

Does distribution and type of aid affect internal migration following a cyclone? Evidence from Bangladesh

Evidence from
Bangladesh

Shahed Mustafa

Department of Sustainability, University of Suffolk, Ipswich, UK

Darryl John Newport

Suffolk Sustainability Institute, University of Suffolk, Ipswich, UK

Clare Rigg

Lancaster University Management School, Lancaster University, Lancaster, UK, and

Md Shahidul Islam

Essex Business School, University of Essex, Colchester, UK

Received 20 September 2023
Revised 26 February 2024
Accepted 25 April 2024

Abstract

Purpose – The purpose of this study is to explore the impacts of aid in the form of food, cash, and agricultural inputs on internal migration following a series of cyclones in the southern coastal areas of Bangladesh. The impacts of sources of aid, such as institutional or social network sources, were also analysed. With the increasing frequency of extreme climatic events, it becomes crucial to understand the impacts of different post-cyclonic aid on human mobility.

Design/methodology/approach – A total of 472 households across 16 blocks (moujas) in the Patharghata sub-district of Barguna district were selected for participation using a stratified sampling strategy. Data were captured via a survey which included individual and household-level demographics, migration and aid-receipt following cyclones. Data were analysed using a mixture of descriptive and inferential statistical methods.

Findings – The analysis revealed that migration was significantly higher among households which did not receive institutional food aid. More specifically, non-receipt of food aid and cash aid after a cyclone, different sources of income, non-availability of alternative sources of income, lack of land ownership and severity of cyclones up to a certain level increased migration among the households where a minority of household members migrated. In contrast, the absence of food aid and the severity of cyclones were found to be significant factors in increasing migration among the households where a majority of household members migrated. The authors argue that the decision to migrate from the households where most members migrated increased with the rise in cyclone severity.

© Shahed Mustafa, Darryl John Newport, Clare Rigg and Md Shahidul Islam. Published by Emerald Publishing Limited. This article is published under the Creative Commons Attribution (CC BY 4.0) licence. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this licence may be seen at <http://creativecommons.org/licenses/by/4.0/> legalcode

Conflict of interest: The authors declared no conflict of interest with respect to the research, authorship and publication of this study.

Data availability: The data that support the findings of this study are openly available in Mendeley Data at <http://doi.org/10.17632/78nwspx9ph.1> (Mustafa, 2022).



Originality/value – The contribution of this research in the field of aid and migration is unique. To the best of the authors' knowledge, no research was conducted before on the impacts of distribution and type of aid on internal migration following a cyclone.

Keywords Aid, Bangladesh, Climate change, Cyclone, Food security, Migration

Paper type Research paper

1. Introduction

Climate researchers have cautioned that extreme weather event-induced migration is expected to become a major challenge as climate change worsens (Adger *et al.*, 2021; Berlemann and Steinhardt, 2017; Bernzen *et al.*, 2019; Regaud *et al.*, 2018). This issue has drawn global attention since the inter-governmental panel on climate change (IPCC)'s First Assessment Report in 1990, where event-induced migration was termed as possibly the gravest impact of climate change on human migration as millions are uprooted by extreme weather events (Myers, 1993). Since then, over the past three decades, climate-induced migration has drawn growing attention among researchers and policymakers (Bates, 2002; Black *et al.*, 2013; Davis *et al.*, 2018; Foresight, 2011; Kaczan and Orgill-Meyer, 2020; Mathews, 1989; Myers, 1993; Reuveny and Moore, 2009). Researchers gradually recognise possible climate-vulnerable areas, their people and the main drivers of migration (Klepp, 2017). Yet, a few are sceptical about directly linking climate change and migration (Black, 2001; Boas *et al.*, 2019; Castles, 2002). As a result, in-depth research is needed to apply sound methodologies to identify factors of out-migration rather than directly pointing towards climate change.

Human displacements due to natural hazards are complicated by a variety of individual-, household- and environmental-level factors (Bardsley and Hugo, 2010; Berlemann and Steinhardt, 2017; Boustan *et al.*, 2012), as well as an array of varying opportunities and drivers of migration (Burrows and Kinney, 2016; Kaczan and Orgill-Meyer, 2020). Migration may be local, national or international, temporary or permanent, planned because of pull factors or forced by push factors, driven by a sudden-onset disaster or merely by the threat of it (Black *et al.*, 2011; Curtis *et al.*, 2020). Conversely, migration intention might also be impeded by diverse factors (Castells-Quintana *et al.*, 2018; Collins, 2013; Yang *et al.*, 2019), including scarcity of migration opportunities or resources (Altvater, 2004) and geopolitical considerations (Anastasopoulos, 2019). Therefore, migration is far from an automatic response to an environmental disaster.

Indeed, when people move due to challenging weather conditions, it is not solely because of natural calamities but also due to social, economic, political and demographic factors (de Haas, 2021; Mustafa *et al.*, 2023). While these are considered macro or top-down factors that move people, there are other micro-level bottom-up factors such as people's capabilities and aspirations (de Haas, 2021). In other words, some people choose their destinations based on their choices and knowledge, rather than being forced to move. This paper marks the line between the top-down and bottom-up views of migration and explores how environmental stresses drive people to relocate. It emphasises the significance of post-disaster aids in providing relief to affected people and their role for them. In addition, understanding the impact of post-disaster aid allows authorities to allocate resources strategically, identifying suitable aid types for specific affected areas during rescue preparation. Moreover, this paper delves into factors influencing beyond aid after a cyclone. It contributes to academia by presenting the role of post-disaster aids in building community resilience, that is the community's ability to recover, rebuild and adapt in the aftermath of a disaster. This

knowledge can not only guide policymakers in creating frameworks for swift and organised aid delivery but also can also improve overall disaster response strategies.

According to the adaptive coping paradigm, people who experience disaster exert agency over their behavioural response, assessing their risk, resources and resilience (Mallick and Vogt, 2012). Indeed, decisions of local inhabitants to leave or to stay in their destroyed ecosystem in pursuit of a secure livelihood with available resources (Saha, 2017), as well as to return to their original residence (Curtis *et al.*, 2020), may be affected by the availability and type of aid these people receive. Thus, the availability of aid may increase the range of decision-making tools and actions for individuals facing environmental stressors, allowing them to remain *in situ* while supporting themselves and their families (Daly *et al.*, 2020; Muir *et al.*, 2020). For instance, in a study of the human responses to the April 2004 tornado in Bangladesh, B.K. Paul (2005) reports that not one individual from eight affected villages migrated elsewhere, primarily for fear of missing out on post-disaster aid distributed by the government and non-government organisations (NGOs). To contextualise the aforementioned aid, concepts related to climate migrations and factors driving climate migrations are discussed in the following sections.

2. Dimensions of climate-induced migration

Several theoretical lenses are available to discuss the concepts related to climate-induced migration, such as human security, adaptation and coping and geopolitics.

2.1 Human security and climate-induced migration

Since the beginning of research on the impact of climate change, researchers have paid attention to the impacts of extreme climatic events on human security (Bates, 2002; Floyd, 2008; Kartiki, 2011; Mathews, 1989; Myers, 1993, 1997, 2002; Myers and Kent, 1995; Oels, 2012). Accordingly, there has been a development in academic discourse on this concept and the ties between climate change and migration (Burrows and Kinney, 2016). Human security is defined by Barnett *et al.* (2008) as “a variable condition”, where people and communities have the ability to manage environmental stressors according to their needs. UNDP (1994) linked the concept of human security with human development by recognising it as a process of widening the range of people’s choices. Thus, human security can be described as people’s ability to exercise their choices safely and freely during or after a natural hazard.

One of the choices of affected people to improve their status after a natural hazard is migration (Jha *et al.*, 2018; Kartiki, 2011). This concept of migration as a response to climate hazards might be built upon the paradigm of human security. While it is considered that facilitating migration can improve human security (Adams and Adger, 2013; Ionesco *et al.*, 2017; Schwan and Yu, 2018). Adger *et al.* (2021) and Mallick and Vogt (2012) argue that in some cases, human security can worsen after migration. Migration is indeed a behavioural response to environmental stresses, and people’s ability to cope with these stresses is crucial in structuring behavioural options (Oels, 2012). These behavioural options are shaped by people’s access to resources (Barnett *et al.*, 2008; A. Sen, 1983). As a result, there are calls to safeguard the rights of climate change migrants to humanitarian aid (Methmann and Oels, 2015).

2.2 Adaptation and climate-induced migration

Given their available resources, individuals who face vulnerability can pursue different response options, one of which is adaptation (Lazar *et al.*, 2015). This strategy refers to any adjustments that reduce vulnerability (IPCC, 2007). To understand adaptation from the context of vulnerability, consideration should be paid to dimensions such as *in situ* and *ex situ* adaptation. The former refers to staying at the same place. It can be viewed from two

perspectives. Firstly, people can choose to stay by increasing the resilience of the existing location, livelihood and means of production (Castells-Quintana *et al.*, 2018). Failure to move away from the vulnerable place for the lack of capital is the other view, which is termed a “trapped” population (Collins, 2013; Foresight, 2011; Geddes *et al.*, 2012).

On the other hand, *ex situ* adaptation refers to the migration of the affected people to another place (Bardsley and Hugo, 2010) and can also be viewed from two perspectives. Individuals migrate to other areas as they fail to adapt to the same place, known as distress migration (Adamo, 2018; Jha *et al.*, 2018; Warner, 2010). This relocation happens when environmental vulnerability reaches a point when there is no choice but to move. The other view is in anticipation of improving the population’s well-being when people are relocated in a planned way (Geddes *et al.*, 2012; Klepp, 2017).

However, migration response is location- and context-specific (Goulden *et al.*, 2009; McLeman and Smit, 2006). Vulnerability as a function of adaptive capacity and exposure to hazards may produce different adaptation outcomes based on a particular time, place and climatic stressors (Black *et al.*, 2011; McLeman and Smit, 2006). For example, a study by Johnson *et al.* (2016) suggests that individuals with lower *in situ* adaptive capacity will tend to migrate in the event of climate-related hazards. On the other hand, Chen *et al.* (2017) argue that the poor are more likely to adopt the *in situ* adaptation option due to a lack of resources. Therefore, migration is both a manifestation of vulnerability and an adaptive response by individuals (Oels, 2012).

2.3 Geopolitics and climate-induced migration

Decision-making within the human-nature relationship tends to be viewed from either the neoclassical perspective of the scarcity of resources or the Malthusian perspective of shortage (Altvater, 2004), either of which is capable of driving migration. While the neoclassical economy envisions that displaced people aim to safeguard their economic prosperity by capitalising on their skills and services in markets where wages are bound to be higher (Massey, 2009), this theory does not apply when shortages of food, as theorised by Malthus, force such migration or when states exploit climate disasters for political gain (Wood and Wright, 2016). Indeed, post-disaster migration can also be fuelled by cultural and geopolitical factors, as evidenced by the population diversity-induced migration following Hurricane Katrina (Anastasopoulos, 2019).

After a natural hazard, emergency aid comes from different sources, including government, foreign countries and international NGOs. However, corrupt practices in the post-disaster aid distribution network can erode its objective (Mahmud and Prowse, 2012). It appears that bribery, political nepotism and misappropriation of resources are widespread in Bangladesh after the cyclones (Nadiruzzaman and Wrathall, 2015). This practice is also prevalent in regions with high good governance indicators, such as the Gulf Coast of the USA, which has frequent incidents of natural disasters, as mentioned by Leeson and Sobel (2008). They pointed to an incident in Buchanan County of Virginia in 2002, where county officials accepted a bribe for awarding relief-related restoration contracts following flooding. These examples show a possible link between natural disasters and desperation or exploitation (Altvater, 2004). Exploitation by the stakeholders in the distribution network can deprive the affected people of aid and, as a result, lead to incidents of migration.

3. Climate-induced migration

3.1 Push-pull factors of migration

Drivers of migration after natural hazards can be linked to migration theory, such as (Lee, 1966) pioneering conceptualisation of push-pull factors (Black *et al.*, 2011; Burrows and

Kinney, 2016; Foresight, 2011). The pull factors are usually voluntary, attracting immigration, such as abundant sought-after resources, economic opportunities, rural-urban wage differentials and political stability (Black *et al.*, 2011; Jahan, 2012). On the other hand, push factors such as lack of economic and livelihood opportunities, environment (including natural hazards), political instability and conflict can lead to emigration (Black *et al.*, 2011; Hugo, 1996). However, extreme climatic events do not necessarily prompt migration since there are social safety nets, aid or measures put in place by governments (Javed *et al.*, 2021).

3.2 Aid, extreme-weather events and migration

Several studies have found varied results of the effects of aid on migration (Clist and Restelli, 2021; Gamsó and Yuldashev, 2018; Lanati and Thiele, 2018; Murat, 2020; Stevenson *et al.*, 2012). These relationships are based on where aid is provided, to whom and in what situation. For example, with regard to the recent influx of migrants in Italy, Clist and Restelli's (2021) investigation finds that development aid does not lessen migration. In contrast, Lanati and Thiele (2018) reported that a 10% boost in total aid can lower emigration rates to organisation for economic co-operation and development countries by around 1%. Other studies, such as those of Gamsó and Yuldashev (2018), Murat (2020) and Stevenson *et al.* (2012) also find that there is a negative relationship between aid and migration aspirants; aid in the form of social protection can lessen distress migration and support *in situ* adaptation (Schwan and Yu, 2018).

These examples and studies indicate that the impact of aid on migration is geography- and situation-specific. As a result, there is a need for a case-by-case investigation. While studies have paid attention to the influence of the availability and distribution of aid on post-disaster migration decisions (Ahmad and Ma, 2020; Daly *et al.*, 2020; Dellmuth *et al.*, 2021), to our knowledge they have rarely distinguished among the different forms of aid (food aid, cash payments and agricultural inputs) or the nature of aid providers (institutional or social). In addition, there was a limited amount of research on this relationship concerning Bangladesh. For example, Mallick (2014) highlighted the relationship between migration and aid assistance in their research. The impact of these individual factors on people's decision to migrate or remain and their perception of the adequacy and usefulness of aid have also not been compared. However, it is very likely this perception towards aid shapes a household's sense of security, which influences migration decisions.

As a result, this study aims to investigate how access to aid impacts residents' migration decisions following an environmental hazard and more specifically, which impacts different types of aid exert on inhabitants. Access to aid for the affected population also depends on several factors including the severity of the event, geographical location, damage to properties or the government's preparedness (Becerra *et al.*, 2014; Henderson and Lee, 2015). The study of the relationship between these factors leads us to a more specific analysis of how post-cyclonic institutional and social aid impacted internal migration in the context of a rural coastal sub-district, Patharghata in southern Bangladesh. The resulting insights might be helpful to policymakers and disaster planners seeking to support people who regularly face threats from cyclones in this region.

4. Research context and site selection

Bangladesh, a deltaic country situated in a funnel-shaped regional coastal area is vulnerable to extreme climatic events, such as cyclones, storm surges, floods and droughts, driven by climate change, shifting cycles of precipitation and rising sea levels (Ahsan, 2013; Khan *et al.*, 2015; Quader *et al.*, 2017; Saha, 2017)¹. Historical data from 1877 to 2019 indicate that Bangladesh's coasts were hit by 62 cyclonic or severe cyclonic storms and 38 cyclonic storms of hurricane intensity² (Bangladesh Meteorological Department, 2024; Islam and

Peterson, 2004; Khan, n.d.). In addition, Bangladesh has experienced four “category 4” (wind speed 209–251 km/h) cyclones in the past three decades, in addition to 13 cyclones with lower intensities (Bangladesh Meteorological Department, 2024). Thus, on average, people in coastal areas experience cyclones once every two years. After cyclones, storm surges resulting from the strong winds at the sea surface often lead to rising sea levels, thus flooding the already affected regions (Azad *et al.*, 2018). These floods are also responsible for considerable economic damage, food insecurity and death (Mallick *et al.*, 2017).

Given its high population density (1,252 people per square km) and its status as a trade-insecure country, Bangladesh is one of the most food-insecure countries in the world (World Population Review, 2020; Yu *et al.*, 2010). Extreme climatic events exacerbate this problem, driving vulnerable people to seek shelter in more secure nearby locations (Faruk *et al.*, 2018). Government and NGOs and affluent locals contribute to providing relief materials, mainly food, for affected communities (S.K. Paul and Routray, 2011). However, it appears that not all people who need food assistance are covered by food aid, while not all people who are included in the food aid network need food assistance (B.K. Paul and Chatterjee, 2019). Thus, food security following extreme climatic events is often adversely affected due to uncoordinated distribution. Despite the relief efforts, people may opt to migrate elsewhere to support their subsistence needs (Mallick and Vogt, 2014; Mustari and Karim, 2017).

The sub-district Patharghata of the district of Barguna, situated in Bangladesh’s central-southern coastal area [see Figure 1: Map (a) and (b)], was selected as the site for inquiry as

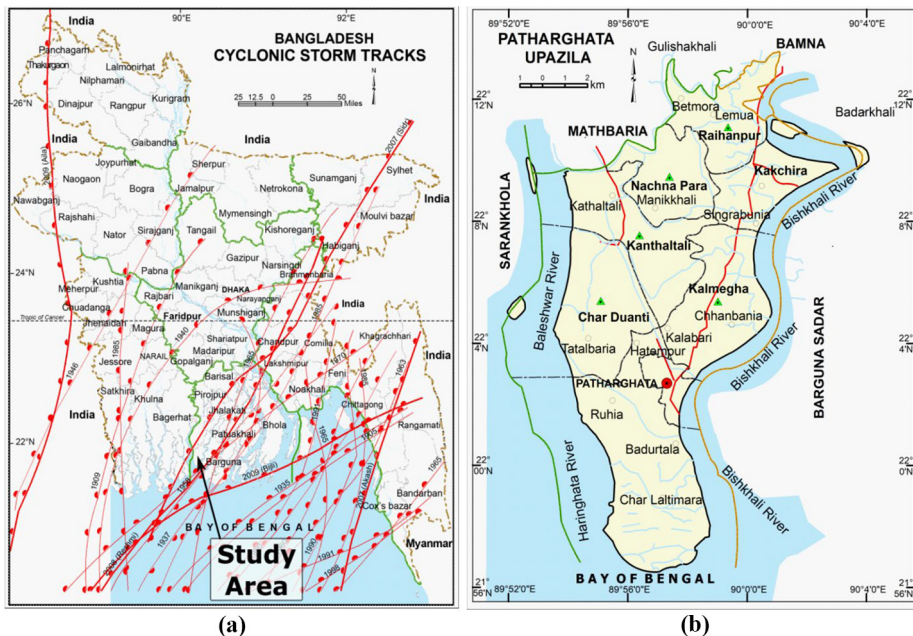


Figure 1. Map (a): the cyclonic storm tracks over Bangladesh and the location of the study area; map (b): the detail of the study area Patharghata sub-district

Source: Reproduced by the author and collected from:

- <http://en.banglapedia.org/index.php?title=Cyclone;>
- <https://bdmaps.blogspot.com/2011/12/patharghata-upazila.html>
- Also mentioned in Mustafa *et al.* (2023)

several cyclones have hit this and its adjacent region in the past decade ([Bangladesh Meteorological Department, 2024](#)). Two deadliest cyclones in the history of Bangladesh, Sidr (2007) and Aila (2009) hit this region and wreaked havoc on lives and properties. Cyclone Sidr with winds of 240 km/h claimed around 3,406 lives with an estimated damage of US \$1.7bn ([GoB, 2008](#)). Subsequently, this area experienced two more consecutive cyclones – Fani and Bulbul – on 04th July and 09th November 2019, respectively ([Bangladesh Meteorological Department, 2024](#)). As a result, this area offered an opportunity to examine the relationship between relief efforts and migration decisions. Specifically, we analysed whether aid distributed during the post-cyclonic period impacts post-cyclonic migration and whether different types of aid (cash, food aid or agricultural inputs) influence migratory actions differently.

5. Methodology

Quantitative methods were used to analyse the likelihood of migration based on the receipt of post-cyclonic aid and other control variables such as demographic and economic characteristics and environmental stresses. There was a variation in the number of members that migrated from the households following a cyclone. Many households did not have any members migrated, while others had household members, ranging from an individual to the entire household, who migrated after the cyclone. Given the variation, the households were divided into categories based on the number of members migrated, with interest in assessing the effects of the exposure and control variables on households' migratory decisions (none migrated/a minority of the household members migrated [1] a majority of the household members migrated [2]). The comparison among the households based on the number of members who migrated shows the differential behaviour of the members towards migration. As the response variable consists of three categories of the number of household members migrated, a multinomial logistic model was an appropriate method of assessing the intended effects and the differentials among them by the post-cyclonic migratory categories. The inclusion of migrants' perception of the severity of cyclones as a control variable helped to include respondents' post-cyclonic experiences into the model in addition to other individual and household-level variables. Moreover, using stratified sampling allowed for collecting and accumulating data based on several strata from a diversified group of people. The methodology is discussed in the following section.

5.1 Sample and sampling strategy

The target population was divided into several strata using a stratified random sampling strategy to obtain a representative database about migration in the coastal area of Bangladesh. Strata were developed based on characteristics such as the distance from the seashore, men–women ratio, profession, wealth and religion. The aim of sorting the population into different strata was to capture the heterogeneous population into homogenous groups and to avoid sampling bias ([Acharya *et al.*, 2013](#)). Strata were estimated based on data made available by the District Report of Bangladesh Population and Housing Census of 2011 ([Bangladesh Bureau of Statistics, 2011](#)).

The study was conducted in 16 administrative blocks (locally known as *mouja*) (see [Figure 2](#)) geographically divided into North, South, East and West zones. This was done to include the diversity of severity and damage the households experienced. The inclusion of households from all four directions indicates the variable distance of households from the shoreline. All the primary professions from these zones, such as fisheries, day-labourer, farming and business owners, were included ([Bangladesh Bureau of Statistics, 2011](#); [Rahim *et al.*, 2018](#)). Respondents were also selected to diversely represent land ownership, a proxy

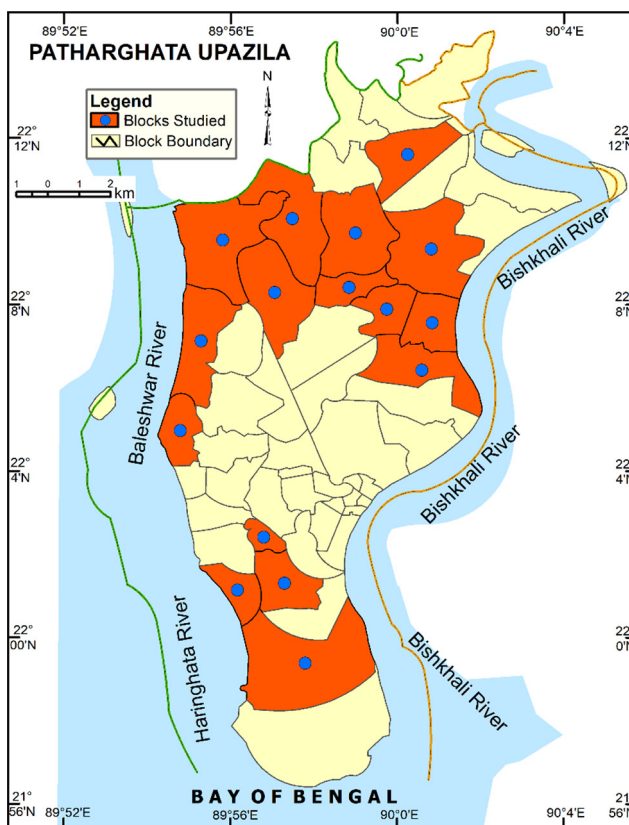


Figure 2.
Blocks studied in
Patharghata sub-
district

Source: Map collected from <http://www.delta-portal.net/> and reproduced by the authors

for their wealth. Religious diversity and men–women ratio were considered following the regional proportions, as recorded in the census (Bangladesh Bureau of Statistics, 2011).

A total of 472 households took part in the study. Out of these, 27 households were excluded due to the timing of their migration. The post-cyclonic migration is considered a short-term migration (Black *et al.*, 2011) and short-term migration may last 3–12 months (Piguet *et al.*, 2011). As a result, those who had migrated within 180 days of a cyclone were considered as migrants, as the last two major cyclones occurred within the past 180 days of starting the survey.

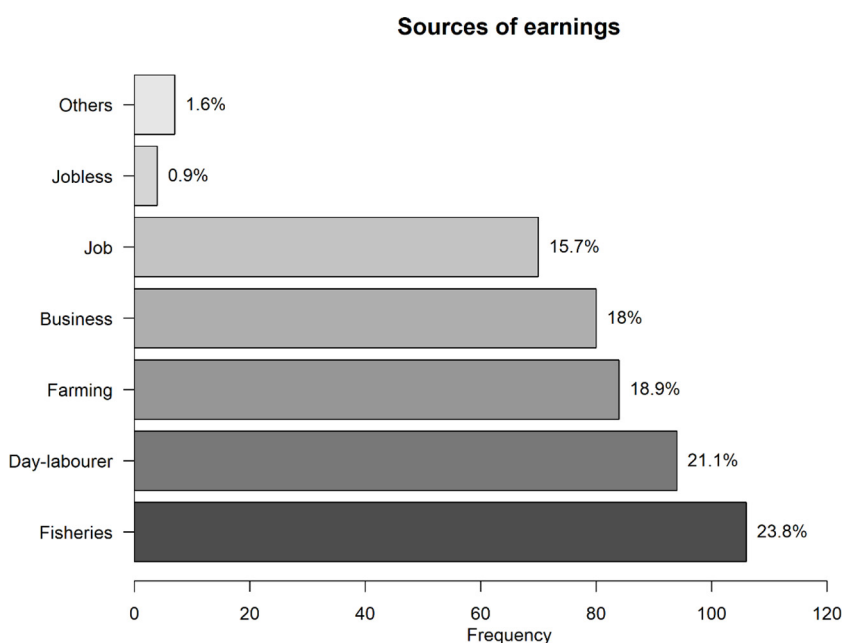
Table 1 summarises the profiles of the respondents, with one member of each household being interviewed. The total respondents, 58% ($n = 273$) were male. About half of those interviewed ($n = 254$, 54%) were household heads, while the remaining respondents were other household members, such as spouses or sons or daughters. In this study, 74% ($n = 161$) of the participants who were questioned were married to the head of the household.

The distribution of sources of earnings for households in the sample is summarised in Figure 3 and graphically shown in Figure 3. Manual work such as fisheries, day

Respondent characteristics	Frequency (%) <i>n</i> = 472
<i>Respondent's gender</i>	
Male	273 (58)
Female	199 (42)
<i>Respondent is head of household</i>	
Yes	254 (54)
No	218 (46)
<i>Respondent's relation to household</i>	
Married to head	161 (74)
Child of head	41 (19)
Parent of head	12 (5)
Other family member	4 (2)

Table 1.
Profile of all the respondents

Source: Mustafa *et al.* (2023)



Source: Created by authors

Figure 3.
Distribution of sources of earnings for the head of households in the sample

labour and farming are especially common. Day labourers are those who were hired for a day. Individuals who do not have a fixed income at the end of the month, such as shopkeepers, auto-rickshaw pullers and product vendors were included in the “Business” category. Those who receive a fixed salary at the end of a month are included in the “Job” category.

5.2 Data collection

A survey was conducted between December 2019 and February 2020, and data were collected from one of the members of the households. The respondents were requested to provide details about their demographics, socio-economic status, aid receipts, perception about the damage done due to cyclones, as well as their migration situations after cyclones.

The data presented in this study are the sub-set of a larger project. Two questionnaires were replicated to prepare the questionnaire for this study and consent was obtained from the respective authorities. These are Delta Portal (GeoData Institute, 2024) and Rural Household Multi-Indicator Survey (RHoMIS, 2024). The questionnaire was first translated from English to Bengali, the local language. The complete questionnaire used in the larger project contained 112 questions. However, this paper reports only on data from 27 questions. Among these, Question no. 32, used to collect aid-related data, was replicated from the RHoMIS questionnaire (not numbered). Questions no. 38–44 were used to collect “migrant’s perception of environmental issues” data and were based on the questionnaire available on GeoData Institute (Question 6.2.1). Bearing in mind that the crops and livestock are essential parts of rural coastal households, the question about the impact on the economic security of GeoData Institute was further extended to understand the effects on crops and the impacts on livestock to gain more specific information about households’ damage to economic security.

To conduct the survey, two teams were used, consisting of a female and a male member. The inclusion of women in the teams helped them to approach households where conservative rural women do not usually directly address strangers. Moreover, local students were used as field surveyors, as they spoke the same dialect as the respondents and could socialise with them. Before starting the survey, the author briefed the surveyors on the survey schedule and trained them on the survey method. Each of the participants was asked for their consent to participate in the survey. In addition, to break the ice between the surveyors and some of the respondents, the sessions started with socialising and were continued throughout the questioning session. In the pilot survey, 10 to 12 respondents were initially interviewed and the questions were fine-tuned to match their experience before the full survey campaign began.

The first author gained the permission of the ethics committee of the relevant institute to collect data about human subjects. Since this research does not involve any investigations that might put stakeholders at risk nor involve medical experiments, it meets the criteria for exemption for ethics approval in the host country, which is Bangladesh.

5.3 Measures, variables and response scales

The response variable in our analysis was the multinomial event of post-cyclonic internal migration in a household. The multinomial (three categories) post-cyclonic migratory event within each household was defined as follows: whether none from that household (HH) migrated, a minority of the HH members migrated or a majority of the HH members migrated. These categories were selected based on the participating households’ responses [none (= 0), a few members of the HH, about half of the HH (merged = 1) and the entire HH (= 2)] to the question “How many members migrated?”. The three categories of post-cyclonic migratory actions were considered with an aim of investigating the varying influences of the exposure variables on the different levels of migration.

Aligning with the aims of this research, the primary exposure variables were households’ receipt of four types of post-cyclonic aid either from institutions or from their social network (family/friend/affluent). Respondents were asked: “What type of aid or gift have you received in a post-cyclonic period: from Government/NGOs or from family, friends, and affluent?” The response options were None = 0 (reference category) or Received = 1 for: food, cash, agricultural inputs and others. The receipt status of each type of aid from each

source (institutional or social network) was coded dichotomously (yes/no) before using as exposure variables in the statistical analyses.

Besides the primary exposure, other control variables were considered to examine the covariate-adjusted influences of the exposure variables on the post-cyclonic migratory actions. The control variables included the HH's demographic and economic characteristics, which often influence migration decisions (Curran *et al.*, 2006; C. Gray *et al.*, 2014). The demographic characteristics included the age of the HH head [20–40, 41–50, >50 years], the religion of the HH head [Islam, Hindu], the highest level of education of the HH head [No schooling, primary, secondary, higher secondary or higher] and HH population [1–3, 4–6, >6 persons]. The household economic characteristics included the number of earning members [0–1, >1], the sources of household earnings [job, business, farming, fisheries, day-labourer/others], the status of having alternative earning sources [0 = No, 1 = Yes] and the household's land ownership status [0 = No, 1 = Yes].

Another control variable used in this investigation was the cyclone's severity, represented by household experiences about cyclones (Muir *et al.*, 2020; Nawrotzki *et al.*, 2014). The severity of cyclones influences the level at which migration is forced. Severity is also linked with the households' experience during and after the cyclones. Because of this, the respondents were asked to express their experiences of seven items of extreme climatic events and changes after a cyclone: impacts on the structure of their houses, their regular (daily) food intake, drinking water, their regular income, health, crops and livestock. Responses were given on a Likert scale [0 = No impact/does not know, 1 = A few impacts, 2 = Moderate impacts, 3 = Severe impacts] and used to form a single measure of cyclone severity by averaging the item-wise responses. Internal consistency, measured by Cronbach's alpha, was used to justify the reliability of the constructed scale of cyclone severity. Table A1 summarises the individual items used to measure the severity of cyclones and the acceptable measure of reliability (Cronbach's alpha > 0.70) of the constructed aggregate scale (Tavakol and Dennick, 2011).

5.4 Data analysis techniques

Data were analysed using descriptive and inferential statistical methods. Fundamental aspects of respondents, including their households and economic characteristics, were captured and summarised using frequency and percentage distributions. The non-parametric chi-square tests tested for one-to-one associations of the defining characteristics with the response of post-cyclonic household migratory decisions. Inferential statistical methods were used to estimate the effects of aid receipts and other controlling factors. In this case, multivariable multinomial logistic regression was used to model the possible effects of post-cyclonic aid on the occurrence of post-cyclonic migration after adjusting the controlling factors. This method was chosen since previous studies have successfully used multinomial logit models to estimate the relationship between migration and climatic events (Goldbach, 2017; Gray and Bilsborrow, 2013; Gray, 2009; Henry *et al.*, 2003; Mueller *et al.*, 2014; Thiede *et al.*, 2016).

In multinomial logistic regression modelling, with π_{ij} being the probability of an event, j ($= 1, 2, \dots, J$) being observed for an individual, i ($= 1, 2, \dots, n$) and X_k ($k = 1, 2, \dots, K$) being the explanatory variables considered, the multinomial logistic regression model gives:

$$\pi_{ij} = \frac{\exp \left[\beta_0 + \sum_{k=1}^K \beta_k X_{ik} \right]}{\sum_{j=1}^J \exp \left[\beta_0 + \sum_{k=1}^K \beta_k X_{ik} \right]}$$

where, β_0 and β_k ($k=1,2, \dots, K$) are the regression parameters measuring the intercept and the effect of k_{th} explanatory variable, respectively. The Hosmer–Lemeshow test was used to assess the goodness-of-fit of the multiple logistic regression (Hosmer *et al.*, 2013). The Akaike information criterion-based stepwise (forward and backward) variable selection method was applied to build a parsimonious good-fit multinomial logistic regression. All statistical analyses were conducted using a statistical computing environment R 4.0 and a 5% level to assess the statistical significance.

6. Results

6.1 Post-cyclonic aid receipts by households

Table 2 presents the univariate and bivariate frequency and percentage distributions, along with chi-square test p -values, for association with the responses concerning the post-cyclonic aid received by the households. It was observed that about two-third of the households ($n = 285$, 64%) received institutional (Government/NGOs) food aid following a cyclone (Column 6). Post-cyclonic migration was statistically significantly higher ($\chi^2 p$ -value < 0.01) among the households that did not receive institutional food aid (a minority of HH members migrated: 45%; a majority of HH members migrated: 20%) compared to households that received such food aid (a minority of HH members migrated: 8%; a majority of HH members migrated: 2%) (Columns 3 and 4).

In addition, the occurrence of post-cyclonic migration was statistically significantly higher ($\chi^2 p$ -value < 0.01) among the households that did not receive any institutional cash aid (a minority of HH members migrated: 36%; a majority of HH members migrated: 13%) than among households that received such cash aid (a minority of HH members migrated: 8%; a majority of HH members migrated: 2%). In terms of agricultural aid, only 8% ($n = 34$) of households received any such aid from the government or NGOs and the analysis did not show a statistically significant association with post-cyclonic migration. A similar result was found for the households who received other types of institutional aid (e.g. corrugated iron, blankets and clothes). The prevalence of households receiving aid from the social network (family/friend/affluent) following a cyclone was low. As a result, these were not further tested for their association with post-cyclonic migration occurrence and were also excluded from further statistical analyses of multinomial logistic regression.

The combination of food aid and cash aid receipts and their impacts on post-cyclonic migration are shown in Figure 4. Households that did not receive any of these aids form the largest group of migrants for both groups of households: a minority of HH members migrated or a majority of HH members migrated. On the other hand, the largest group of households that did not experience any post-cyclonic migration was reported to receive both food and cash aid following a cyclone.

6.2 Households' demographic and economic profile

Table 3 further presents the univariate and bivariate analysis results and the tests of association for the household's demographic and economic characteristics with the post-cyclonic migratory decision. The majority of the selected households ($n = 166$, 37%) had heads aged 41–50 (Column 6). Most of the heads of households ($n = 388$, 87%) follow the religion of Islam and a little less than half ($n = 201$, 45%) had primary education at least, with around one-third ($n = 127$, 29%) having no schooling.

The majority of households ($n = 322$, 72%) had a population of four to six people and only one-third ($n = 150$, 34%) of the households had more than one earning member. More than half of the households ($n = 256$, 58.47%) are landless. None of the key variables (age, religion, level of education of the head, household population, number of earning members

Post-cyclonic aid	Members of the households migrated after a cyclone			χ^2 Test <i>p</i> -value	Total (<i>n</i> = 445) Frequency (%)
	None migrated (<i>n</i> = 313) Frequency (%)	A minority of HH members migrated (<i>n</i> = 95) Frequency (%)	A majority of HH members migrated (<i>n</i> = 37) Frequency (%)		
1	2	3	4	5	6
<i>Food aid from govt/NGOs</i>					
No	56 (35)	72 (45)	32 (20)	<0.01	160 (36)
Yes	257 (90)	23 (8)	5 (2)		285 (64)
<i>Food aid from social network</i>					
No	309 (71)	93 (21)	36 (8)	–	438 (98)
Yes	4 (57)	2 (29)	1 (14)		7 (2)
<i>Cash aid from govt/NGOs</i>					
No	105 (51)	75 (36)	28 (13)	<0.01	208 (47)
Yes	208 (88)	20 (8)	9 (4)		237 (53)
<i>Cash aid from social network</i>					
No	310 (71)	94 (21)	36 (8)	–	440 (99)
Yes	3 (60)	1 (20)	1 (20)		5 (1)
<i>Agricultural aid from govt/NGOs</i>					
No	285 (69)	90 (22)	36 (9)	–	411 (92)
Yes	28 (82)	5 (15)	1 (3)		34 (8)
<i>Agricultural aid from social network</i>					
No	313 (70)	95 (22)	37 (8)	–	445 (100)
Yes	0 (0)	0 (0)	0 (0)		0 (0)
<i>Other aid from govt/NGOs</i>					
No	260 (68)	86 (23)	34 (9)	0.10	380 (85)
Yes	53 (81)	9 (14)	3 (5)		65 (15)
<i>Other aid from social network</i>					
No	313 (70)	95 (22)	37 (8)	–	445 (100)
Yes	0 (0)	0 (0)	0 (0)		0 (0)
<i>Sufficiency of food aid to support a family</i>					
No	186 (68)	64 (23)	24 (9)	0.35	274 (62)
Yes	127 (74)	31 (18)	13 (8)		171 (38)

Table 2.
Post-cyclonic aid receipt by households

Source: Created by authors

and land ownership) exhibited a statistically significant association with post-cyclonic migration (χ^2 *p*-value > 0.05 for all) (Column 5). However, it can be seen from Table 3 that the head of household age-group 41–50 contains most of the households (*n* = 166, 37%) among those who migrated. Moreover, most migrants belong to households whose size is between four and six members (*n* = 111, 69.81%). The households that have only one earner have most of the migrants (*n* = 295, 66%).

Within the household demographic and economic characteristics, sources of earnings and alternative sources of earnings exhibited a statistically significant (χ^2 test *p*-values < 0.01) association with the post-cyclonic migration among the households. Most of the individuals who migrate work predominantly in fisheries and as day labourers. Households with these sources of earnings also experienced the highest percentage of post-cyclonic

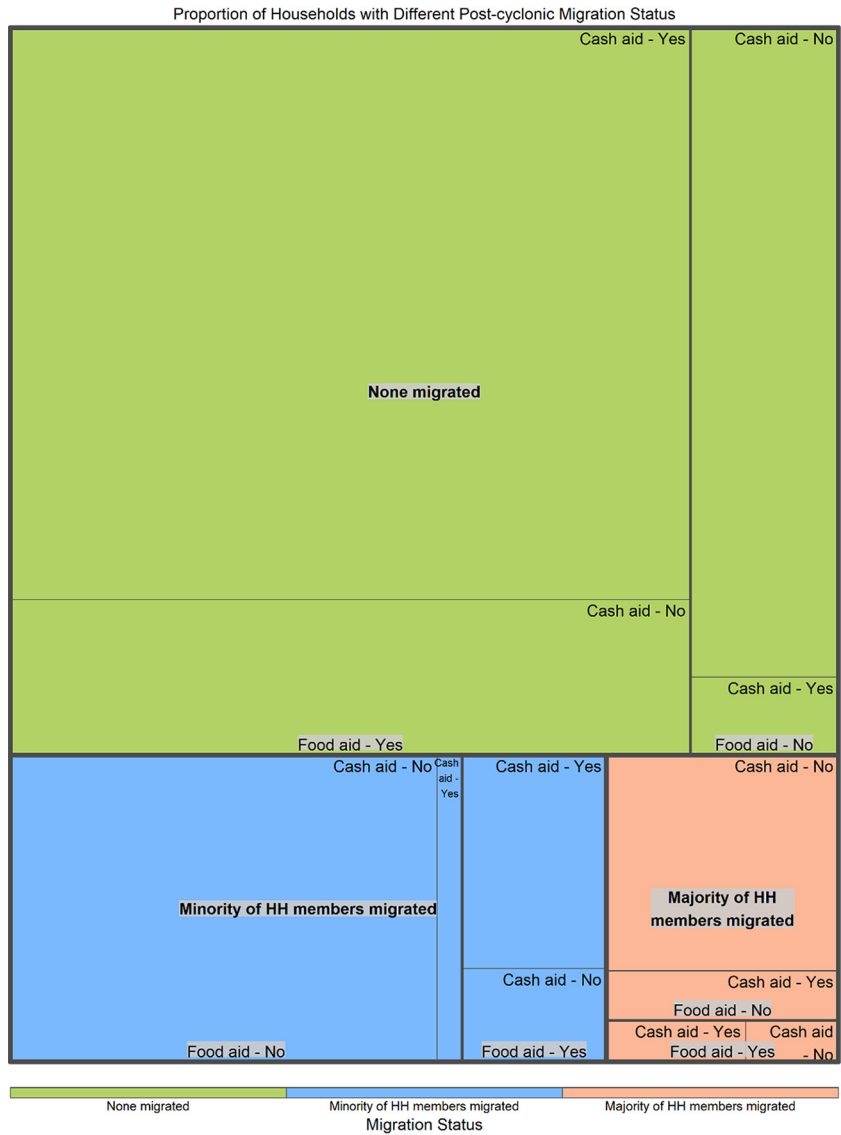


Figure 4. Different types of aid receipts and their impacts on post-cyclonic migration

Notes: The green area is composed of the number of households in which there is no incidence of migration. This is divided into two groups: those who received food aid and those that did not. Both are further divided into groups that received cash aid and those that did not. The other two migrant groups a minority of HH members and a majority of HH members are shown in the figure in the same way as explained above

Source: Created by authors

1	Members of the HH migrated after a cyclone			χ^2 Test <i>p</i> -value	Total (<i>n</i> = 445) Frequency (%)
	None migrated (<i>n</i> = 313) Frequency (%)	A minority of HH members migrated (<i>n</i> = 95) Frequency (%)	A majority of HH members migrated (<i>n</i> = 37) Frequency (%)		
	2	3	4	5	6
<i>Age of head (years)</i>					
20–40	94 (71)	31 (23)	8 (6)	0.46	133 (30)
41–50	118 (71)	36 (22)	12 (7)		166 (37)
>50	101 (69)	28 (19)	17 (12)		146 (33)
<i>Religion of HH</i>					
Islam	271 (70)	83 (21)	34 (9)	0.66	388 (87)
Hindu	42 (74)	12 (21)	3 (5)		57 (13)
<i>Highest level of education of head</i>					
No schooling	94 (74)	26 (20)	7 (6)	0.25	127 (29)
Primary (1–5)	133 (66)	46 (23)	22 (11)		201 (45)
Secondary and higher (6+)	86 (73)	23 (20)	8 (7)		117 (26)
<i>Household population</i>					
1–3	47 (72)	13 (20)	5 (8)	0.69	65 (15)
4–6	227 (70)	66 (21)	29 (9)		322 (72)
>6	39 (67)	16 (28)	3 (5)		58 (13)
<i>Number of earning family members</i>					
0–1	201 (68)	64 (22)	30 (10)	0.12	295 (66)
>1	112 (74)	31 (21)	7 (5)		150 (34)
<i>Sources of household earnings</i>					
Job	55 (79)	13 (18)	2 (3)	<0.01	70 (16)
Business	58 (72)	18 (23)	4 (5)		80 (18)
Farming	68 (81)	9 (11)	7 (8)		84 (19)
Fishing	60 (57)	31 (29)	15 (14)		106 (24)
Day-labourer/ others	72 (68)	24 (23)	9 (9)		105 (23)
<i>Alternative sources of income</i>					
No	91 (62)	43 (29)	14 (9)	<0.01	148 (33)
Yes	222 (75)	52 (17)	23 (8)		297 (67)
<i>Own land</i>					
No	174 (68)	60 (23)	22 (9)	0.41	256 (58)
Yes	139 (74)	35 (18)	15 (8)		189 (42)

Table 3.
Households'
demographic and
economic profile

Source: Created by authors

migration (29% when a minority of HH members migrated, and 14% when a majority of HH members migrated in the case of fisheries; whereas 23% when a minority of HH members migrated and 9% when a majority of HH members migrated in case of day-labourers). About two-thirds of the households (*n* = 315, 66.74%) had alternative earning sources, but households with no alternative earning sources experienced significantly higher post-cyclonic migration (a minority of HH members migrated: 29%; a majority of HH members migrated: 9% against a minority of HH members migrated: 17%; a majority of HH members migrated: 8%).

6.3 Estimates of the severity of the cyclone

The cyclones' severity was measured through the households' experience of cyclones. As demonstrated in Figure 5, it is apparent that the severe impacts of cyclones were perceived most by the households where the majority of HH members migrated. A similar finding was also evident from the descriptive statistics in Table 4 and in detail in Table A1. Further explorations revealed that the post-cyclonic migration event also positively correlated with

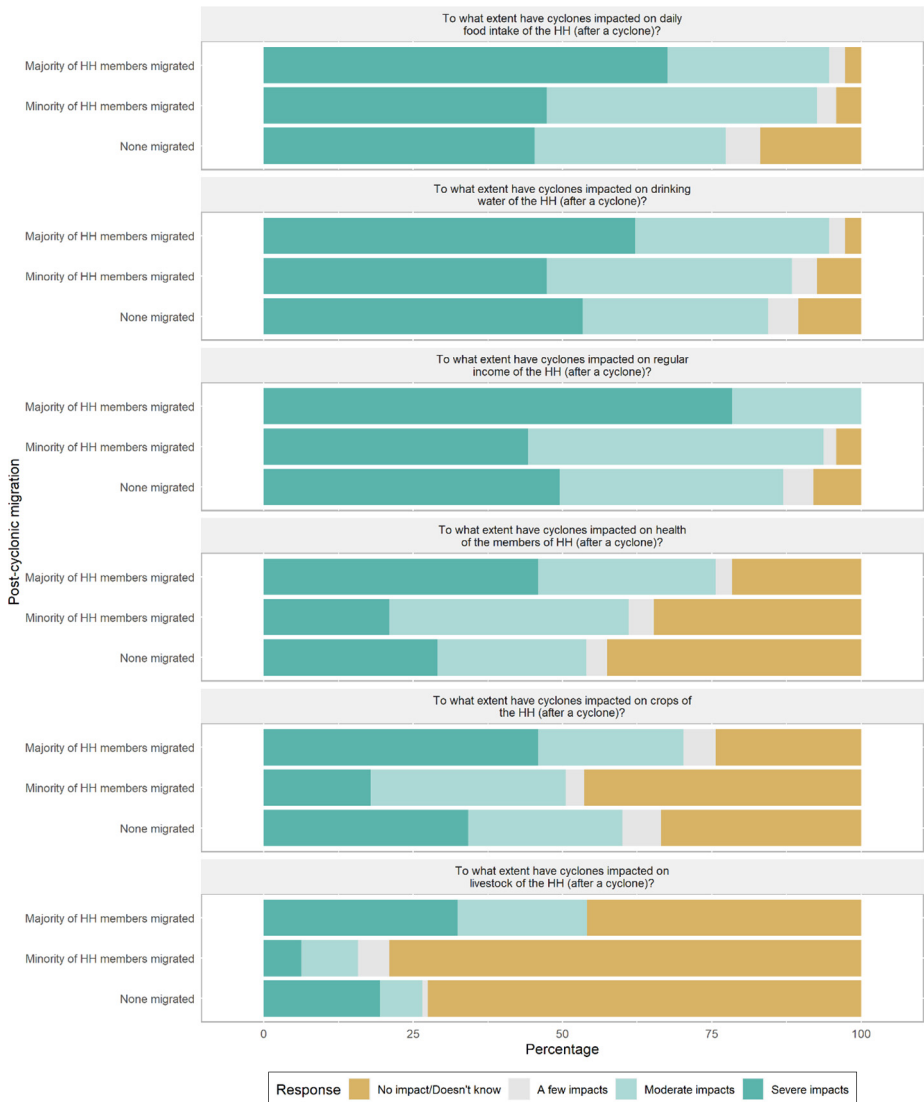


Figure 5. Households' perception of cyclone severity by the extent of post-cyclonic migratory actions

Source: Created by authors

the derived scale of cyclone severity. The cyclone severity score ranged from 0 to 3 and had an overall ($n = 445$) mean of 1.91 (SD = 0.65).

The post-cyclonic migration proportion among the households gradually increased with the heightened severity of a cyclone, as evident in Table 4, Figure 5 and Figure 6(e). We observed an average severity of cyclone score of 1.86 (SD = 0.69) among the households that did not experience any post-cyclonic migration. The average severity score was 1.89 (SD = 0.48) among the households that had a minority of HH members migrated. The most notable impact that the severity of the cyclone had was on households with a majority of HH members that migrated, with an average severity score of 2.33 (SD = 0.54). A one-way analysis of variance test found these differences to be highly statistically significant ($p < 0.001$). Further post hoc pairwise comparisons using Tukey’s Honest Significant Difference test found statistically significantly higher average cyclone severity among the households where a majority of HH members migrated compared to the households with a minority of HH members migrated (p -value < 0.01) as well as households that had no migration (p -value < 0.01).

6.4 Predicting post-cyclonic migration

Table 5 presents the estimates of odds ratios [3] of different predictors based on two types of household migration from the multinomial logistic regression model. Reflecting the results reported in Table 2 and Table 3 and using the same predictors for analyses, the multinomial logistic regression also found the institutional food aid and institutional cash aid to statistically significantly affect the probability of post-cyclonic migration, even after adjusting for the household demographic and economic factors. Households that received post-cyclonic food aid from Government/NGOs compared to those that did not, in which a minority of HH members migrated, were found to have statistically significantly lower odds (Odds ratio = 0.09, 95% CI: 0.04, 0.19) of experiencing post-cyclonic migration than the “none migrated” households group. Similarly, the post-cyclonic food aid recipient households relative to non-recipients, in which a majority of HH members migrated, were also found to have statistically significantly lower odds (Odds ratio = 0.02, 95% CI: 0.01, 0.07) relative to the group households where “none migrated”. In other words, households where a minority of HH members migrated and which did not receive food aid after a cyclone, compared to those that did, exhibited around 11 times [4] higher odds of migrating compared to households where none migrated. Similarly, households where a majority of HH members migrated and did not receive post-cyclonic food aid relative to those that did, were subject to 50 times higher odds of migrating compared to non-migrated households.

Post-cyclonic cash aid from Government/NGOs significantly reduced the odds by 57% of post-cyclonic migration of the households where a minority of HH members migrated relative to those in which none migrated (Odds ratio = 0.43, 95% CI: 0.20, 0.92). In other words, households that did not receive cash aid relative to those that received have statistically significant 2.32 times [5] higher odds of experiencing the migration of a minority of HH members relative to the households where none migrated. However, the

Households	Mean (SD)
None migrated	1.86 (0.69)
A minority of HH members migrated	1.89 (0.48)
A majority of HH members migrated	2.33 (0.54)

Notes: $F(2, 442) = 8.83; p < 0.001$

Source: Created by authors

Table 4.
Summary of questionnaire items measuring the severity of cyclones questioning extreme climatic events and change

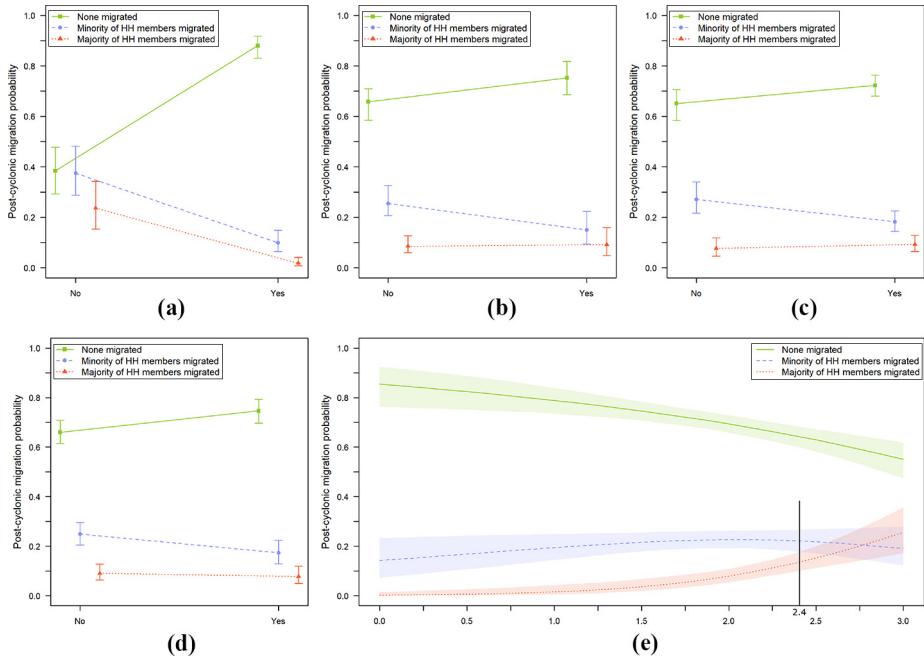


Figure 6. “Effect-plots” showing estimated post-cyclonic migration probabilities against the statistically significant (p -value < 0.05) predictors of the model while keeping the other predictors fixed at reference levels; which depict: (a) those who received post-cyclonic food aid; (b) those who received post-cyclonic cash aid; (c) alternative sources of income; (d) land ownership; and (e) severity of cyclones

Notes: The y-axis shows fitted or predicted values of the response variable, and the x-axis represents the focal predictors or the statistically significant independent variables. The bars (and shades in (e)) on each of the categories of predictors show the confidence interval, and the lines that join the points (in a, b, c, d) are for the visual aid to show the position. The probability of post-cyclonic migration is high among the households: (a) who did not receive post-cyclonic food aid, (b) who did not receive cash aid, (c) who did not have alternative sources of income, (d) who did not have land ownership, and (e) who experienced the average level of cyclone severity

Source: Created by authors

impact of post-cyclonic cash aid on the households where a majority of HH members migrated was not statistically significant.

Among the controlling factors accounting for the household demographic and economic characteristics, having alternative sources of earning played a statistically significant role in reducing the odds of post-cyclonic migration by 50% where a minority of HH members migrated relative to households where none migrated (Odds ratio = 0.50, 95% CI: 0.28, 0.90). Households with alternative income sources relative to those without were twice as likely to be part of the group where a minority of HH members migrated rather than in the group of households where none migrated. However, the effect of alternative income sources on the households where a majority of HH members migrated was not statistically significant.

Owning land compared to no land ownership contributed significantly to reducing the odds of migrating. Households that owned land and where a minority of HH members migrated were twice as likely to experience migration as opposed to those that did not own land and none from the HH migrated (Odds ratio = 0.48, 95% CI: 0.27, 0.86). However, this effect of land ownership on the households where a majority of HH members migrated was not statistically significant.

Predictors	OR (95% CI [6]), <i>p</i> -value	
	A minority of HH members migrated (Ref: None migrated)	A majority of HH members migrated (Ref: None migrated)
<i>Food aid from govt/NGOs</i>		
No	Ref	Ref
Yes	0.09 (0.04, 0.19), <0.01*	0.02 (0.01, 0.07), <0.01*
<i>Cash aid from govt/NGOs</i>		
No	Ref	Ref
Yes	0.43 (0.20, 0.92), 0.03*	0.73 (0.24, 2.25), 0.57
<i>Alternative sources of income</i>		
No	Ref	Ref
Yes	0.50 (0.28, 0.90), 0.02*	0.92 (0.39, 2.16), 0.84
<i>Own land</i>		
No	Ref	Ref
Yes	0.48 (0.27, 0.86), 0.01*	0.56 (0.24, 1.30), 0.18
Severity of cyclone score	1.76 (1.12, 2.77), <0.01*	8.29 (3.63, 18.90), <0.01*
Hosmer–Lemeshow goodness-of-fit test		$\chi^2(8) = 24.40, p\text{-value} = 0.08$
Note: * <i>p</i> < 0.05		
Source: Created by authors		

Table 5.
Estimated odds ratios and 95% confidence intervals from the multinomial logistic regression model predicting post-cyclonic migration

The severity of the cyclone (Table A1) also played a significant role in increasing the odds of post-cyclonic migration where a minority of HH members migrated relative to the households where none migrated by about two-fold for each additional unit of severity score (Odds ratio = 1.76, 95% CI: 1.12, 2.77). The migrating odds of a household where a majority of HH members migrated relative to those where none migrated were more than eight-fold higher (Odds ratio = 8.29, 95% CI: 3.63, 18.90) for each increase in the cyclonic severity score. The probability of migration, as can be seen in Figure 6(e) of the households where a majority of HH members migrated remained significantly lower than that of the households where a minority of HH members migrated. This trend continued as long as the cyclone severity score remained lower than 2.4. cyclones more severe than that score, according to the severity scale, made the migration of households with a majority of HH members indifferent to the households with a minority of HH members' migration, as confidence interval overlaps each other. More importantly, such high severity of cyclones left an upward trend of making the migration of households with majority members more likely. The figure also shows the diminishing propensity of the households to stay as the severity of the cyclone increases.

The estimated multinomial logistic regression model exhibited a satisfactory fit with the observations, as indicated by the Hosmer–Lemeshow goodness-of-fit test, $\chi^2(8) = 24.40, p\text{-value} = 0.08$. Figure 6 further provides a visual presentation of the fitted multinomial logistic regression model for estimated post-cyclonic migration probabilities by the direct exposures and selected controlling factors.

In addition to this statistical analysis, an illustrative summary of the relationships between variables has been developed to capture the key findings of this study (see Figure 7). It provides an aerial view of the dynamics of post-cyclone migration as observed in this study, including the critical role that institutional support from NGOs and governments plays in managing the distribution of various aid to households.

7. Discussion

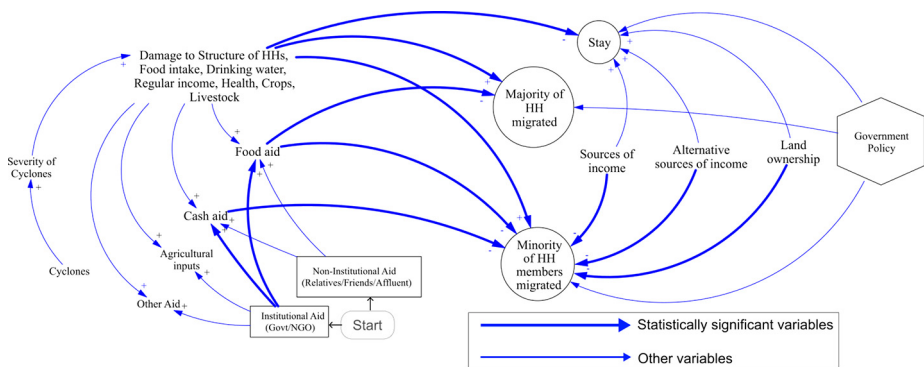
The distribution and variations of post-cyclonic aid, combined with other households' demographic and economic factors, influence human mobility. More specifically, this study showed that internal migrations are significantly impacted by post-cyclonic institutional food aid, cash aid, households' sources of income, alternative sources of income, land ownership and cyclones' severity.

Households that did not receive post-cyclonic food aid are more likely to migrate after a cyclone than the households that received it. This finding is in agreement with that of [Gamso and Yuldashev \(2018\)](#) and [Murat \(2020\)](#), who also found that aid can reduce migration. After a cyclone, food aid is found to be a vital form of emergency assistance for the affected people. The lack of this assistance might have constituted a push factor leading to migration. In contrast, those who stayed at the same place might have done so due to receiving food aid to meet the necessities for their families. A further classification of these households found that both the minority and the majority of members of the households migrated due to a lack of food aid. Therefore, food aid was a strong factor in deciding migration among the households.

In the case of post-cyclonic cash aid, households that did not receive it are more likely to migrate. It has been observed that this impact is significant only in households from which a minority of members migrated. This finding supports the results of [Muir et al. \(2020\)](#) that cash transfers and other forms of aid work as a tool for influencing migration decisions. In contrast, cash aid is not found to be a significant influencing factor for the households where a majority of household members migrated. This might have been caused by the lack of cash resources, misappropriation or political nepotism, as suggested by [Nadiruzzaman and Wrathall \(2015\)](#). This also confirms that, while cash aid is helpful, food aid during a disaster is vital for all households because basic needs, such as food, need to be fulfilled first. It is interesting to note, however, that while food and cash aid are influencing factors for household migration, agricultural aid is found not to be a significant factor. This is possibly due to the reduced need for the affected households to resume agricultural activities in the immediate aftermath of a cyclone.

Aid from institutional agents such as government and NGOs was found to be the primary source and distribution network rather than social networks. This finding broadly

Figure 7. Causal diagram of post-cyclonic migration flows; the bold arrows show statistically significant variables while the thin arrows show other non-significant variables



Notes: The “+” symbols denote a positive relationship between adjacent variables, while the “-” symbol denotes negative associations

Source: Created by authors

supports the result of [Burrows and Kinney \(2016\)](#), [Castells-Quintana *et al.* \(2018\)](#) and [Muir *et al.* \(2020\)](#). The likely reason is that the government and NGOs are more organised and equipped to carry out relief work. On the other hand, after an extreme climatic event, aid from the social network might be less effective because relatives and friends staying in the surrounding area are also adversely affected by the event.

The occupation of the household's primary earner is a significant factor in migration. Those who rely on fishing and day labouring for subsistence made up the most significant number of migrants among the sample ([Table 3](#)). This is supported by the views of [Bhatta *et al.* \(2015\)](#) and [Jha *et al.* \(2018\)](#), who found losses in climate-sensitive occupations are major reasons for migration in South Asia. This is possibly linked to the fact that households who rely on fishing are likely pushed to migrate due to the inaccessibility of the sea or damage to their vessels or nets ([Mallick and Vogt, 2012](#)). The gradual depletion of fish stocks may also force fishers to change their profession, spurring migration ([Black *et al.*, 2011](#); [Shams and Shohel, 2016](#)). In contrast, households that rely primarily on day labouring for subsistence have greater latitude to move, perhaps because they are not tied to any particular place through ownership of immobile resources, such as land ([Mallick *et al.*, 2017](#)). The scarcity of resources as viewed by Malthus drives these "vulnerable" categories of migrants to seek new opportunities in their host communities ([Oels, 2012](#)).

Households with alternative sources of income were found not to use migration as a survival mechanism [[Figure 6\(c\)](#)]. This finding, known as *in situ* adaptation, is consistent with [Castells-Quintana *et al.* \(2018\)](#) and [Yang *et al.* \(2019\)](#), who found that alternative sources of income can reduce the vulnerabilities of affected people. Similarly, in our study, individuals with alternative earnings did not migrate probably because they could cope with their alternative sources of income.

The results of this study also showed that households that do not have land were more likely to migrate after a cyclone. This corroborates the findings of [Akhter and Bauer \(2014\)](#), [Alam *et al.* \(2020\)](#) and [Kartiki \(2011\)](#) that landless or marginal land owners will migrate. This might be due to a lack of incentives and fixed properties that drive individuals to migrate to other places. In addition, social networks might pull them to go to a particular place ([Adams and Adger, 2013](#)). However, these findings contradict the claim of [Kaczan and Orgill-Meyer \(2020\)](#) that migration is prevalent among rich households. This difference in opinion is potentially due to setting land ownership; establishing a higher capacity to invest in migration.

Households' post-cyclonic migration probability increased with the severity of cyclones. This finding is in line with those of [Kaczan and Orgill-Meyer \(2020\)](#) and [Muir *et al.* \(2020\)](#) that the severity of a climatic event is one of the functions of migration. However, this study further distinguished the severity of impacts between households where a minority and a majority of household members migrated. It was found that the probability of a majority of household members migrating increased with the severity of cyclones, while the probability of a minority of household members migrating decreased. This is probably due to the fact that households' capacity to cope with environmental stresses, termed the state of human security by [Oels \(2012\)](#), faded and they decided for *ex situ* adaptation, i.e. distress migration.

Women were found to migrate less. This gender inequality in migration reflects the standard feature of an imbalanced male-female ratio in the workforce ([Etzold *et al.*, 2014](#); [Mallick and Vogt, 2012](#); [Warner and Afifi, 2014](#)). Women in this rural southern region usually do household chores, while males work outside and earn for the family ([Reggers, 2019](#)). This shows the dominance and decision-making power of the male head of the family over females. Consequently, many women are trapped in a vulnerable position socially, economically and environmentally ([Adger *et al.*, 2015](#); [Collins, 2013](#); [Foresight, 2011](#)) and thus are less able to migrate. This vulnerable situation of women could potentially be

improved by equal access to resources and by minimising nepotism in aid distribution (Nadiruzzaman and Wrathall, 2015).

The survey also shows that, in terms of demographic characteristics, the most mobile groups are middle-aged household heads, the age group 41–50 (Table 3). This is likely because younger heads of households have fewer or no alternative members to look after their family in their absence and thus cannot migrate so easily. Likewise, older individuals have passed societally mandated working age, reducing their ability to migrate for economic reasons (C.L. Gray and Mueller, 2012).

8. Conclusion and recommendations

This study investigated the impact of aid in the form of food, cash and agricultural inputs on post-cyclonic migration in the coastal areas of Bangladesh. It revealed that, after a cyclone, food aid from institutional sources constitutes an incentive for household members to stay in their places. Cash aid also functioned as an incentive to stay in households where a minority of HH members migrated. However, cash aid does not influence migration when a majority of HH members migrate. Other socioeconomic and environmental factors also influence households' decisions on migration. Households with alternative income sources are found not to migrate to other places after a cyclone. Households reliant on low-skilled manual jobs, such as fishing or day labour, are especially prone to disruption. Households who have land ownership are found to be less mobile than those without land. These mobility factors are especially significant among households where a minority of household members migrated. Another factor shaping mobility is the cyclone's severity: the more severe the cyclone, the higher the probability of a household migrating. Cyclone severity pushes households to migrate with most of their family members. Migration was noticeable among households whose heads fell within the 41–50 years age group. These results suggest that post-cyclonic migration is more prevalent among households that are less privileged and more vulnerable; scarcity of resources drives people to post-cyclonic distress migration. This study addresses the existing research gap in understanding the connections between various forms of aid and their impacts on human migration, particularly in the cyclone-prone coastal areas of Bangladesh.

This study had several limitations. Firstly, in this research, retrospective data were collected based on recalling respondents' memories. However, the questionnaire pattern, training and motivation provided to the field assistants were to keep recall bias at a minimum level. Secondly, there is a possibility of concealing aid-related information by the respondents. Although we explained to them that the data were collected for research purposes only, a few respondents may have presumed us to be government representatives and thought revealing true information about receiving aid may bar them from getting future aid. Thirdly, certain household characteristics, such as age, religion, education and profession used in this investigation were of the head of households, as the head mostly takes household decisions in the social context of Bangladesh (Reggers, 2019). Finally, the study did not include an in-depth analysis of the migrants, i.e. their migration patterns and destinations. Given that climate change is likely to increase natural hazards in the region, further studies on migration patterns, migration destinations and other inherent reasons for migration and migration barriers are warranted. In addition, comparative studies across different regions facing similar challenges can yield valuable insights into the study of post-cyclonic migration. Moreover, from the viewpoint of policy assessment, future research on assessing the effectiveness of existing policies related to disaster aid and migration can contribute to more targeted and efficient interventions.

For an effective disaster management plan, governments and NGOs can prioritise food security in post-cyclonic aid distribution work. Moreover, a household database can be kept available based on the socioeconomic and environmental factors identified here for need-based aid distribution. This database would further enable disaster aid management teams to distribute relief quickly and minimise distress migration.

Notes

1. Half or less than half of the household members migrated.
2. More than half or the whole household members migrated.
3. Odds ratio = $\frac{\text{odds after a unit change in the independent variable}}{\text{original}}$; Odds = $\frac{\text{probability of migration}}{\text{probability of no migration}}$
4. 11 times = 1/0.09
5. 2.32 times = 1/0.43
6. CI = Confidence interval

In Germanwatch's Global Climate Risk Index 2020, Bangladesh was placed seventh of 181 countries in terms of severity of the risk to the environment from 1999 to 2018 (Eckstein *et al.*, 2020).

Cyclonic or severe cyclonic storms show wind speeds from 63-118 km/h and cyclonic storms of hurricane intensity show wind speed above 118 km/h.

References

- Acharya, A.S., Prakash, A., Saxena, P. and Nigam, A. (2013), "Sampling: why and how of it?", *Indian Journal of Medical Specialities*, Vol. 4 No. 2, doi: [10.7713/ijms.2013.0032](https://doi.org/10.7713/ijms.2013.0032).
- Adamo, S.B. (2018), "Environmentally-Related international displacement: following in Graeme Hugo's footsteps", in Hugo, G., Abbasi-Shavazi, M.J. and Kraly, E.P. (Eds), *Demography of Refugee and Forced Migration*, Springer International Publishing, Cham, pp. 201-216, doi: [10.1007/978-3-319-67147-5_10](https://doi.org/10.1007/978-3-319-67147-5_10).
- Adams, H. and Adger, W.N. (2013), "A changing environment for human security: Transformative approaches to research", in Wolf, J., O'Brien, K. and Sygna, L. (Eds), *Policy and Action*, Routledge-Earthscan, Oxford.
- Adger, W.N., de Campos, R.S., Siddiqui, T., Gavonell, M.F., Szaboova, L., Rocky, M.H., Bhuiyan, M.R.A. and Billah, T. (2021), "Human security of urban migrant populations affected by length of residence and environmental hazards", *Journal of Peace Research*, Vol. 58 No. 1, pp. 50-66, doi: [10.1177/0022343320973717](https://doi.org/10.1177/0022343320973717).
- Adger, W.N., Arnell, N.W., Black, R., Dercon, S., Geddes, A. and Thomas, D.S.G. (2015), "Focus on environmental risks and migration: causes and consequences", *Environmental Research Letters*, Vol. 10 No. 6, p. 60201, doi: [10.1088/1748-9326/10/6/060201](https://doi.org/10.1088/1748-9326/10/6/060201).
- Ahmad, M.I. and Ma, H. (2020), "An investigation of the targeting and allocation of post-flood disaster aid for rehabilitation in Punjab, Pakistan", *International Journal of Disaster Risk Reduction*, Vol. 44, p. 101402, doi: [10.1016/j.ijdr.2019.101402](https://doi.org/10.1016/j.ijdr.2019.101402).
- Ahsan, E.M. (2013), *Coastal Zone of Bangladesh: Fisheries Resources and Its Potentials (First)*, Lambert Academic Publishing, doi: [10.13140/2.1.1253.7928](https://doi.org/10.13140/2.1.1253.7928).
- Akhter, S. and Bauer, S. (2014), "Household level determinants of rural-urban migration in Bangladesh", *International Journal of Humanities and Social Sciences*, Vol. 8 No. 1, pp. 24-27.
- Alam, G.M.M., Alam, K., Mushtaq, S., Sarker, M.N.I. and Hossain, M. (2020), "Hazards, food insecurity and human displacement in rural riverine Bangladesh: implications for policy", *International Journal of Disaster Risk Reduction*, Vol. 43, p. 101364, doi: [10.1016/j.ijdr.2019.101364](https://doi.org/10.1016/j.ijdr.2019.101364).

- Altwater, E. (2004), "Is there an ecological Marxism", in Schmidt, J.D. (Ed.), *Development Studies and Political Ecology in a North South Perspective*, Aalborg University, Denmark.
- Anastasopoulos, L.J. (2019), "Migration, immigration, and the political geography of American cities", *American Politics Research*, Vol. 47 No. 2, pp. 362-390, doi: [10.1177/1532673X17740936](https://doi.org/10.1177/1532673X17740936).
- Azad, A., Al Mita, K., Zaman, M., Akter, M., Asik, T., Haque, A., Hussain, M. and Rahman, M. (2018), "Impact of tidal phase on inundation and thrust force due to storm surge", *Journal of Marine Science and Engineering*, Vol. 6 No. 4, p. 110, doi: [10.3390/jmse6040110](https://doi.org/10.3390/jmse6040110).
- Bangladesh Bureau of Statistics (2011), "Population and housing census".
- Bangladesh Meteorological Department (2024), "Historical cyclones", available at: <http://bmd.gov.bd/p/Historical-Cyclones/> (accessed 27 July 2024).
- Bardsley, D.K. and Hugo, G.J. (2010), "Migration and climate change: examining thresholds of change to guide effective adaptation decision-making", *Population and Environment*, Vol. 32 No. 2-3, pp. 238-262, doi: [10.1007/s11111-010-0126-9](https://doi.org/10.1007/s11111-010-0126-9).
- Barnett, J., Matthew, R.A. and O'Brien, K. (2008), "Global environmental change and human security", in Brauch, H.G., Spring, Ü.O., Mesjasz, C., Grin, J., Dunay, P., Behera, N.C., Chourou, B., Kameri-Mbote, P. and Liotta, P.H. (Eds.), *Globalization and Environmental Challenges*, Springer, Berlin Heidelberg, pp. 355-361, doi: [10.1007/978-3-540-75977-5_24](https://doi.org/10.1007/978-3-540-75977-5_24).
- Bates, D.C. (2002), "Environmental refugees? Classifying human migrations caused by environmental change", *Population and Environment*, Vol. 23 No. 5, pp. 465-477, doi: [10.1023/A:1015186001919](https://doi.org/10.1023/A:1015186001919).
- Becerra, O., Cavallo, E. and Noy, I. (2014), "Foreign aid in the aftermath of large natural disasters", *Review of Development Economics*, Vol. 18 No. 3, pp. 445-460, doi: [10.1111/rode.12095](https://doi.org/10.1111/rode.12095).
- Berlemann, M. and Steinhardt, M.F. (2017), "Climate change, natural disasters, and migration—a survey of the empirical evidence", *CESifo Economic Studies*, Vol. 63 No. 4, pp. 353-385, doi: [10.1093/cesifo/ifx019](https://doi.org/10.1093/cesifo/ifx019).
- Bernzen, A., Jenkins, J. and Braun, B. (2019), "Climate change-induced migration in coastal Bangladesh? A critical assessment of migration drivers in rural households under economic and environmental stress", *Geosciences*, Vol. 9 No. 1, p. 51, doi: [10.3390/geosciences9010051](https://doi.org/10.3390/geosciences9010051).
- Bhatta, G.D., Aggarwal, P.K., Poudel, S. and Belgrave, D.A. (2015), "Climate-induced migration in South Asia: migration decisions and the gender dimensions of adverse climatic events", *Journal of Rural and Community Development*, Vol. 10 No. 4, pp. 1-23.
- Black, R. (2001), "New issues in refugee research - environmental refugees: myth or reality?", (Issue 34).
- Black, R., Adger, W.N., Arnell, N.W., Dercon, S., Geddes, A. and Thomas, D. (2011), "The effect of environmental change on human migration", *Global Environmental Change*, Vol. 21, pp. S3-S11, doi: [10.1016/j.gloenvcha.2011.10.001](https://doi.org/10.1016/j.gloenvcha.2011.10.001).
- Black, R., Arnell, N.W., Adger, W.N., Thomas, D. and Geddes, A. (2013), "Migration, immobility and displacement outcomes following extreme events", *Environmental Science and Policy*, Vol. 27, pp. S32-S43, doi: [10.1016/j.envsci.2012.09.001](https://doi.org/10.1016/j.envsci.2012.09.001).
- Boas, I., Farbotko, C., Adams, H., Sterly, H., Bush, S., van der Geest, K., Wiegel, H., Ashraf, H., Baldwin, A., Bettini, G., Blondin, S., de Bruijn, M., Durand-Delacore, D., Fröhlich, C., Gioli, G., Guaita, L., Hut, E., Jarawura, F.X., Lamers, M. and Hulme, M. (2019), "Climate migration myths", *Nature Climate Change*, Vol. 9 No. 12, pp. 901-903, doi: [10.1038/s41558-019-0633-3](https://doi.org/10.1038/s41558-019-0633-3).
- Boustan, L.P., Kahn, M.E. and Rhode, P.W. (2012), "Moving to higher ground: migration response to natural disasters in the early twentieth century", *American Economic Review*, Vol. 102 No. 3, pp. 238-244, doi: [10.1257/aer.102.3.238](https://doi.org/10.1257/aer.102.3.238).
- Burrows, K. and Kinney, P. (2016), "Exploring the climate change, migration and conflict nexus", *International Journal of Environmental Research and Public Health*, Vol. 13 No. 4, p. 443, doi: [10.3390/ijerph13040443](https://doi.org/10.3390/ijerph13040443).

-
- Castells-Quintana, D., Lopez-Uribe, M. D P. and McDermott, T.K.J. (2018), "Adaptation to climate change: a review through a development economics lens", *World Development*, Vol. 104, pp. 183-196, doi: [10.1016/j.worlddev.2017.11.016](https://doi.org/10.1016/j.worlddev.2017.11.016).
- Castles, S. (2002), "Environmental change and forced migration: making sense of the debate", UNHCR.
- Chen, J.J., Mueller, V., Jia, Y. and Tseng, S.K.-H. (2017), "Validating migration responses to flooding using satellite and vital registration data", *American Economic Review*, Vol. 107 No. 5, pp. 441-445, doi: [10.1257/aer.p20171052](https://doi.org/10.1257/aer.p20171052).
- Clist, P. and Restelli, G. (2021), "Development aid and international migration to Italy: Does aid reduce irregular flows?", *The World Economy*, Vol. 44 No. 5, pp. 1281-1311, doi: [10.1111/twec.13017](https://doi.org/10.1111/twec.13017).
- Collins, A.E. (2013), "Applications of the disaster risk reduction approach to migration influenced by environmental change", *Environmental Science and Policy*, Vol. 27, pp. S112-S125, doi: [10.1016/j.envsci.2012.10.005](https://doi.org/10.1016/j.envsci.2012.10.005).
- Curran, S.R., Shafer, S., Donato, K.M. and Garip, F. (2006), "Mapping gender and migration in sociological scholarship: Is it segregation or integration?", *International Migration Review*, Vol. 40 No. 1, pp. 199-223, doi: [10.1111/j.1747-7379.2006.00008.x](https://doi.org/10.1111/j.1747-7379.2006.00008.x).
- Curtis, K.J., DeWaard, J., Fussell, E. and Rosenfeld, R.A. (2020), "Differential recovery migration across the rural-urban gradient: minimal and short-term population gains for rural disaster-affected Gulf Coast counties", *Rural Sociology*, Vol. 85 No. 4, pp. 856-898, doi: [10.1111/ruso.12305](https://doi.org/10.1111/ruso.12305).
- Daly, P., Mahdi, S., McCaughey, J., Mundzir, I., Halim, A., Nizamuddin, A. and Srimulyani, E. (2020), "Rethinking relief, reconstruction and development: evaluating the effectiveness and sustainability of post-disaster livelihood aid", *International Journal of Disaster Risk Reduction*, Vol. 49, p. 101650, doi: [10.1016/j.ijdrr.2020.101650](https://doi.org/10.1016/j.ijdrr.2020.101650).
- Davis, K.F., Bhattachan, A., D'Odorico, P. and Suweis, S. (2018), "A universal model for predicting human migration under climate change: examining future sea level rise in Bangladesh", *Environmental Research Letters*, Vol. 13 No. 6, p. 64030, doi: [10.1088/1748-9326/aac4d4](https://doi.org/10.1088/1748-9326/aac4d4).
- de Haas, H. (2021), "A theory of migration: the aspirations-capabilities framework", *Comparative Migration Studies*, Vol. 9 No. 1, p. 8, doi: [10.1186/s40878-020-00210-4](https://doi.org/10.1186/s40878-020-00210-4).
- Dellmuth, L.M., Bender, F.A.-M., Jönsson, A.R., Rosvold, E.L. and von Uexkull, N. (2021), "Humanitarian need drives multilateral disaster aid", *Proceedings of the National Academy of Sciences*, Vol. 118 No. 4, p. e2018293118, doi: [10.1073/pnas.2018293118](https://doi.org/10.1073/pnas.2018293118).
- Etzold, B., Ahmed, A.U., Hassan, S.R. and Neelormi, S. (2014), "Clouds gather in the sky, but no rain falls. Vulnerability to rainfall variability and food insecurity in Northern Bangladesh and its effects on migration", *Climate and Development*, Vol. 6 No. 1, pp. 18-27, doi: [10.1080/17565529.2013.833078](https://doi.org/10.1080/17565529.2013.833078).
- Faruk, M., Ashraf, S.A. and Ferdous, M. (2018), "An analysis of inclusiveness and accessibility of cyclone shelters, Bangladesh", *Procedia Engineering*, Vol. 212, pp. 1099-1106, doi: [10.1016/j.proeng.2018.01.142](https://doi.org/10.1016/j.proeng.2018.01.142).
- Floyd, R. (2008), "The environmental security debate and its significance for climate change", *The International Spectator*, Vol. 43 No. 3, pp. 51-65, doi: [10.1080/03932720802280602](https://doi.org/10.1080/03932720802280602).
- Foresight (2011), "Migration and global environmental change, final project report", In Government Office for Science - London.
- Gamso, J. and Yuldashev, F. (2018), "Does rural development aid reduce international migration?", *World Development*, Vol. 110, pp. 268-282, doi: [10.1016/j.worlddev.2018.05.035](https://doi.org/10.1016/j.worlddev.2018.05.035).
- Geddes, A., Adger, W.N., Arnell, N.W., Black, R. and Thomas, D.S.G. (2012), "Migration, environmental change, and the 'challenges of governance'", *Environment and Planning C: Government and Policy*, Vol. 30 No. 6, pp. 951-967, doi: [10.1068/c3006ed](https://doi.org/10.1068/c3006ed).
- GeoData Institute (2024), "Delta portal", available at: www.delta-portal.net/geoserver/www/documentation_downloads/Bangladesh_questionnaire_HholdHead.pdf (accessed 27 July 2024).
-

- GoB (2008), "Cyclone SIDR in Bangladesh: damage, loss, and needs assessment for disaster recovery and reconstruction", available at: <https://reliefweb.int/report/bangladesh/cyclone-sidr-bangladesh-damage-loss-and-needs-assessment-disaster-recovery-and>
- Goldbach, C. (2017), "Out-migration from coastal areas in Ghana and Indonesia—the role of environmental factors", *CESifo Economic Studies*, Vol. 63 No. 4, pp. 529-559, doi: [10.1093/cesifo/ix007](https://doi.org/10.1093/cesifo/ix007).
- Goulden, M., Naess, L.O., Vincent, K. and Adger, W.N. (2009), "Accessing diversification, networks and traditional resource management as adaptations to climate extremes", in Adger, W.N., Lorenzoni, I. and O'Brien, K.L. (Eds), *Adapting to Climate Change*, Cambridge University Press, Cambridge, pp. 448-464, doi: [10.1017/CBO9780511596667.029](https://doi.org/10.1017/CBO9780511596667.029).
- Gray, C.L. (2009), "Environment, land, and rural out-migration in the Southern Ecuadorian Andes", *World Development*, Vol. 37 No. 2, pp. 457-468, doi: [10.1016/j.worlddev.2008.05.004](https://doi.org/10.1016/j.worlddev.2008.05.004).
- Gray, C. and Bilsborrow, R. (2013), "Environmental influences on human migration in rural Ecuador", *Demography*, Vol. 50 No. 4, pp. 1217-1241, doi: [10.1007/s13524-012-0192-y](https://doi.org/10.1007/s13524-012-0192-y).
- Gray, C.L. and Mueller, V. (2012), "Natural disasters and population mobility in Bangladesh", *Proceedings of the National Academy of Sciences*, Vol. 109 No. 16, pp. 6000-6005, doi: [10.1073/pnas.1115944109](https://doi.org/10.1073/pnas.1115944109).
- Gray, C., Frankenberg, E., Gillespie, T., Sumantri, C. and Thomas, D. (2014), "Studying displacement after a disaster using Large-Scale survey methods: Sumatra after the 2004 tsunami", *Annals of the Association of American Geographers*, Vol. 104 No. 3, pp. 594-612, doi: [10.1080/00045608.2014.892351](https://doi.org/10.1080/00045608.2014.892351).
- Henderson, J.V. and Lee, Y.S. (2015), "Organization of disaster aid delivery: spending your donations", *Economic Development and Cultural Change*, Vol. 63 No. 4, pp. 617-664, doi: [10.1086/681277](https://doi.org/10.1086/681277).
- Henry, S., Schoumaker, B. and Beauchemin, C. (2003), "The impact of rainfall on the first out-Migration: a multi-level event-history analysis in Burkina Faso", *Population and Environment*, Vol. 25 No. 5, pp. 423-460, doi: [10.1023/B:POEN.0000036928.17696.e8](https://doi.org/10.1023/B:POEN.0000036928.17696.e8).
- Hosmer, D.W., Lemeshow, S. and Sturdivant, R.X. (2013), *Applied Logistic Regression*, Wiley, NJ, doi: [10.1002/9781118548387](https://doi.org/10.1002/9781118548387).
- Hugo, G. (1996), "Environmental concerns and international migration", *International Migration Review*, Vol. 30 No. 1, pp. 105-131.
- Ionesco, D., Mokhnacheva, D. and Gemenne, F. (2017), *The Atlas of Environmental Migration*, Routledge, doi: [10.4324/9781315777313](https://doi.org/10.4324/9781315777313).
- IPCC (2007), "Climate change 2007: impacts, adaptation and vulnerability", in Martin, P., Canziani, O., Palutikof, J., van der Linden, P. and Hanson, C. (Eds), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge.
- Islam, T. and Peterson, R.E. (2004), "A climatological study on the landfalling tropical cyclones of Bangladesh".
- Jahan, M. (2012), "Impact of rural urban migration on physical and social environment: the case of Dhaka city", *International Journal of Development and Sustainability Online*, doi: [10.1007/s10980-015-0172-x](https://doi.org/10.1007/s10980-015-0172-x).
- Javed, A., Ahmed, V. and Amal, B.K. (2021), "The social safety nets and poverty alleviation in Pakistan: an evaluation of livelihood enhancement and protection programme", *Britain International of Humanities and Social Sciences (BloHS) Journal*, Vol. 3 No. 1, pp. 21-36, doi: [10.33258/biohs.v3i1.357](https://doi.org/10.33258/biohs.v3i1.357).
- Jha, C.K., Gupta, V., Chattopadhyay, U. and Amarayil Sreeraman, B. (2018), "Migration as adaptation strategy to cope with climate change", *International Journal of Climate Change Strategies and Management*, Vol. 10 No. 1, pp. 121-141, doi: [10.1108/IJCCSM-03-2017-0059](https://doi.org/10.1108/IJCCSM-03-2017-0059).

-
- Johnson, F.A., Hutton, C.W., Hornby, D., Lázár, A.N. and Mukhopadhyay, A. (2016), "Is shrimp farming a successful adaptation to salinity intrusion? A geospatial associative analysis of poverty in the populous Ganges–Brahmaputra–Meghna Delta of Bangladesh", *Sustainability Science*, Vol. 11, pp. 423-439, doi: [10.1007/s11625-016-0356-6](https://doi.org/10.1007/s11625-016-0356-6).
- Kaczan, D.J. and Orgill-Meyer, J. (2020), "The impact of climate change on migration: a synthesis of recent empirical insights", *Climatic Change*, Vol. 158 Nos 3/4, pp. 281-300, doi: [10.1007/s10584-019-02560-0](https://doi.org/10.1007/s10584-019-02560-0).
- Kartiki, K. (2011), "Climate change and migration: a case study from rural Bangladesh", *Gender and Development*, Vol. 19 No. 1, pp. 23-38, doi: [10.1080/13552074.2011.554017](https://doi.org/10.1080/13552074.2011.554017).
- Khan, S.R. (n.d.), "Cyclone hazard in Bangladesh".
- Khan, M.M.H., Bryceson, I., Kolivras, K.N., Faruque, F., Rahman, M.M. and Haque, U. (2015), "Natural disasters and land-use/land-cover change in the southwest coastal areas of Bangladesh", *Regional Environmental Change*, Vol. 15 No. 2, pp. 241-250, doi: [10.1007/s10113-014-0642-8](https://doi.org/10.1007/s10113-014-0642-8).
- Klepp, S. (2017), "Climate change and migration", *Oxford Research Encyclopedia of Climate Science*, Oxford University Press, Oxford, doi: [10.1093/acrefore/9780190228620.013.42](https://doi.org/10.1093/acrefore/9780190228620.013.42).
- Lanati, M. and Thiele, R. (2018), "The impact of foreign aid on migration revisited", *World Development*, Vol. 111, pp. 59-74, doi: [10.1016/j.worlddev.2018.06.021](https://doi.org/10.1016/j.worlddev.2018.06.021).
- Lazar, A.N., Nicholls, R.J., Payo, A., Adams, H., Mortreux, C., Suckall, N., Vincent, K., Sugata, H., Amisigo, B.A., Rahman, M., Haque, A., Adger, N. and Hill, C. (2015), "A method to assess migration and adaptation in deltas: a preliminary fast-track assessment".
- Lee, E.S. (1966), "A theory of migration", *Demography*, Vol. 3 No. 1, p. 47, doi: [10.2307/2060063](https://doi.org/10.2307/2060063).
- Leeson, P.T. and Sobel, R.S. (2008), "Weathering corruption", *The Journal of Law and Economics*, Vol. 51 No. 4, pp. 667-681, doi: [10.1086/590129](https://doi.org/10.1086/590129).
- McLeman, R. and Smit, B. (2006), "Migration as an adaptation to climate change", *Climatic Change*, Vol. 76 Nos 1/2, pp. 31-53, doi: [10.1007/s10584-005-9000-7](https://doi.org/10.1007/s10584-005-9000-7).
- Mahmud, T. and Prowse, M. (2012), "Corruption in cyclone preparedness and relief efforts in coastal Bangladesh: lessons for climate adaptation?", *Global Environmental Change*, Vol. 22 No. 4, pp. 933-943, doi: [10.1016/j.gloenvcha.2012.07.003](https://doi.org/10.1016/j.gloenvcha.2012.07.003).
- Mallick, B. (2014), "Cyclone-induced migration in southwest coastal Bangladesh", ASIEN 130, January, pp. 60-82, available at: http://asien.asienforschung.de/wp-content/uploads/sites/6/2014/01/ASIEN_130_Mallick.pdf
- Mallick, B. and Vogt, J. (2012), "Cyclone, coastal society and migration: empirical evidence from Bangladesh", *International Development Planning Review*, Vol. 34 No. 3, pp. 217-240, doi: [10.3828/idpr.2012.16](https://doi.org/10.3828/idpr.2012.16).
- Mallick, B. and Vogt, J. (2014), "Population displacement after cyclone and its consequences: empirical evidence from coastal Bangladesh", *Natural Hazards*, Vol. 73 No. 2, pp. 191-212, doi: [10.1007/s11069-013-0803-y](https://doi.org/10.1007/s11069-013-0803-y).
- Mallick, B., Ahmed, B. and Vogt, J. (2017), "Living with the risks of cyclone disasters in the South-Western coastal region of Bangladesh", *Environments*, Vol. 4 No. 1, p. 13, doi: [10.3390/environments4010013](https://doi.org/10.3390/environments4010013).
- Massey, D.S. (2009), "The political economy of migration in an era of globalization", in Martinez, S. (Ed.), *International Migration and Human Rights: The Global Repercussions of U.S. policy*, University of CA Press, CA.
- Mathews, J.T. (1989), "Redefining security", *Foreign Affairs*, Vol. 68 No. 2, pp. 162-177.
- Methmann, C. and Oels, A. (2015), "From 'fearing' to 'empowering' climate refugees: governing climate-induced migration in the name of resilience", *Security Dialogue*, Vol. 46 No. 1, pp. 51-68, doi: [10.1177/0967010614552548](https://doi.org/10.1177/0967010614552548).
- Mueller, V., Gray, C. and Kosec, K. (2014), "Heat stress increases long-term human migration in rural Pakistan", *Nature Climate Change*, Vol. 4 No. 3, pp. 182-185, doi: [10.1038/nclimate2103](https://doi.org/10.1038/nclimate2103).

- Muir, J.A., Cope, M.R., Angeningsih, L.R. and Jackson, J.E. (2020), "To move home or move on? Investigating the impact of recovery aid on migration status as a potential tool for disaster risk reduction in the aftermath of volcanic eruptions in Merapi, Indonesia", *International Journal of Disaster Risk Reduction*, Vol. 46, p. 101478, doi: [10.1016/j.ijdr.2020.101478](https://doi.org/10.1016/j.ijdr.2020.101478).
- Murat, M. (2020), "Foreign aid, bilateral asylum immigration and development", *Journal of Population Economics*, Vol. 33 No. 1, pp. 79-114, doi: [10.1007/s00148-019-00751-8](https://doi.org/10.1007/s00148-019-00751-8).
- Mustafa, S. (2022), "Data on climate migration", Mendeley. doi: [10.17632/JS2HWYBRXM1](https://doi.org/10.17632/JS2HWYBRXM1)
- Mustafa, S., Newport, D. and Rigg, C. (2023), "Post-cyclonic migration in coastal areas: an assessment of who, where, why migrates, and barriers to migration", *International Journal of Disaster Risk Reduction*, Vol. 92, p. 103726, doi: [10.1016/j.ijdr.2023.103726](https://doi.org/10.1016/j.ijdr.2023.103726).
- Mustari, S. and Karim, A.H.M.Z. (2017), "Migration, an alternative to bring resilience for coastal Bangladesh: Napitkhali village experience", *European Journal of Social Sciences*.
- Myers, N. (1993), "Environmental refugees in a globally warmed world", *BioScience*, Vol. 43 No. 11, pp. 752-761, doi: [10.2307/1312319](https://doi.org/10.2307/1312319).
- Myers, N. (1997), "Environmental refugees", *Population and Environment*, Vol. 19 No. 2, pp. 167-182, doi: [10.1023/A:1024623431924](https://doi.org/10.1023/A:1024623431924).
- Myers, N. (2002), "Environmental refugees: a growing phenomenon of the 21st century", *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, Vol. 357 No. 1420, pp. 609-613, doi: [10.1098/rstb.2001.0953](https://doi.org/10.1098/rstb.2001.0953).
- Myers, N. and Kent, J. (1995), *Environmental Exodus: An Emergent Crisis in the Global Arena*, Climate Institute.
- Nadiruzzaman, M. and Wrathall, D. (2015), "Participatory exclusion – cyclone SIDR and its aftermath", *Geoforum*, Vol. 64, pp. 196-204, doi: [10.1016/j.geoforum.2015.06.026](https://doi.org/10.1016/j.geoforum.2015.06.026).
- Nawrotzki, R.J., Brenkert-Smith, H., Hunter, L.M. and Champ, P.A. (2014), "Wildfire-migration dynamics: lessons from Colorado's fourmile canyon fire", *Society and Natural Resources*, Vol. 27 No. 2, pp. 215-225, doi: [10.1080/08941920.2013.842275](https://doi.org/10.1080/08941920.2013.842275).
- Oels, A. (2012), "From 'securitization' of climate change to 'Climatization' of the security field: comparing three theoretical perspectives", in Scheffran, J., Brzoska, M., Brauch, H.G., Link, P.M. and Schilling, J. (Eds), *Climate Change, Human Security and Violent Conflict: Challenges for Societal Stability*, Springer, Berlin Heidelberg, pp. 185-205, doi: [10.1007/978-3-642-28626-1_9](https://doi.org/10.1007/978-3-642-28626-1_9).
- Paul, B.K. (2005), "Evidence against disaster-induced migration: the 2004 tornado in North-Central Bangladesh", *Disasters*, Vol. 29 No. 4, pp. 370-385, doi: [10.1111/j.0361-3666.2005.00298.x](https://doi.org/10.1111/j.0361-3666.2005.00298.x).
- Paul, B.K. and Chatterjee, S. (2019), "Climate change-induced environmental hazards and Aila relief measures undertaken to Sundarbans in Bangladesh and India", in Sen, H.S. (Ed.), *The Sundarbans: A Disaster-Prone eco-Region*, Springer, Cham, pp. 469-490, doi: [10.1007/978-3-030-00680-8_16](https://doi.org/10.1007/978-3-030-00680-8_16).
- Paul, S.K. and Routray, J.K. (2011), "Household response to cyclone and induced surge in coastal Bangladesh: coping strategies and explanatory variables", *Natural Hazards*, Vol. 57 No. 2, pp. 477-499, doi: [10.1007/s11069-010-9631-5](https://doi.org/10.1007/s11069-010-9631-5).
- Piguet, E., Pecoud, A. and Guchteneire, P. (2011), "Migration and climate change: an overview", *Refugee Survey Quarterly*, Vol. 30 No. 3, pp. 1-23, doi: [10.1093/rsq/hdr006](https://doi.org/10.1093/rsq/hdr006).
- Quader, M., Khan, A. and Kervyn, M. (2017), "Assessing risks from cyclones for human lives and livelihoods in the coastal region of Bangladesh", *International Journal of Environmental Research and Public Health*, Vol. 14 No. 8, p. 831, doi: [10.3390/ijerph14080831](https://doi.org/10.3390/ijerph14080831).
- Rahim, M.A., Siddiqua, A., Binte Nur, M.N. and Zaman, A.K.M.M. (2018), "Community perception on adverse effects of natural hazards on livelihood and enhancing livelihood resiliency: a case study at Patharghata Upazila, Barguna", *Procedia Engineering*, Vol. 212, pp. 149-156, doi: [10.1016/j.proeng.2018.01.020](https://doi.org/10.1016/j.proeng.2018.01.020).

-
- Regaud, K.K., Sherbinin, A., Jones, B., Ober, K., Schewe, J., Adamo, S., McCusker, B., Heuser, S. and Midgley, A. (2018), "Preparing for internal climate migration", doi: [10.7916/D8Z33FNS](https://doi.org/10.7916/D8Z33FNS).
- Reggers, A. (2019), "Climate change is not gender neutral: gender inequality, rights and vulnerabilities in Bangladesh", *Confronting Climate Change in Bangladesh*, Springer, Cham, pp. 103-118, doi: [10.1007/978-3-030-05237-9_8](https://doi.org/10.1007/978-3-030-05237-9_8).
- Reuveny, R. and Moore, W.H. (2009), "Does environmental degradation influence migration? Emigration to developed countries in the late 1980s and 1990s", *Social Science Quarterly*, Vol. 90 No. 3, pp. 461-479, doi: [10.1111/j.1540-6237.2009.00569.x](https://doi.org/10.1111/j.1540-6237.2009.00569.x).
- RHoMIS (2024), "No title", available at: www.rhomis.org/survey.html (accessed 6 July 2021).
- Saha, S.K. (2017), "Cyclone Aila, livelihood stress, and migration: empirical evidence from coastal Bangladesh", *Disasters*, Vol. 41 No. 3, pp. 505-526, doi: [10.1111/disa.12214](https://doi.org/10.1111/disa.12214).
- Schwan, S. and Yu, X. (2018), "Social protection as a strategy to address climate-induced migration", *International Journal of Climate Change Strategies and Management*, Vol. 10 No. 1, pp. 43-64, doi: [10.1108/IJCCSM-01-2017-0019](https://doi.org/10.1108/IJCCSM-01-2017-0019).
- Sen, A. (1983), *Poverty and Famines*, Oxford University Press, Oxford, doi: [10.1093/0198284632.001.0001](https://doi.org/10.1093/0198284632.001.0001).
- Shams, S. and Shohel, M.M.C. (2016), "Food security and livelihood in coastal area under increased salinity and frequent tidal surge", *Environment and Urbanization ASIA*, Vol. 7 No. 1, pp. 22-37, doi: [10.1177/0975425315619046](https://doi.org/10.1177/0975425315619046).
- Stevenson, J., Vargo, J., Seville, E., Kachali, H., McNaughton, A. and Powell, F. (2012), "The recovery of Canterbury's organisations: a comparative analysis of the 4 September 2010, 22 February and 13 June 2011 Earthquakes".
- Tavakol, M. and Dennick, R. (2011), "Making sense of Cronbach's alpha", *International Journal of Medical Education*, Vol. 2, pp. 53-55, doi: [10.5116/ijme.4dfb.8dfd](https://doi.org/10.5116/ijme.4dfb.8dfd).
- Thiede, B., Gray, C. and Mueller, V. (2016), "Climate variability and inter-provincial migration in South America, 1970–2011", *Global Environmental Change*, Vol. 41, pp. 228-240, doi: [10.1016/j.gloenvcha.2016.10.005](https://doi.org/10.1016/j.gloenvcha.2016.10.005).
- UNDP (1994), Human Development Report 1994, available at: http://hdr.undp.org/sites/default/files/reports/255/hdr_1994_en_complete_nostats.pdf
- Warner, K. (2010), "Global environmental change and migration: governance challenges", *Global Environmental Change*, Vol. 20 No. 3, pp. 402-413, doi: [10.1016/j.gloenvcha.2009.12.001](https://doi.org/10.1016/j.gloenvcha.2009.12.001).
- Warner, K. and Afifi, T. (2014), "Where the rain falls: evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity", *Climate and Development*, Vol. 6 No. 1, pp. 1-17, doi: [10.1080/17565529.2013.835707](https://doi.org/10.1080/17565529.2013.835707).
- Wood, R.M. and Wright, T.M. (2016), "Responding to catastrophe", *Journal of Conflict Resolution*, Vol. 60 No. 8, pp. 1446-1472, doi: [10.1177/0022002715596366](https://doi.org/10.1177/0022002715596366).
- World Population Review (2020), "Bangladesh population", available at: <http://worldpopulationreview.com/countries/bangladesh-population/>
- Yang, J., Owusu, V., Andriess, E. and Dziwornu Ablo, A. (2019), "In-Situ adaptation and coastal vulnerabilities in Ghana and tanzania", *The Journal of Environment and Development*, Vol. 28 No. 3, pp. 282-308, doi: [10.1177/1070496519852992](https://doi.org/10.1177/1070496519852992).
- Yu, B., You, L. and Fan, S. (2010), "Toward a typology of food security in developing countries".
-

Extreme climatic events and change items measuring the severity of cyclones	Frequency (%); <i>n</i> = 445	Mean (SD)
<i>To what extent have cyclones impacted the structure of the housing?</i>		
0 (No impact/does not know)	15 (3)	2.46 (0.74)
1 (A slight impact)	20 (5)	
2 (Moderate impacts)	156 (35)	
3 (Severe impact)	254 (57)	
<i>To what extent have cyclones impacted the regular (daily) food intake of the h/h (after a cyclone)?</i>		
0 (No impact/does not know)	58 (13)	2.17 (1.01)
1 (A slight impact)	22 (5)	
2 (Moderate impact)	153 (34)	
3 (Severe impact)	212 (48)	
<i>To what extent have cyclones impacted the drinking water of the h/h (after a cyclone)?</i>		
0 (No impact/does not know)	41 (9)	2.3 (0.93)
1 (A slight impact)	21 (5)	
2 (Moderate impact)	148 (33)	
3 (Severe impact)	235 (53)	
<i>To what extent have cyclones impacted the regular income of the h/h (after a cyclone)?</i>		
0 (No impact/does not know)	29 (6)	2.34 (0.83)
1 (A slight impact)	18 (4)	
2 (Moderate impact)	172 (39)	
3 (Severe impact)	226 (51)	
<i>To what extent have cyclones impacted the health (injury, diarrhoea, etc.) of the h/h (after a cyclone)?</i>		
0 (No impact/does not know)	174 (39)	1.47 (1.27)
1 (A slight impact)	16 (4)	
2 (Moderate impact)	127 (28)	
3 (Severe impact)	128 (29)	
<i>To what extent have cyclones impacted the crops of the h/h (after a cyclone)?</i>		
0 (No impact/does not know)	158 (35)	1.55 (1.26)
1 (A slight impact)	25 (6)	
2 (Moderate impact)	121 (27)	
3 (Severe impact)	141 (32)	
<i>To what extent have cyclones impacted livestock of the h/h?</i>		
0 (No impact/does not know)	319 (71)	0.73 (1.20)
1 (A slight impact)	8 (2)	
2 (Moderate impact)	39 (9)	
3 (Severe impact)	79 (18)	
<i>Scale reliability</i>		
<i>Cronbach's alpha</i>		0.71
(Excludes the item measuring cyclone impact on crops due to lack of correlation with other items)		
Source: Created by authors		

Table A1.
Summary of
questionnaire items
measuring the
severity of cyclones
questioning extreme
climatic events and
change

Corresponding author

Shahed Mustafa can be contacted at: s.mustafa@uos.ac.uk

For instructions on how to order reprints of this article, please visit our website:

www.emeraldgrouppublishing.com/licensing/reprints.htm

Or contact us for further details: permissions@emeraldinsight.com