


Article

Impact of Cyclone Yaas 2021 Aggravated by COVID-19 Pandemic in the Southwest Coastal Zone of Bangladesh

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Abstract: The severe tropical Cyclone Yaas hit on 26 May 2021 in 16 coastal districts of Bangladesh and affected 1.30 million people. Moreover, the study areas are highly affected by the COVID-19 pandemic, which has increased the vulnerability of the people. Therefore, the objective of this study is to assess the impact of cyclone Yaas aggravated by the COVID-19 pandemic in the southwest coastal zone of Bangladesh. COVID-19-aggregated Cyclone Yaas impact data at the household level were collected from Kalapara Upozilla of Potuakhali district, the area most affected by Cyclone Yaas. A total of 196 households were surveyed, and a quantitative approach was applied to analyse the data. The results show that households in the study area were severely affected by Cyclone Yaas in terms of income, housing, food consumption patterns, and water sanitation and hygiene. The outcome also revealed that the affected households received relief from the government, international/non-government organizations, donor agencies, as well as adopted coping strategies such as obtaining credit, selling assets, reducing daily meal intake, and tapping into savings. These strategies may be useful for a temporary recovery but not for the long term. The results of the study will help policymakers to reform policies.

Keywords: Cyclone Yaas; COVID-19; coping; disasters; households



Citation: Subhani, R.; Saqib, S.E.; Rahman, M.A.; Ahmad, M.M.; Pradit, S. Impact of Cyclone Yaas 2021 Aggravated by COVID-19 Pandemic in the Southwest Coastal Zone of Bangladesh. *Sustainability* **2021**, *13*, 13324. <https://doi.org/10.3390/su132313324>

Academic Editors: Michalis Diakakis and Katerina Papagiannaki

Received: 20 October 2021

Accepted: 23 November 2021

Published: 1 December 2021

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1. Introduction

Bangladesh, a tropical maritime nation on the northern border of the Bay of Bengal, is one of the most enriched ecosystems in the world. These rich ecosystems provide a sustainable food supply to the coastal inhabitants and host a broad range flora and fauna [1–5]. The geographic location of the country makes Bangladesh vulnerable to natural disasters. For instance, flash floods, cyclones and storm surges, droughts, tornadoes, riverbank erosion, and landslides are the major disasters observed here [6–9]. The distinctive natural location of the country and the physical characteristics of tropical monsoon climate in the South Asian subcontinent are largely accountable for the cyclone exposure that has marked Bangladesh as one of the most disaster-prone countries in the world [10–13]. According to historic records of the previous 100 years, among the 508 cyclones formed in the Bay of Bengal, 17% have passed over the coastlines of Bangladesh [14]. In terms of the number of people who have suffered a variety of cyclones and cyclonic surges every year, the Bangladesh coast is the most hazardous area [11,15,16]. When the annual cyclones roar in, hundreds and often thousands of people are swept away [13].

The coastal zones of Bangladesh are very susceptible to tropical storms and tidal surges. Here, the danger of climate-change-induced damage to socio-economic growth is rising gradually. The collective effects of sea level rise and subsidence, changes in discharge from upstream tributaries, increased incidence and intensity of tropical storm-surges, and erosion of embankments in the coast pose a serious threat to the natural resource base and livelihood opportunities of coastal communities [11,12,17]. Among these disasters, cyclones are considered the major and the most devastating catastrophe to the human habitation in this country [13,15,18,19]. A study conducted in the coastal regions of Bangladesh by Subhani and Ahmad [20] shows that cyclone Sidr struck the southwest coast of Bangladesh on 15 November 2007, causing 3406 fatalities, and over 55,000 individuals experienced physical injuries. Moreover, cyclone Sidr impacted nearly 2.30 million households and damaged or destroyed 2.50 million acres of cropland [12]. A year later, on 25 May 2009, cyclone Aila hit the same region, resulting in 190 deaths, injuring over 7000 people, affecting approximately 5 million people, and extensively damaging over 1400 km of embankments, an estimated 8800 km of roads, and 350,000 acres of cropland [12,20,21]. Cyclone Mahasen struck in the Patuakhali district on 16 May 2013, affecting almost 1.5 million people and destroying thousands of acres of cropland, fishponds, and fish farms [11,12]. On 20 May, Amphan struck the coasts of Bangladesh and India, with a constant wind speed of 112 km/h and gusts of 190 km/h, causing massive damage and claiming hundreds of lives. In the period of the global COVID-19 pandemic, the super cyclone Amphan struck in Bangladesh at the harvest time of paddy rice and mango fruit. Due to COVID-19, it was very difficult to evacuate people from cyclone damage [22–24]. The co-occurrence of a natural hazard (cyclones) and a biological scourge (COVID-19) resulted in a severe crisis and challenges to society and its systems [25].

The severe tropical cyclone Yaas hit the 16 southwest coastal districts of Bangladesh on 26 May 2021. Approximately 1.30 million coastal people in the southwest coastal districts Bhola, Patuakhali, Pirozpur, Borguna, and Satkhira were affected. The wind speed of Cyclone Yaas was about 150 km/h with high tidal inundation [26,27]. The cyclone coincided with the full moon, causing 6–8 feet tidal waves that broke into the polders and inundated thousands of acres of land and forced people to move out [27]. Just a year before, on 21 May 2020, the tropical cyclone Amphan struck the same areas and people were still struggling to cope with the devastation from Amphan, which made the situation even worse when Yaas struck [26,27]. The coastal inhabitants are predominantly poor, some of them are landless, and their livelihood options are mainly agriculture, fisheries, and salt farming [20]. This large section of impoverished communities is severely affected by climate-induced disasters negatively impacting their livelihoods and increasing vulnerability as they are forced to adopt negative coping strategies as well as in risk of gender-based violence, child labour, child marriage and human trafficking, and access to safe drinking water and sanitation facilities [6,11,13,14]. Moreover, the COVID-19 pandemic further increased the vulnerability and risks of the affected people in the study area [27]. This study is the first attempt to assess the impacts of Cyclone Yaas 2021 aggravated by the COVID-19 pandemic. The study will also focus on how Cyclone Yaas during COVID-19 increased the vulnerability of the affected people and the acquired coping strategies adopted by the affected households to recover losses incurred by the disaster.

Though Bangladesh has improved considerably in its disaster preparedness and prevention in the recent years, the lack of adequate critical infrastructure and institutional support from the individual to the community level has been a major issue [11,12]. However, there is a shortage of appropriately enacted policies, and this motivates an extensive inquiry into how a coastal community in Bangladesh perceives, reacts, and adapts to a cyclone disaster [15]. The conclusions of the study will help policymakers to reform policies that should be more sustainable and help decrease vulnerability of households in the coastal study area.

2. Methodology

2.1. Selection of the Study Area

The study purposely selected the Patuakhali district hit by the Cyclone Yaas. Patuakhali is among the coastal districts that were severely hit by the cyclone and are highly vulnerable to climate change [28]. Furthermore, this area also contains the largest affected population by Cyclone Yaas. Data show, that approximately 31% of the population in Patuakhali were affected by Yaas (Appendix A) [27]. The Kalapara Upazila of Patuakhali district, most affected by Cyclone Yaas, was purposely selected as study area. It borders in the north and west against Amtali Upazila sub-district. In the east, it is bounded by Galachipa Upazila and Rabnabad, while in the south, there is the Bay of Bengal (Figure 1). The Kalapara Upazila has a total area of 483.08 square kilometres, and a total population of 202,000 with 104,000 males and 98,000 females. There are 24 mahallas, 9 pauras, 58 mauzas, 217 villages, and 9 union parishads in the Kalapara Upazila. The average annual rainfall is 2654 mm and temperature 25.9 °C in the Patuakhali district [11,12,29,30]. Figure 1 presents a map of the study area.

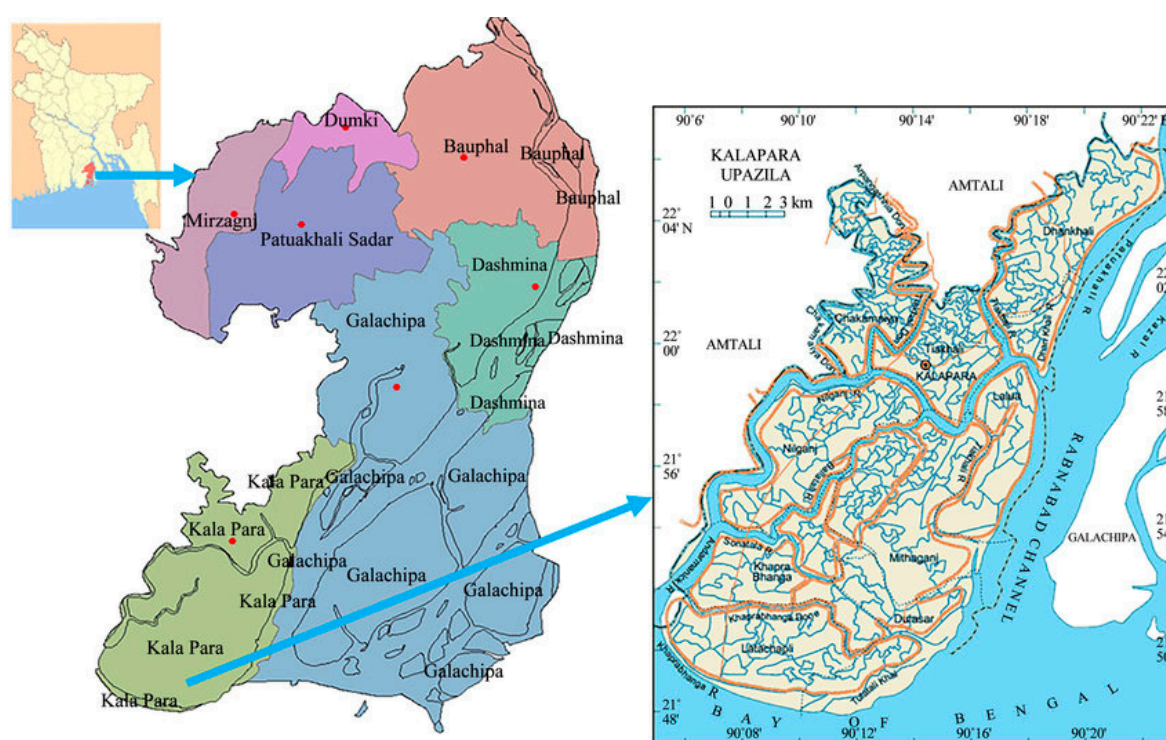


Figure 1. Map of cyclone-affected districts (Source: [28]).

2.2. Sampling Procedure

The estimated affected households were 107,158 in the district that has been calculated by dividing the total affected population, which is 559,363 [27] by household size which is 5.22 [31]. We calculated the sample size from the total farm households through Yamane's [32] formula (Equation (1)), at a 95% confidence level and $\pm 7\%$ margin of error. Regarding the margin of error, Ullah et al. (2015) [33] used an even larger margin of 13% in sample size calculation, and $\pm 7\%$ was used by Hussain and Thapa (2012) [34].

$$n = N / (1 + Ne^2) \quad (1)$$

Here, “ n ” represents the sample size, “ N ” is the total number of farming households in the study area, and “ e ” is the precision that is $\pm 7\%$.

The total calculated sample size was 205 households (Figure 2). Data were collected from 205 households who were affected by Cyclone Yaas. These households were selected randomly from the lists of affected households in the study area. However, due to some incomplete data, 9 questionnaires were dropped from the sampling and a total of 196 households were further analysed. Figure 2 presents the flowchart of the sampling procedure.

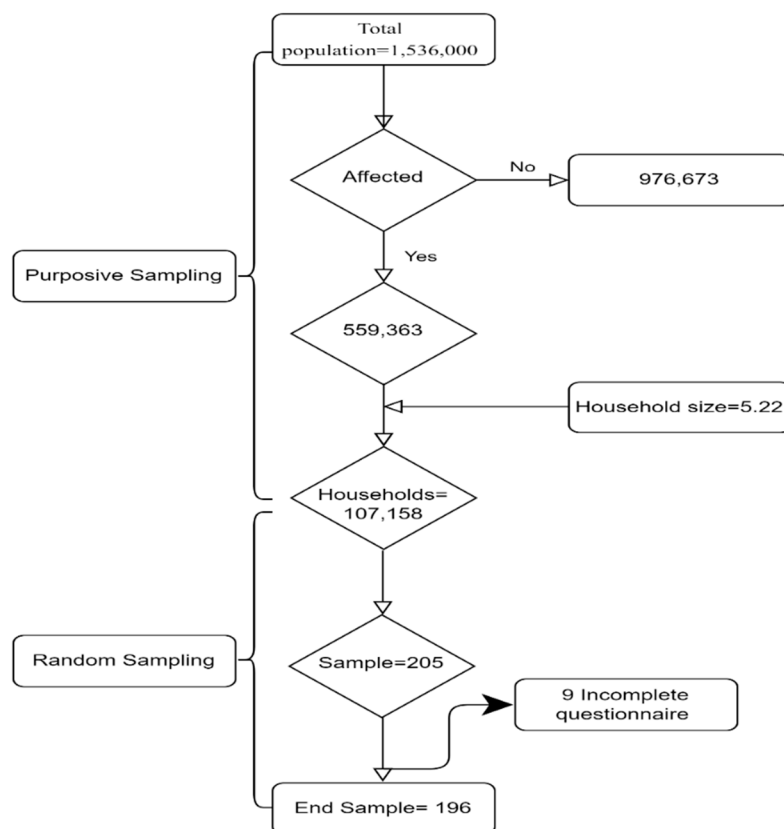


Figure 2. Sampling procedure.

2.3. Data Collection

The data were collected during June and July of 2021. This was during the COVID-19 period, and all the COVID-19 Standard Operating Procedures (SOPs) were followed, including wearing masks, avoiding shaking hands, and a six feet distance during the interview. Trained data assistants were hired who have already worked in different non-governmental organizations (NGOs), trained through Zoom meetings. The data were collected from the head of the households; in their absence, the elderly persons were interviewed during survey. Surveys were conducted through a semi-structured questionnaire.

2.4. Data Analysis

We have used a quantitative data analysis. Quantitative data were analysed through descriptive statistics, such as frequencies and percentages, and analytical statistics that included the Wilcoxon sign rank test compare situation before and after the cyclone. We cannot incorporate the paired T-test as the data are not normal [35]. We have also used secondary data collected from journal articles, non-governmental organizations (NGOs) and government reports, and several published relevant research papers.

2.5. Publication Ethics

All the participants were informed about the purpose of the study, and their written consents were obtained. They were assured that their identity will not be disclosed based on their information; the findings will be published in newspapers or as journal articles.

3. Results and Discussion

3.1. Demographic Characteristics of the Respondent Households

Table 1 summarizes the demographic characteristics of the respondent households. Among the 196 households, the average age of the head of household was 41 years. The average size of the affected household was 5.05, with three key earning members of the family on average. In addition, regarding educational attainment, the duration of attending school was approximately five years. Among the respondent households, approximately 73% were male and 27% were female. The data from the field surveys found that among the 196 respondents, approximately 176 households (90%) were temporarily displaced from the affected areas. Field observation case studies indicate that the displaced people mostly took shelter at the nearby highway and in cyclone shelters.

Table 1. Demographic characteristics of the respondent households.

Characteristics	Mean	SD
Age of the household head (years)	41	7.23
Household size (numbers)	5	1.24
Earning Members (numbers)	3	0.68
Education (years)	5	2.23
Gender	f	%
Male	144	73
Female	52	27
Migrated Households	178	90

Source: Field Survey, 2021.

3.2. Impacts of Cyclone Yaas in 2021

3.2.1. Monetary Losses and Damages to the Household Assets

A large number of people lost their lives, shelters, and/or livelihoods (Figure 3a). It is estimated that, during Cyclone Yaas, about 26,000 houses (Figure 3b) were destroyed, displacing people to shelter on roads at sufficient elevation [27]. Table 2 presents the monetary losses and damages to the households' assets by Cyclone Yaas according to the respondent households.

Table 2. Monetary losses and damages to the household assets by Cyclone Yaas in the respondent households.

Asset	f	%	Mean (BDT)	SD
Dwelling House	181	92	2570	1481
Agriculture	166	85	10,289	7773
Fishery	152	78	13,099	8067
Livestock	128	65	4609	1924
Poultry	176	90	3051	2241
Business	144	73	2542	1228
Furniture	145	74	10,441	6943

Source: Field Survey 2021, Note: USD 1= BDT 85 (Currency of Bangladesh—Taka), f = frequency.

Table 2 reveals that 92% of households had their dwelling (house) damaged by Cyclone Yaas, while 85% had agricultural damage and 78% had damage to fishing or fish farming. Furthermore, 90% of the households had damage to poultry and 65% had livestock losses from the disaster. During the cyclone, flooding in the study area inundated the entire area

with saline water, causing massive damage to agriculture and fishery. The affected coastal people were mostly dependent on agriculture and fishing [20,27]. Therefore, there were severe impacts on agricultural production, fisheries, and livestock, along with decreased income and employment opportunities of these coastal inhabitants [20]. The study area was struck by cyclone Amphan in 2020, and people were still struggling to recover from the losses when Cyclone Yaas made the situation worse. The intensity of asset damage in the study area was comparable to cyclones Sidr and Aila in terms of the effects on livestock, poultry, and fisheries. Figure 3a,b present the adverse flooding impacts of Cyclone Yaas in the study area.



Figure 3. The adverse impacts of Cyclone Yaas in the study area. (a,b) present the adverse flooding impacts of Cyclone Yaas in the study area.

3.2.2. Monthly Income of Households Impacted by Cyclone Yaas

Bangladesh is an agriculture-based country [36] where agricultural livelihoods are becoming more susceptible, particularly in the coastal area, due to more intense extreme climatic events including floods, droughts, storm surges, and cyclones [37]. Table 3 shows the monthly and source of income before and after Cyclone Yaas for the respondent households.

Table 3. Monthly household incomes before and after Cyclone Yaas.

Source of Income	before Yaas	after Yaas	Z-Values
Total Income (Monthly /BDT)	11,278.06 (17,948.52)	7669.39 (12,400.55)	−4.231 ***
Land (Acres)	0.95 (0.98)	0.73 (0.59)	−4.283 ***
Livestock (No.)	1.88 (2.39)	1.76 (5.23)	−3.773 ***
Poultry (No.)	16.33 (13.18)	4.73 (9.64)	−9.652 ***
Savings (BDT)	3798.47 (4920.80)	295.92 (1073.78)	−9.829 ***
Ornaments (BDT)	2298.98 (3312.52)	1987.76 (2469.50)	−3.895 ***
House (BDT)	21,000.00 (15,738.90)	18,413.27 (17,437.88)	−5.083 ***
Crops (BDT)	3441.33 (7005.89)	587.76 (1682.20)	−6.183 ***
Agriculture (BDT)	394.90 (741.64)	296.43 (722.77)	−3.581 ***
Non-agriculture (BDT)	145.41 (251.82)	100.00 (182.57)	−6.854
Small Business (BDT)	819.39 (1495.68)	1296.94 (3177.69)	−2.059 **
Commercial Aqua Farming (BDT)	862.24 (2361.31)	826.53 (2366.54)	−867
Prawn-fry Collection (BDT)	615.31 (2238.74)	241.84 (891.20)	−3.863 ***
Service (BDT)	1811.22 (5940.74)	1750.00 (5915.10)	−2.762 ***
Remittances (BDT)	852.04 (2179.99)	2204.08 (6045.06)	−3.695 ***
Assets (BDT)	1704.08 (8015.00)	862.24 (4004.66)	−3.219 ***
Begging (BDT)	30.10 (90.93)	95.41 (268.19)	−4.834 ***
Livestock Rearing (BDT)	602.04 (1959.80)	270.41 (832.57)	−2.483 **

Note: USD 1 = BDT 85 (Currency of Bangladesh—Taka); ***, ** = at 1%, 5% levels of significance, respectively. Results are based on positive ranks. Source: Field Survey 2021.

The data (Table 3) indicate that the mean monthly income of the affected households prior to Yaas was BDT 11,278.06, but after Yaas, this was reduced to BDT 7669.39, which is a statistically significant change. The data also show assets such as monetary values of savings, ornaments, and land that were also reduced. The overall incomes of the households from agriculture, non-agriculture, fish farming, and business were also reduced after Yaas. The affected people in the study area were also reliant on natural resources for their livelihoods [20].

3.2.3. Impacts on Weekly Food Consumption

Post-cyclone agricultural losses, due to scarcity of resources, affected the food consumption patterns in the vulnerable communities. Field survey data (Table 4) shows the impacts on food consumption patterns before and after Cyclone Yaas.

Table 4. Impacts of cyclone on weekly food items consumption.

Consumption of Food Item	before Yaas	after Yaas	Z-Value
Rice (Kg/week)	2.72 (1.38)	2.02 (0.78)	−6.863 ***
Wheat (Kg/week)	0.89 (1.181)	0.79 (1.08)	−3.347 ***
Poha (Kg/week)	0.78 (1.12)	0.41 (0.79)	−5.108 ***
Potato (Kg/week)	1.79 (1.06)	1.51(0.96)	−5.166 ***
Pulses (Kg/week)	1.29(0.72)	0.94 (0.57)	−7.606 ***
Fish (Kg/week)	2.28 (1.19)	2.16 (1.12)	−3.744 ***
Chicken (Kg/week)	0.46(0.76)	0.22 (0.42)	−5.209 ***
Eggs (Kg/week)	2.58 (3.27)	1.64 (1.31)	−5.883 ***
Milk (Lit/week)	0.65 (1.13)	0.21 (0.50)	−5.391 ***
Sugar (Kg/week)	1.03 (0.94)	0.93 (0.97)	−4.243 ***
Vegetables (Kg/week)	2.43 (1.07)	2.24 (1.13)	−4.617 ***
Edible Oil (Lit/week)	2.37 (1.21)	1.95 (0.81)	−6.489 ***
Fruits (Kg/week)	1.21 (1.84)	0.74 (0.83)	−5.115 ***

Source: Field Survey 2021. Note: ***= at 1% levels of significance, respectively. Results are based on positive ranks.

Table 4 indicates significant differences in food item intakes in the affected households before and after Cyclone Yaas. The saline intrusion in soil and water, due to the tidal surge, damaged fishing and agriculture. Salinity in crop fields will hamper crop production for a prolonged duration and directly impacts food security of the affected households in the study area. Moreover, massive amounts of livestock and poultry were swept away by Cyclone Yaas, and the loss of livestock has induced food insecurity in the households.

3.2.4. Access to Water Sanitation and Hygiene (WASH) Amenities

Based on the situation report of Cyclone Yaas [27], saline water from Cyclone Yaas submerged the low-lying coastal areas, including the study area Patuakhali Kalapara Upozilla (Figure 4a). Therefore, safe Drinking Water, Sanitation, and Hygiene (WASH) facilities were adversely affected (Figure 4b). A government report claims that approximately 18,000 tube wells and latrines were broken, which fully collapsed the sanitation system [27].

Field data revealed that only 18% of households had access to basic sanitation, while 27% had access to safe drinking water. An assessment report [27] showed approximately 19% of tube wells, 35% ponds, and 12% of rainwater harvesting systems were damaged by Cyclone Yaas. Tube-wells were the only supply of safe drinking water. Data also showed that approximately 43% of sanitation facilities were damaged. As a result, many people failed to have access to safe drinking water and sanitation. The poor quality of water impacted human health and became infected with various water-borne diseases, such as

skin rashes and diarrhoea. Moreover, washing hands and maintaining other safe hygiene practices were hindered, which also increased the risk of spreading the COVID-19 virus among the affected households. Figure 4a,b presents typical damage impacting WASH access in the affected area.



Figure 4. Damage impacting WASH access in the affected area. (a,b) present typical damage impacting WASH access in the affected area.

3.3. Coping with the Cyclone Impacts

3.3.1. Relief to the Respondents Extended from Different Institutions

Post-disaster impacts are often so serious that people require outside support to recover from the losses. Immediately after Cyclone Yaas, different organizations including the Government of Bangladesh, International/Non-Governmental Organizations (I/NGOs), and national and international humanitarian agencies helped the affected people and distributed shelter kits, food packages, tarpaulins, and cash grants [27]. Table 5 presents some relief initiatives from such institutions.

Table 5. Relief initiatives from various institutions.

Relief	f	%
Food	95	48
WASH	39	20
Shelter	35	18
Medicine	85	43
Others (cloths, household items)	30	15

Source: Field Survey 2021. f = frequency.

According to Table 5, approximately 48% of the affected households received food relief, while 43% received medicines and medical services. Approximately 20% received water and sanitation support. These are very important elements to control COVID-19 spread in the affected areas. Data also indicate that 18% received shelter and 15% received other support, such as Vulnerable Group Feeding (VGF) cash grants and food. They generally provide items such as clothes, drinking water, medicine, and food [27] from the government, NGOs, and donor agencies. Case studies and field observations found that the relief was not adequate for even initial support, nor to reduce vulnerability of the affected households in anticipation of the next adverse event.

3.3.2. Access to Loans and Its Utilization

The respondent households were severely affected. Therefore, they had to take loans from different institutions such as banks, neighbours, and money investors. Table 6 shows the loan status of the affected households post Cyclone Yaas.

Table 6. Loan status of the households.

Loan	f	Mean (BDT)	SD
Amount of Loan	167	5826	2837
Utilization of the Loan			
Repairing	125	3784	1413
Agriculture	113	3831	1469
Fishing	167	5538	4898
Business	103	4339	2568
Others (medical treatment, education)	38	3105	1767

Source: Field Survey 2021, Note: USD 1 = BDT 85 (Currency of Bangladesh—Taka), f = frequency.

In Table 6, the average loan of a household is BDT 5826.00, which was used to invest mostly in fish farming, off-farm business, and in agriculture, repairing, or others such as medical services.

3.3.3. Coping Strategies at the Household Level

Adopting coping strategies is a necessary approach among the affected households in a post-disaster situation [38]. Table 7 shows the coping strategies adopted on a household level post Cyclone Yaas.

Table 7. Coping strategies on a household level.

Strategy	f	%
Obtained Credit	119	61
Sold assets	126	64
Reduced daily meal intake	156	79
Relied on savings	91	46
Others (reduced expenditure on health and education, change in cropping practices)	31	16

Source: Field Survey 2021, f = frequency.

Data from the field survey in Table 7 indicate that the affected households in Potu-akhali adopted various coping strategies to recover from Cyclone Yaas. Data show that approximately 79% of the households reduced daily food consumption, while 64% percent sold durable household assets, and 61% obtained credit from formal and informal institutions, neighbours, moneylenders, and relatives to cope with the situation. Furthermore, approximately 16% households adopted other strategies, such as diversifying their income sources, homestead gardening, and livestock rearing. However, these strategies were useful for temporary recovery but not for the long term [20,39].

3.4. Spread of COVID-19 among the Affected Households

Cyclone Yaas hit during the COVID-19 pandemic, when people were fighting the COVID-19 virus in the study area [27], which increased the vulnerability of the affected households. The study also aimed to reveal the reasons for COVID-19 spreading in the affected areas after Cyclone Yaas, summarized in Figure 5.

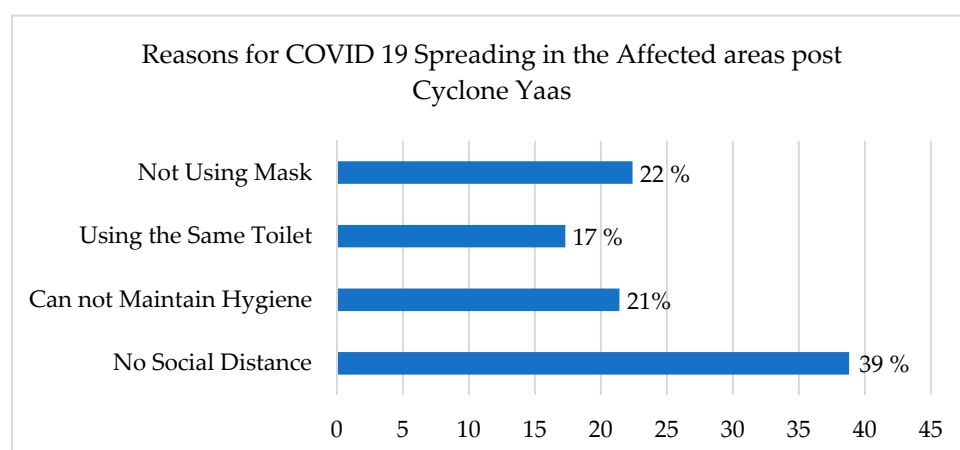


Figure 5. Reasons for COVID-19 spreading in the affected areas post Cyclone Yaas.

Figure 5 shows that approximately 39% of the households justified not maintaining social distancing at the rescue centre, such as cyclone shelters or the highway, as one of the major reasons of the virus spreading. Moreover, 22% of households claimed no use of facial masks and maintaining hygiene practice, which were other important factors, and approximately 17% said using same toilet also caused increased the spread of COVID-19 in the study area.

3.5. Impacts on COVID-19 by Cyclone Yaas in the Respondent Households

Table 8 presents impacts on COVID-19 by Cyclone Yaas in the respondent households.

Table 8. Impacts on COVID-19 by Cyclone Yaas in the respondent households.

Impacts	f	%
Cyclone Yaas increased the risk of COVID-19	132	67
COVID-19 infected in the family	36	18
Received medical services	8	4

Source: Field Survey 2021, f = frequency.

Table 8 summarizes impacts on COVID-19 by Cyclone Yaas in the households. Approximately 67% of the respondent households assumed that Cyclone Yaas adversely impacted the spread of COVID-19 in the affected area. Data from the field survey showed that approximately 18% of the households claimed that their family member became infected by COVID-19 post Cyclone Yaas, and among them, only 4% received medical services while the rest were in self-treatment at home.

4. Limitation of the Study

The field survey was conducted during the lockdown due to COVID-19. Therefore, the study could not cover all the socio-economic components of the vulnerable respondent households such as housing conditions, assets, occupation before and after Cyclone Yaas, gender roles, and migration.

5. Conclusions

The severe Cyclone Yaas hit on 26 May 2021 in the southwest coastal districts in Bangladesh. The study area, Patuakhali, was the most adversely impacted by the cyclone. Moreover, COVID-19 aggravated the impacts. Therefore, this paper tried to investigate the impacts of Cyclone Yaas aggravated by the COVID-19 pandemic in the southwest coastal

zone of Bangladesh. It used a quantitative method approach. The study area was Kalapara Upozilla under Patuakhali District, the most vulnerable area due to Cyclone Yaas.

Most of the households in the study area were displaced and took shelter in a nearby cyclone shelter, a highway, or relatives houses. Post Cyclone Yaas, some institutional support has been provided to these affected households. However, it was not sufficient to cope with the cyclone impacts and recover the losses from the disaster. Consequently, these households were relying on informal coping strategies to adapt themselves to the stress situation such as obtained credits, sold assets, and reduced daily meal consumption, expensed from savings to cope up to the stress situation in the area. However, these strategies were not adequate. The outcome of the study showed that households in the southwest coastal area were severely impacted by Cyclone Yaas in terms of losses and damages, which reduced monthly income by approximately BDT 3609 on average, in addition to a lack of access to WASH amenities and the unavailability of food for consumption. Furthermore, these impacts were aggravated by the COVID-19 pandemic. It was observed that post Cyclone Yaas, the COVID-19 also spread in the study area and among the respondent households due to not using facial masks and the inability to maintain social distance and proper hygiene. The study found that approximately 18% of households were infected by COVID-19 post Cyclone Yaas and only 4% received medical treatment.

In light of the current situation, the study suggested in the near term adequate emergency relief, including house materials that are needed immediately to repair the damaged houses and sanitation system so that these households can return to their homes and can decrease the risk of COVID-19 spread. Emergency cash assistance will be needed so that the people would not sell away their production assets, and enough food grants should be provided to meet the basic needs of food, so that people can consume normal proportions of food. From the literatures review, it is observed that the study area is a historically cyclone-prone area, therefore, some permanent strategies are required to minimize the crisis. In the future, an institutional framework should also be re-designed to provide the skills and knowledge for emergencies to minimize the losses from the future disasters. The outcomes of the study will help policymakers to reform policies in order to decrease the vulnerability of households in the coastal study area.

Author Contributions: Conceptualization, R.S. and M.M.A.; methodology, R.S., S.E.S., and S.P.; software, R.S., S. E. S., and M.A.R.; validation, R.S., S. E. S., M.M.A., and S.P.; formal analysis, R.S. and S.E.S.; investigation, R.S.; data curation, R.S. and S. E. S.; writing—original draft preparation, R.S., S.E.S., and M.A.R.; writing—review and editing, R.S., S.E.S., and M.A.R.; visualization, R.S., S.E.S., and M.A.R.; supervision, M.M.A. and S.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Prince of Songkla University and the Ministry of Higher Education, Science, Research and Innovation, Thailand, under the Reinventing University Project (Grant Number REV64029).

Data Availability Statement: Not applicable.

Acknowledgments: We are grateful to M. Zakir Hossain Khan, Executive Director at Change Initiative, Bangladesh, for all kinds of support to collect data during the lockdown in Bangladesh. We also would like to express our sincere gratitude to Shahriar Chowdhury, Lecturer, Faculty of Environmental Management, Prince of Songkla University, HatYai, Songkhla, Thailand, for his generous help and suggestions during the whole research period. We express great thanks to the Research Development Office (RDO/PSU) and Seppo Karrila for the English proofreading support.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

District	Affected Population	Total Population (Projected in 2021)	Percentage of Affected Population
Bagerhat	24,916	1,406,578	2
Barguna	17,320	939,310	2
Barisal	127,162	2,293,071	6
Bhola	169,260	1,853,656	9
Jhalokathi	149,000	671,297	22
Khulna	50,400	2,259,613	2
Patuakhali	559,363	1,807,356	31
Pirozpur	108,000	1,115,447	10
Satkhira	94,850	2,115,096	4
Total	1,300,271	14,461,424	9

Source [27]

References

- Ahmed, S.; Afrin, T.; Barua, A. New distributional record of *Charybdis japonica*, *Coenobita violascens*, *Galene bispinosa*, and *Portunus reticulatus* (Crustacea: Decapoda) from Bangladesh waters of the Bay of Bengal. *Reg. Stud. Mar. Sci.* **2021**, *44*, 101785. [\[CrossRef\]](#)
- Al Mamun, M.; Liu, Q.; Chowdhury, S.; Uddin, S.; Nazrul, K.; Sultana, R. Stock Assessment for Seven Fish Species Using the LBB Method from the Northeastern Tip of the Bay of Bengal, Bangladesh. *Sustainability* **2021**, *13*, 1561. [\[CrossRef\]](#)
- Bandyopadhyay, S.; Dasgupta, S.; Khan, Z.H.; Wheeler, D. Spatiotemporal Analysis of Tropical Cyclone Landfalls in Northern Bay of Bengal, India and Bangladesh. *Asia Pac. J. Atmos. Sci.* **2021**, *57*, 799–815. [\[CrossRef\]](#)
- Gayathri, R.; Murty, P.L.N.; Bhaskaran, P.K.; Kumar, T.S. A numerical study of hypothetical storm surge and coastal inundation for AILA cyclone in the Bay of Bengal. *Environ. Fluid Mech.* **2016**, *16*, 429–452. [\[CrossRef\]](#)
- Gerard, A. Lessons from Sidr and Katrina: Examining Bangladeshi progress in managing storm surge and some remaining challenges in the northern Bay of Bengal and central Gulf of Mexico regions. *Int. J. Emerg. Manag.* **2016**, *12*, 328–341. [\[CrossRef\]](#)
- Ahasan, R.; Saimon, M.S.A. Developing a Web Based Decision Support System for Disaster Management on Aila Affected Area of Koyra Upazila, 2020. In Proceedings of the 3rd International Conference on Advances in Civil Engineering, CUET, Chittagong, Bangladesh, 21–23 December 2016. [\[CrossRef\]](#)
- Sarker, N.I.; Wu, M.; Alam, G.M.; Shouse, R.C. Life in riverine islands in Bangladesh: Local adaptation strategies of climate vulnerable riverine island dwellers for livelihood resilience. *Land Use Policy* **2020**, *94*, 104574. [\[CrossRef\]](#)
- Gazi, A.K. People with Vulnerabilities to Cyclone in The Coastal Area Of Bangladesh: An Overview. *Int. J. Soc. Sci. Econ. Rev.* **2019**, *1*, 80–91. [\[CrossRef\]](#)
- Barua, U.; Akhter, M.S.; Ansary, M.A. District-wise multi-hazard zoning of Bangladesh. *Nat. Hazards* **2016**, *82*, 1895–1918. [\[CrossRef\]](#)
- Islam, A.; Mitra, D.; Dewan, A.; Akhter, S.H. Coastal multi-hazard vulnerability assessment along the Ganges deltaic coast of Bangladesh—A geospatial approach. *Ocean Coast. Manag.* **2016**, *127*, 1–15. [\[CrossRef\]](#)
- Mallick, B.; Ahmed, B.; Vogt, J. Living with the risks of cyclone disasters in the south-western coastal region of Bangladesh. *Environments* **2017**, *4*, 13. [\[CrossRef\]](#)
- Ahmed, B.; Kelman, I.; Fehr, H.K.; Saha, M. Community Resilience to Cyclone Disasters in Coastal Bangladesh. *Sustainability* **2016**, *8*, 805. [\[CrossRef\]](#)
- Talukder, M.F.; Shamsuzzoha, M.; Hasan, I. Damage and agricultural rehabilitation scenario of post cyclone Mahasen in coastal zone of Bangladesh. *J. Soc. Anthropol.* **2018**, *2*, 36–43.
- Hoque, M.A.-A.; Phinn, S.; Roelfsema, C.; Childs, I. Modelling tropical cyclone risks for present and future climate change scenarios using geospatial techniques. *Int. J. Digit. Earth* **2017**, *11*, 246–263. [\[CrossRef\]](#)
- Hoque, M.A.-A.; Pradhan, B.; Ahmed, N.; Roy, S. Tropical cyclone risk assessment using geospatial techniques for the eastern coastal region of Bangladesh. *Sci. Total. Environ.* **2019**, *692*, 10–22. [\[CrossRef\]](#) [\[PubMed\]](#)
- Bakkensen, L.A.; Mendelsohn, R.O. Global Tropical Cyclone Damages and Fatalities under Climate Change: An Updated Assessment. In *Hurricane Risk*; Springer: Singapore, 2019; pp. 179–197.
- Uddin, N.; Islam, A.S.; Bala, S.K.; Islam, G.T.; Adhikary, S.; Saha, D.; Haque, S.; Fahad, G.R.; Akter, R. Mapping of climate vulnerability of the coastal region of Bangladesh using principal component analysis. *Appl. Geogr.* **2019**, *102*, 47–57. [\[CrossRef\]](#)
- Uddin, M.S.; Haque, C.E.; Walker, D.; Choudhury, M.-U.-I. Community resilience to cyclone and storm surge disasters: Evidence from coastal communities of Bangladesh. *J. Environ. Manag.* **2020**, *264*, 110457. [\[CrossRef\]](#)
- Hossain, N. The 1970 Bhola cyclone, nationalist politics, and the subsistence crisis contract in Bangladesh. *Disasters* **2017**, *42*, 187–203. [\[CrossRef\]](#)

20. Subhani, R.; Ahmad, M.M. Socio-economic impacts of cyclone aila on migrant and non-migrant households in the southwestern coastal areas of Bangladesh. *Geosciences* **2019**, *9*, 482. [CrossRef]
21. Nahiduzzaman, S. Simulation of Storm Surge Level at a Tidal Channel due to Coastal Cyclone along the Bangladesh Coast. Master's Thesis, Bangladesh University of Science and Technology, Dhaka, Bangladesh, 2018. Available online: <http://lib.buet.ac.bd:8080/xmlui/handle/123456789/4940> (accessed on 9 October 2021).
22. Kumar, S.; Lal, P.; Kumar, A. Influence of Super Cyclone “Amphan” in the Indian Subcontinent amid COVID-19 Pandemic. *Remote. Sens. Earth Syst. Sci.* **2021**, *4*, 96–103. [CrossRef] [PubMed]
23. Waheduzzaman, M.; Mizanuzzaman, M. Impact of salinity on the livelihoods of the coastal people in Bangladesh: An assessment on post Amphan situation. *J. Glob. Ecol. Environ.* **2021**, *11*, 6–24.
24. Khan, M.J.U.; Durand, F.; Bertin, X.; Testut, L.; Krien, Y.; Islam, A.K.M.; Hossain, S. Towards an efficient storm surge and inundation forecasting system over the Bengal delta: Chasing the super-cyclone Amphan. *Nat. Hazards Earth Syst. Sci. Discuss.* **2020**, *21*, 2523–2541. [CrossRef]
25. Quigley, M.C.; Attanayake, J.; King, A.; Prideaux, F. A multi-hazards earth science perspective on the COVID-19 pandemic: The potential for concurrent and cascading crises. *Environ. Syst. Decis.* **2020**, *40*, 199–215. [CrossRef] [PubMed]
26. Kundu, S.K.; Santhanam, H. A report on the impacts of cyclone Yaas over a fish landing centre vulnerable to cyclonic storms and natural hazards—Talsari, Northern Odisha. *Local Environ.* **2021**, *26*, 1043–1050. [CrossRef]
27. CARE. Needs Assessment Working Group (NAWG) & Information Management Working Group (IMWG) Bangladesh. Switzerland: CARE. 2021. Available online: <https://reliefweb.int/report/bangladesh/cyclone-yaas-light-coordinated-joint-needs-analysis-needs-assessment-working-group> (accessed on 18 August 2021).
28. Hasan, M.; Sarker, M.A.; Uddin, M.N.; Rahman, Z.; Lei, B. Role of a Coastal NGO in Attaining Climate Resilience in Bangladesh. *Am. J. Clim. Chang.* **2018**, *7*, 187–203. [CrossRef]
29. Hoque, M.A.A.; Tasfia, S.; Ahmed, N.; Pradhan, B. Assessing spatial flood vulnerability at Kalapara Upazila in Bangladesh using an analytic hierarchy process. *Sensors* **2019**, *19*, 1302. [CrossRef] [PubMed]
30. Ahamed, S.; Rahman, M.M.; Faisal, M.A. Reducing cyclone impacts in the coastal areas of Bangladesh: A case study of Kalapara Upazila. *J. Bangladesh Inst. Plan* **2012**, *2075*, 9363.
31. Hasan, M.K.; Khalid-Ur-Rashid, M.; Akter, R. Climate change impacts on local people livelihood and its adaptation through agroforestry in coastal district Patuakhali of Bangladesh. *Agric. For. J.* **2019**, *3*, 6–14.
32. Yamane, T. *Elementary Sampling Theory*, 2nd ed.; Harper and Row: New York, NY, USA, 1967.
33. Ullah, R.; Jourdain, D.; Shivakoti, G.P.; Dhakal, S. Managing catastrophic risks in agriculture: Simultaneous adoption of diversification and precautionary savings. *Int. J. Disaster Risk Reduct.* **2015**, *12*, 268–277. [CrossRef]
34. Hussain, A.; Thapa, G.B. Smallholders' access to agricultural credit in Pakistan. *Food Secur.* **2012**, *4*, 73–85. [CrossRef]
35. Derrick, B.; White, P.; Toher, D. Parametric and non-parametric tests for the comparison of two samples which both include paired and unpaired observations. *J. Mod. Appl. Stat. Methods* **2019**, *18*, 2–23. [CrossRef]
36. Nasim, F.A.; Hoque, M.Z.; Haque, M.E.; Islam, M.S.; Parveen, N.; Chakma, S.; Afrad, M.S.I. How does adoption of crop variety reduce the impact of drought in agriculture and mitigate food insecurity of smallholder farmers? A case study on BUDhan1 rice variety in Bangladesh. *Asian J. Agric. Ext. Econ. Sociol.* **2019**, *30*, 1–12. [CrossRef]
37. Hoque, M.Z.; Cui, S.; Xu, L.; Islam, I.; Tang, J.; Ding, S. Assessing agricultural livelihood vulnerability to climate change in coastal Bangladesh. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4552. [CrossRef] [PubMed]
38. Abdullah, A.N.M.; Zander, K.K.; Myers, B.; Stacey, N.; Garnett, S.T. A short-term decrease in household income inequality in the Sundarbans, Bangladesh, following Cyclone Aila. *Nat. Hazards* **2016**, *83*, 1103–1123. [CrossRef]
39. Warner, K.; Van Der Geest, K.; Kreft, S.; Huq, S.; Harmeling, S.; Kusters, K.; De Sherbinin, A. *Evidence from the Frontlines of Climate Change: Loss and Damage to Communities Despite Coping and Adaptation*; University-Institute for Environment and Human Security (UNU-EHS): Bonn, Germany, 2012.