 4 days ○ Normal internet connectivity not resumed till now ○

### How much were YOU/YOUR FAMILY affected by the cyclone?

We are stating below some possible aspects of damage. In the context of each aspect, please rate how much you or your family were affected in the scale of 1–5. Here, 1 indicates "I/my family was not affected at all" and 5 indicates "I/my family was extremely severely affected".

- Uprooting of trees: 1  2  3  4  5
- Damage to buildings: 1  2  3  4  5
- Waterlogging/flooding: 1  2  3  4  5
- Disruption of electric supply: 1  2  3  4  5
- Disruption of phone connectivity: 1  2  3  4  5
- Disruption of internet connectivity: 1  2  3  4  5
- Unavailability of drinking water: 1  2  3  4  5

### Other questions about your locality

Was there any agitation in or around your locality after the Amphan cyclone, to protest against non-availability of essential supplies (e.g., electricity, water)? Yes  No  Cannot say

Which of the following is true regarding waterlogging/flooding in your locality?

My locality gets regularly flooded during heavy rains and was also flooded due to Amphan.

My locality does NOT usually get flooded but was flooded due to Amphan.

My locality did not get flooded due to Amphan.

If you or your locality faced any other problems due to the cyclone Amphan, please list them here. \_\_\_\_.

### Use of social media

NORMALLY, how frequently do you use social media (i.e., visit sites like Facebook, Twitter, WhatsApp, Instagram, etc.)? Almost always online  A few times a day  A few times a week  A few times a month  I do not use social media

In general, which social media sites do you use? You can select one or more options. Twitter  WhatsApp  Facebook  Instagram  Other \_\_\_\_.

Have you POSTED any information related to Amphan on social media, within 7 days after the cyclone? You can select one or more options.

I did not use social media within 7 days after Amphan.

I used social media, but did not post any information related to Amphan.

Generally described the situation in my locality.

Posted images of the damages in my locality.

Connected to Government accounts/NGOs/service providers and asked for help.

Inquired about safety of others.

Posted information that can help others (e.g., helpline numbers, assured safety of others in my region).

Informed others about safety of myself/my family.

Posted my opinion on issues related to Amphan.

Other \_\_\_\_.

Have you RECEIVED any useful information related to Amphan from social media, within 7 days after the cyclone? You can select one or more options.

- I did not use social media within 7 days after Amphan.
- I used social media, but did not receive any useful information related to Amphan.
- Received important updates from my own locality.
- Received important updates from other regions.
- Received useful updates from Government accounts/NGOs/service providers.
- Received information about safety of others.
- Other \_\_\_\_.

Please describe (in a few sentences) some social media posts that you found to contain important information on Amphan. You can also mention some keywords indicating the type of important posts, or give examples of important posts. \_\_\_\_.

Did social media hinder/worsen the situation related to Amphan in any way? You can select one or more options.

- I did not use social media within 7 days after Amphan.
- I used social media, but did not observe any negative effect of social media.
- Observed fake news/rumors.
- Observed too much useless posts.
- Observed too much of political arguments.
- Observed too much of religious/superstitious posts.
- Observed many posts about other regions, but not enough coverage of my locality.
- Other \_\_\_\_.

Please describe (in a few sentences) some social media posts that you think hindered/worsened the situation. \_\_\_\_.

**Preparedness of authorities**

Were the authorities in your locality (e.g., municipality, electric suppliers, mobile/internet suppliers) prepared to deal with such a disaster situation? Please rate their preparedness in the scale of 1–10, where 1 indicates "Not prepared at all" and 10 indicates "Excellent prepared".

- 1  2  3  4  5  6  7  8  9  10

When authorities in your locality/helpline numbers were contacted for reporting problems, were the responses helpful?

- We did not try to contact any local authority/helpline number.
- We tried to contact authorities, but could not reach them/did not get any response.
- We could contact the authorities, but their responses were NOT helpful.
- We could contact the authorities and received helpful responses.
- Other \_\_\_\_.

If you have any suggestions that will help to better prepare for future disaster events, please list them here. Your suggestions can be general, or specific to your locality. \_\_\_\_.

### Any other information

Please let us know in the text box below if you wish to share any other information about your experiences of cyclone Amphan. E.g., If you wish to give more details about some of your responses in this survey. Or, if you would like to inform about specific social media accounts whose posts you found important or harmful, etc. Specifically, we aim to understand the problems faced after a natural disaster and how digital platforms like social media can help/hinder coping with such disasters. PLEASE CLICK THE "SUBMIT" BUTTON BELOW TO COMPLETE THE SURVEY. \_\_\_\_\_.

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