Disaster-induced migration types and patterns, drivers, and impact: A union-level study in Bangladesh

Chumky, Tahmina; Basu, Mrittika; Onitsuka, Kenichiro; Parvin, Gulsan Ara; Hoshino, Satoshi

World Development Sustainability 1 (2022) 100013

Contents lists available at ScienceDirect

World Development Sustainability

journal homepage: www.elsevier.com/locate/wds

Disaster-induced migration types and patterns, drivers, and impact: A union-level study in Bangladesh

Tahmina Chumky*, Mrittika Basu, Kenichiro Onitsuka, Gulsan Ara Parvin, Satoshi Hoshino

Graduate School of Global Environmental Studies, Kyoto University, Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan

ARTICLE INFO

Keywords:
Disaster-induced migration
Migration pattern
Auxiliary drivers
Qualitative analysis
Slow-onset disasters
Bangladesh

ABSTRACT

Environmental shocks like disasters are reported to induce migration in different parts of the world. Bangladesh has been witnessing migration across the years, but the underlying mechanism of disaster-induced migration needs to be explored and understood with changing climate conditions. The main objective of this study is to evaluate disaster-induced migration types and patterns, the auxiliary drivers and the perceived impact of migration. A semi-structured questionnaire survey was carried out with 155 Union-level key persons from five districts of Bangladesh, and collected qualitative data were thematically analyzed using NVivo. Irrespective of the type of disaster, the major spatial-temporal pattern of migration was perceived to be temporary domestic migration from rural to urban areas. Comparing the auxiliary drivers of migration revealed some common economic drivers. The comparison diagram also identifies several other drivers which are disaster-specific. For e.g., social, demographic, and physical drivers are perceived to drive migration in cyclone-affected areas, while environmental drivers (land degradation, scarcity of safe drinking water, changes in soil condition, etc.) are the primary drivers behind migration in saline-affected areas. Regarding impacts, though household economic status is perceived to get better post-migration, loss of traditions and cultural value, loss of social ties, and loss of security are identified as some of the negative impacts of disaster-induced migration. The current study emphasizes that a migration policy as an umbrella policy may mask the local challenges and community requirements and argues for the need of a disaster-specific migration policy that addresses disaster-induced challenges encountered by local communities.

1. Introduction

Natural catastrophes are becoming more frequent and intense around the world as the climate changes [1,2]. Worldwide, these frequent and severe natural disasters are pushing people to migrate to safer places and to have better livelihoods [3]. In 2019, 4.1 billion people were at risk of being affected by natural disasters around the world. In the same year, storms and floods caused a worldwide loss of 59.3 and 36.8 billion USD, respectively [4]. According to the International Disaster Database, floods and storms can influence large regions of land, potentially affecting between 2.9 and 1.9 billion people worldwide [5]. Furthermore, IPCC's special report, published in 2018, warns that the duration, frequency, and intensity of extreme weather events will rise as a result of climate change, and millions of people will be subjected to their effects [6].

Natural disasters and the accompanying forced migration are already discussed in the Intergovernmental Panel on Climate Change assessment report [7]. Approximately 24 million people have fled because of floods, starvation, and other environmental degradation processes, according to the [8] United Nations High Commissioner for Refugees [9]. This trend keeps accelerating to unprecedented heights. According to Norman Myers [10], there were over 40 million migrants in the world by 2010, owing to environmental and climatic factors, and this number is expected to rise to 200 million by 2050 [10]. However, estimates by Myers [10] have been questioned as 'guesswork' due to the methodology's underlying assumptions [11–13]. However, it is well-reported that migration due to disasters are happening, posing threat to the lives and livelihoods of vulnerable communities.

Human migration is a common adaptation method used to cope with various natural disasters both in developing and developed countries [14–16]. In the event of a natural disaster, temporary or permanent migration is always one of the most critical survival measures [15,17–20] and this type of migration has increased in recent decades in climate-vulnerable developing countries [15,21]. Environmental migration is becoming a more essential option for adaptation and vulnerability reduction, according to the International Organization for Migration (IOM) and the Asian Development Bank [22].

Even if there is a greater degree of voluntariness, merely desiring to relocate does not guarantee that a person is capable of doing so (Black et al., [18]). Migration is not a strategic choice always; rather, it is one of several viable responses to climatic and environmental change, and

* Corresponding author.
E-mail address: chumuki.tamina.52n@st.kyoto-u.ac.jp (T. Chumky).

https://doi.org/10.1016/j.wds.2022.100013
Received 26 January 2022; Received in revised form 20 May 2022; Accepted 22 May 2022

it is frequently the last option [23]. Human migration is quite a complicated decision influenced by the social, economic, demographic, and ecological factors of the environment in which a person lives [24,25]. Individuals' or households' objectives and capacity to cope with climate shocks also influence this decision [26]. Rural to urban migration is influenced by a combination of social and environmental factors and risks, with future economic and educational opportunities frequently playing a dominant role [27–29]. Recent studies claim that environmental changes influence people's migration that has complex temporal and spatial aspects [30] and migration drivers vary depending on the nature and intensity of disasters. A recent study conducted by [3] noticed that migration intention is significantly influenced by drivers like age, ecosystem livelihood, and migration network. Similarly, other studies too identified different drivers that influence migration due to disaster or other environmental challenges [31–33].

Migration outcomes are also different in the case of slow onset and rapid shocks [34]. An increasing body of literature investigates and records the spatial, or geographical, components of human mobility [35], where only a few studies have looked into its temporal dimensions, including long-term and short-term migratory trends [36]. Moreover, the migration paradigm and variation of migration drivers associated with different disasters are not adequately addressed, which is a major challenge now [37]. Further, how migration drivers vary between slow-onset and rapid-onset disasters is yet to be explored.

Therefore, this study aims to explore disaster specific migration patterns and associated drivers, in one of the most disaster-prone developing countries in the world, i.e., Bangladesh. Comparative analysis among different disaster-driven migration drivers will facilitate disaster-specific policy formulation and management of migration challenges, thereby facilitating upliftment of the disaster-affected communities. The current research will enrich the very limited literature globally on the comparison of auxiliary drivers (between and among different disasters) that are responsible for disaster-induced migration.

2. Theoretical framing of the research

Environmental and climatic factors have a significant impact on migratory flows [38]. Further, migration decisions are influenced by risk perception and the availability or scarcity of economic opportunities [3]. People have historically moved in search of better living conditions for themselves as well as their families, or to escape perilous conditions in their own territories [39]. These two fundamental forces formed the basis of Lee's "push and pull" theory, proposed in 1966, which covered economic, environmental, social, and political [40].

According to the neoclassical theory of migration, costs and benefits (mainly wages) of existing and potential alternative locations are the determining issues of an individual's migration decision [41]. This neoclassical viewpoint is modified by the New Economics of Labor Migration (NELM) theory by incorporating risk and self-insurance mechanisms [42]. This risk and self-insurance mechanism can be explained by Kaczan and Orgill-Meyer [34], who argue that the impact of weather shocks on migration is shaped by the vulnerability and capabilities of households [34]. In this case, credit, income, and the presence of social networks have a beneficial impact on migration capabilities while simultaneously reducing vulnerability.

Previous research has shown, for example, by Adger et al. [3], that few households consider environmental degradation as the key driver of past migration decisions, and the majority of households consider the key drivers of migration decisions are sociodemographic and socioeconomic motivations [3]. It has been reported that there are numerous drivers of migration, and climatic events are just one of these [43–47]. As individual migration intentions and patterns are influenced by a range of multiple factors, and the impact of the environment is therefore highly dependent on the economic, political, social, and demographic context, it is very difficult to find individuals who migrate solely for climatic reasons [27,47,48]. So, when deciding if people from low-income countries can move because of climate-related disasters, other factors must be taken into account.

It has also been found from previous studies that there is a clear distinction between slow-onset and rapid-onset disasters that cause communities to migrate rather than stay behind [34,48]. Various types of climatic events (slow and rapid) contribute to migration in many ways as they have identifiable threshold points [25,34,48–50]. In previous research, the most prevalent migration outcomes of slow-onset events are voluntary migration (both temporary and permanent) and immobility, whereas short-term involuntary migration for short-distance is the most common migration outcome of sudden-onset events [48]; and slow-onset weather changes are more likely to cause migration than sudden onset [34]. Some slow-onset environmental phenomena, such as drought, have been shown in the literature to have the opposite impact, resulting in a decline in migration [48], and slow-onset events can also erode the migration ability of people, or they may prefer to stay [51].

There is a more fragile link found between migration intentions and sudden-onset disasters, when the changes are unanticipated and typically considerable, and there is no way to plan for the future. Slow-onset change, on the other hand, is difficult to detect, gradual, and takes time to develop, so the repercussions are not felt immediately [52,53]. This gradual and creeping changes in nature can increase vulnerability of those who stay put [51,54–58].

In the event of a disaster or a climate hazard, there are those who choose to migrate and have the resources to do so; those who are unwilling to migrate due to place attachments already mentioned or who use other adaptation strategies to survive; and those who want to migrate but cannot do so due to a lack of resources, referred to as the "trapped population" [19,59–61]. In a multi-country research on migration and water availability, Warner and Afifi [62] identified immobile people and described such households as those "that do not possess the assets essential to migrate, even to cope with food poverty, or who cannot access migration choices" [62]. Environmental risk affects some groups, but they lack the ability to migrate away from deteriorating conditions. The research referred to such groups as "trapped," highlighting a double vulnerability: the poorest people tend to live in the most environmentally hazardous areas, such as flood plains and steep hill slopes, while also having the fewest resources to shift away from that risk [43,55]. There is also growing literature on how emotional attachments to locations that encapsulate the meanings, values, and feelings connected with a location [63,64], and culture, history, a strong sense of belonging, and social capital strengthening can all impact the desire to stay [65–67]. In other words, in the face of rising climatic hazards, people have exhibited place attachments that make them more likely to stay rather than relocate [63,68]. The drivers of non-migration may be more associated with place attachment and social and community relationships than with economic possibilities and environmental pressures [63,69].

3. Methodology

3.1. Study area

Bangladesh is divided into seven major administrative regions called divisions. Each division is divided into several districts (Zilas), with 64 districts in total. In a district, there are several subdistricts, and under a subdistrict, there are several Unions. Unions are the lowest administrative unit in rural Bangladesh, chaired by Union Parishad Chairman, selected by the local community through a democratic system. The present study was conducted at the Union level of five districts of Bangladesh - two districts (Satkhira, Khulna) from Southwest Bangladesh and three districts (Rajshahi, Chapainawabganj, and Naogaon) from Northwest Bangladesh (Fig. 1).

The three districts, Rajshahi, Chapainawabganj and Naogaon, from Northwest Bangladesh are part of a distinct physiographic unit consisting of a succession of vast blocks of terraced highlands (known as Barind) between the lowland floodplains of two main rivers, Padma and

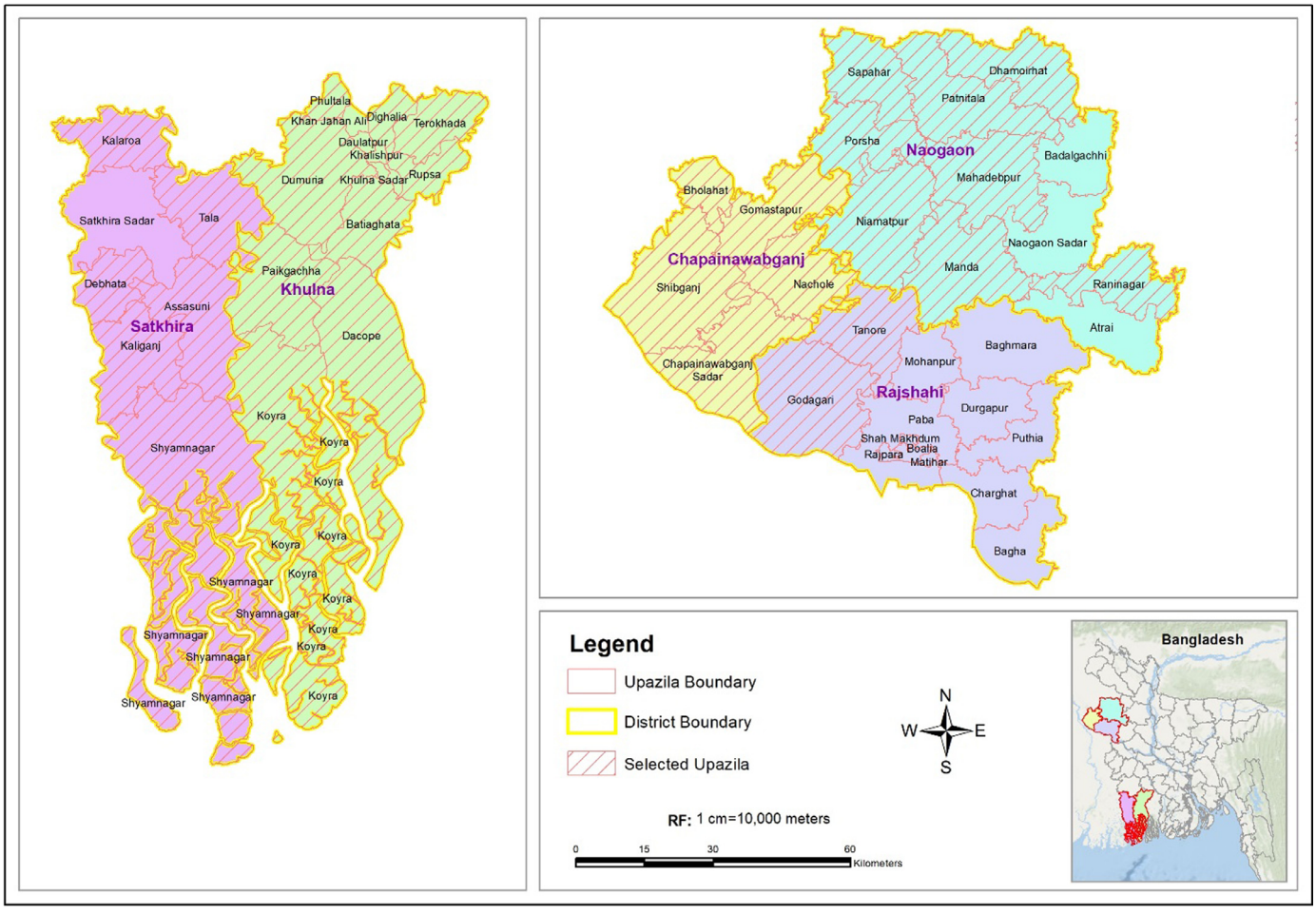

Fig. 1. Study area map using ArcGIS version 10.7.1. The map was prepared with the help of district shapefile data collected from the Local Government and Engineering (LGED) Department.

Jamuna rivers [70]. In the summer average temperature of the region runs from 25 to 35 ˚C; however, the highest temperature may reach to 45 ˚C [71]. As mentioned in previous study, this area witnesses an internal migration of almost 25,000 people due to riverbank erosion [70]. Hence, these three districts were selected to represent areas highly vulnerable to drought and riverbank erosion [71].

Bangladesh is one of the world's most climate-sensitive countries with the coastal strip being country's most climatically fragile region [72]. The coastal area is vulnerable to frequent cyclones, salinity intrusion, flash flooding caused by tidal surges [73] and these disasters have severe impacts on the livelihood and lifestyle of vulnerable communities [74]. Two districts from southwest Bangladesh, Khulna and Satkhira, that encounter frequent storm surges, cyclones, and increased soil and water salinization, were selected for the present study Ahmed and Suphachalasai [75,76]. Furthermore, among the five districts the number of sub-districts were 41, but we have purposively chosen 30 sub-districts for data collection after detailed literature review and discussion with the Upazila Agriculture Officers of the concerned areas because of the extent of natural disasters occurrence and rate of migration in these sub-districts. The total number of sub-districts and the Unions in the selected sub-districts are mentioned in Table 1.

3.2. Survey design and data collection

The required data for the present study were collected through telephonic interviews with Union level key informants using semi structured questionnaire. In the pre-testing phase, a random sampling technique was used for the questionnaire interview. However, it was difficult to convince the respondents across different areas to participate in the interviews. Therefore, a non-probabilistic sampling technique, i.e., the snowball sampling technique was adopted to select the respondents during final data collection. The total number of unions in Bangladesh is 269. The total number of samples for the survey was calculated by a survey system calculator (https://surveysystem.com/sscalc.htm) where the confidence interval level was 95% and the sample expected sample size was 158. A total of 193 calls to key informants were made from which 155 key informants agreed to participate in the interview. Therefore, a total of 155 unions from the abovementioned five districts and thirty sub-districts were included in the current study (Table 1). The number of unions per sub-district is also given in Table 1. The data were collected over one month from 1st October to 31st October 2020. Key informants like Union Parishad Chairman, Primarily, the Union Parishad Chairman was approached to participate in the survey. Upon his /her unavailability or inability to participate, members of the Union Parishad including female members, and the Union Parishad secretary were approached (Table 1). The Union Parishad Chairman and Union members as well as Union officials like Union Parishad secretary are closely connected with village communities and are responsible for all necessary development in each union and the villages under it. The interviews were conducted in the local language (Bengali), and the data were recorded using a digital audio recorder and later translated into English by the researcher. On average, each interview took 20 to 30 min.

The semi-structured questionnaire was designed as per the objectives of the study. After the basic information of the respondents, the

Table 1
Interview participants and sample size distribution.

Districts	Total SD (SSD)	No. of Unions in SSD	SSD (no. of data collected Unions)	Samples (Union)	Respondents' designation
Khulna	9 (9)	68	Rupsa (6), Phultala (4), Batiaghata (7), Koyra (7), Dacope (7), Paikgacha (8), Dumuria (4), Terokhada (1), Dighalia (6)	50	UP member (29), UP Chairman (6), UP Secretary (15)
Satkhira	7 (6)	65	Tala (2), Debhata (5), Kalaroa (2), Shyamnagar (13), Kaliganj (9), Ashashuni (5)	36	UP member (28). UP Secretary (8)
Chapainawabganj	5 (5)	49	Chapinawabganj Sadar (4), Shibganj (5), Gomastapur (2), Bholahat (4), Nachole (5)	20	UP member (13), UP Secretary (7)
Rajshahi	9 (2)	16	Tanore (6), Godagari (6)	12	UP member (9), UP Secretary (3)
Naogaon	11 (8)	71	Manda (2), Mohadevpur (5), Dhamoirhat (3), Patnitala (5), Porsha (5), Sapahar (6), Raninagar (5), Niamatpur (6)	37	UP member (30), UP Secretary (5), UP chairman (2)

Note: SD: Sub-districts, SSD: Selected sub-districts.

questionnaire was comprised of mainly four parts. The first part was related to the basic questions of disasters (ranking of disasters based on occurrence and severity) and disaster-induced migration (which disasters are mainly responsible for migration), migration types (permanent/ temporal or seasonal migration) and patterns (domestic or international migration, rural to urban/ rural to rural/ urban to rural/ urban to urban) in the study area. The second part of the interview schedule was involved with the questions related to auxiliary drivers that leads to migration in the study area. In the third part of the questionnaire, the impacts of migration were asked. Finally, in the fourth part of the questionnaire, questions related to the programs or policy interventions in the union to address migrated households/ tackle outmigration/ supports to the left behind family were asked to the respondents. Lastly, the gentle approaches were made to know the suggestions regarding the most suitable respondent for our research where we could collect further data which was basically a part of snowball sampling.

For questions related to the auxiliary drivers of migration, we have adopted the framework for drivers of migration given by Black et al. [19]. According to Black et al. [19], the conceptual framework elaborated five types of drivers which were responsible for the migration. Those are economic, social, political or institutional, demographic, and environmental drivers. However, based on our research context and the characteristics of the study area, we have adopted the framework of Black et al. [19] with a slight modification. The new included drivers were agricultural and physical drivers, which were analyzed in several existing studies [77,78].

3.3. Data analysis

Simple descriptive analysis was carried out to evaluate the data, and different visualization aids like Rawgraph© and MS Excel were used to present the results. For the qualitative data from semi-structured interviews, transcribed notes and descriptors were imported into NVivo 12, a qualitative data analysis software. Firstly, each interview transcript was read while listening to the corresponding digital recording simultaneously. While doing so, the first stage of coding for the auxiliary driver of disaster-induced migration was identified by assigning a 'node'. Secondly, the data identified in each 'node' was further coded into subcategories, known as the process of 'coding-on'. Coding was used to understand the emphasis and dominance of issues raised by participants. This strategy of open and axial coding was suggested by Strauss and Corbin [79] and used in several qualitative studies [80]. Codes and nodes for all interview transcripts were kept the same. To assess the similarities and differences between auxiliary drivers that influence migration, primarily induced by different disasters, comparison diagrams are developed using the nodes. The results are described here, with selected and illustrative narrations to express the respondents' perceptions.

4. Results and discussion

4.1. Migrants, migration patterns, migration types and main disasters responsible for migration

The most dominating disaster responsible for outmigration in the study area is found is cyclone. Out of the 155 key informants who participated in the survey, nearly 28.96% pointed out cyclones as one of the most severe disasters that induce migration. Cyclone is a rapid-onset disaster, and the damage and impact are reported to be very high compared to other disasters. Haque and Jahan [81] found that, in Bangladesh, the frequency of cyclones has grown more than fivefold over the last three decades, and the mortality is very high [81]. For example, cyclone Sidr slammed the coast in November 2007, killing over 4000 people [82], while cyclone Aila hit the coast on May 25, 2009, affecting millions of people and causing half a million to flee their homes [83].

Salinity is also identified as one of the major disasters that induce migration, as responded to by 16.46% of survey participants. Seawater intrusion and water logging increase the level of soil and water salinity, which have a major detrimental impact on agriculture [84] and lead to food insecurity, ultimately forcing people to choose migration as an adaptation measure [85]. Salinity also increases manifold after any cyclone or storm surge when the sea water enters the land and in the agricultural fields. Sarkar and Vogt [86] found millions of people in Bangladesh's coastal areas are afflicted by salinity in their drinking water. Many coastal residents face being uprooted from traditional livelihood possibilities and being displaced to surrounding urban centers daily.

Floods reoccur every three years in Bangladesh for the past twenty years, and the affected people often decide to migrate due to the prevailing flood risk in the affected areas [87]. Nearly 19.51% of this survey's respondents have mentioned flooding as an important disaster influencing migration decisions. Rayhan [88] conducted a cross-sectional household survey two weeks after a flood in four districts of Bangladesh in 2005 to determine the efficacy of migration (whether migration mitigates the vulnerability of the affected households) and found that, one-fourth of the households had at least one person who had moved permanently due to flood in rural Bangladesh. The study reported that four out of five households have members who have left their homes due to unemployment because of the area's recurring floods, and the majority of them have relocated to cities.

Drought causes agricultural production loss, and it creates livelihood threats for those who are directly dependent on agriculture [89]. From the present study, 19.51% (similar percentage of response to flood) of the participants responded that drought induces human migration in their area, mainly from the unions of Chanduria, Kamargaon, Badhair, Pachondor, Talondo, and Pakri in the district of Rajshahi and Paril, Rosulpur, Bahadurpur, Goala, Tilna, Jahanpur, Agradigun Unions of the

district of Naogaon and Nachole, Radhanagar, and Gobratala Unions of the Chapainawabganj district of North West Bangladesh. Islam etal. [90] conducted a study in Northern Bangladesh to investigate the social and agro-ecological impacts of drought, as well as local perceptions in the research area and found that; during the 1994 severe drought, over 84% of drought victims migrated from drought-prone areas in search of better livelihoods; and in the 2006 drought, around 59% of drought victims left the area [90]. Gray and Mueller [91] reported an increase in employment migration of men in the Ethiopian highlands during severe droughts, especially men from landless households [91].

Riverbank erosion is also reported to be a migration-inducing disaster in Bangladesh [92], especially in the districts of northern Bangladesh due to the disruption of human activities and settlement. Among the survey respondents of the present study, nearly 15.548% mentioned that riverbank erosion is a major cause of people's migration. Hutton and Haque [93] discovered that more than 40% of their study participants had relocated at least three to four times, 36% had moved five to ten times, and 14% had been displaced at least ten times due to riverbank erosion in the Sirajganj and Shariakandi districts of Bangladesh. Only a few people claimed to have been displaced once or twice (5% and 8%).

Of the 155 interviewees in the current study, nearly 71% of respondents mentioned that males are the main migrants after a natural disaster, whereas 10% of respondents mentioned whole household migration, and 19% of respondents mentioned husband and wife migration, leaving their children with relatives in their place of origin. Chumky et al. [94] also found a similar finding from a systematic literature review of the last 3 decades of published articles that men are the main migrants due to naturally occurring disastrous events [94]. There is no evidence of only female outmigration due to disaster (after a disaster, women migrate in company with other family members), which can be attributed to the fact that the social structure is primarily dominated by males in Bangladesh. Call et al. [95] also reported a similar finding that although temporary migration is mediated by wealth and gender, vulnerable groups such as women and the poor are not likely to move because of environmental extremes. If women want to migrate or need to migrate, they accompany other members of the family. In our current study, whole household migration is reported mostly in cases of severe rapid-onset disaster occurrences, after cyclone, riverbank erosion, and severe floods, whole household migration is highlighted by the respondents, and this type of migration is commonly associated with physical damage to infrastructure.

In terms of the spatial pattern of migration, the major spatial pattern of migration is domestic, while 24 out of 155 of the respondents mentioned international migration. It is commonly stated that most environmental migration occurs within national borders [25]. It has been found from a literature review that only internal migration was addressed in 64% of the studies; while international migration was addressed in 19% and both international and domestic migration were addressed in 17% of the studies due to slow onset disaster (Zickgraf, 2019 [69]). One reason for less international migration might be that people need more capital to migrate internationally which is not affordable for all [43,96]. Another reason for choosing internal migration is that people's attachment to their current location may prevent them from wishing to relocate to another country [63].

Almost half of the international migration found in this study is associated with cyclonic events, and no international migration is evident due to drought . This might be due to the nature of disasters, as drought is a slow-onset event and the migration associated with drought is circular in nature, so migrants already have some decided destination. Joarder and Miller in a study of Bangladesh found that, households who already had lost property or been economically insecure as a result of an environmental disaster were much more likely to move permanently, whereas those that lost cattle or crops were more inclined to migrate temporarily [97]. In some of our study areas like Atalia, Sutarkhali, Banishanta, Kamarkhola, Jalma Union of Khulna district and Kulla, Budhata, and Kadakati Union from Satkhira districts, the key informants claimed that both domestic and international migration occurs. As these unions are located near the border, and the chances of getting a job there are higher and the daily wage is more than in the country, people choose to migrate to India more than to migrate internally.

Fig. 2 illustrates the spatial and temporal variation of migration in response to different disasters. Temporary and permanent migration has always been one of the most essential survival tactics used by humanity in the face of adversity of disasters [98]. In a descriptive approach, respondents were asked about the temporality of migration. Majority (115 out of 155) interview participants mentioned, people tend to migrate for a short period of time during an agricultural lean period or crop loss occur due to disaster, where ten interviewees have indicated disaster-induced permanent migration and the rest have mentioned both temporary and permanent migration. Permanent migration is often observed after some severe sudden onset disasters in the study area. Temporal trends vary depending on local settings and infrastructure, even within countries [69]. Chumky et al. [94] also found from the literature over the last 30 years thatmigration induced by natural disasters is mostly temporary, internal, and voluntary around the world Chumky et al., [94]. Similar findings were obtained by Islam and Shamsuddoha [99] where researchers found that dense fog, unpredictable and excessive rainfall, storms, and tidal flooding caused temporary migration, whereas tropical cyclones, saline water intrusion, and river erosion caused permanent migration. Droughts in Naogaon district and salinity in Khulna district caused many to opt for routine economic movement during lean periods to find work in other parts of the country [99].

(Note: The alluvial and diagram is developed using RAWGraphs 2.0 beta [100].

In the present study, 79.57% of the migration pattern is from rural to urban areas, as job opportunities are higher in urban areas than in rural areas. Rural to rural migration (19.82%) is also found, and half of this rural to rural migration is due to floods and riverbank erosion as people do not want to go far from the origin. Very few (0.61%) but urban to rural migration was also found in the study area, which is mentioned in response to the cyclone disaster. Baez et al. studied the influence of droughts and hurricanes on internal mobility in eight countries in northern Latin America and the Caribbean by combining individual-level data from censuses with natural disaster indicators. When faced with drought, it discovered that younger people preferred traveling short distances by shifting to surrounding rural and small towns, probably due to local off-farm employment prospects and reduced moving costs [101]. Drought and land degradation caused rural-to-rural migration away from southern Zambia, according to Makondo and Thomas [102].

4.2. *Auxiliary drivers of migration*

Extreme weather events cause migration both indirectly and directly by exacerbating a variety of circumstances such as job loss or increased debt [103]. Loss of livelihood is identified as one of the main drivers of migration after an extreme event like drought, flood or riverbank erosion as access to the common resources (fisheries, forests, riverbank cultivation) on which poor rural people rely is likely to decline and they become unemployed [97]. In addition, insufficient social services, lack of housing and social insecurity, the possibility of more catastrophes, lack of post-disaster support from the government, a lack of livelihood support and public services in the disaster affected areas contribute to human migration. On the other side, elements such as jobs, income, and housing amenities as well as greater livelihood options at the destination attract people to migrate [20,50,99,104–106].

In the present study, NVivo software was used to draw the comparison diagram of the auxiliary drivers of migration induced by different natural hazards in the study areas. To understand the differences in auxiliary drivers, if any, based on different disaster types, the transcripts of study areas facing a single disaster are used for the comparison diagram.

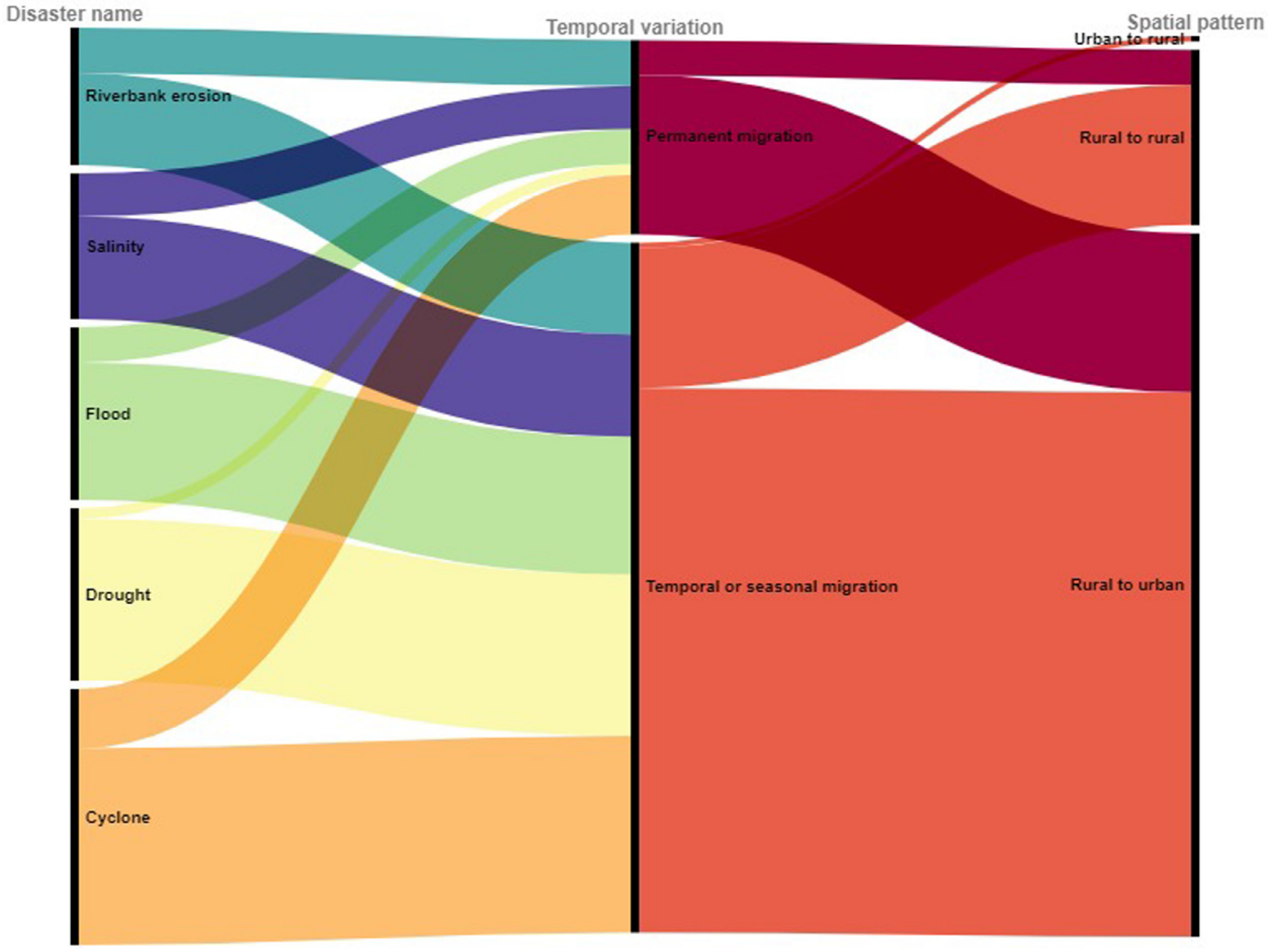

Fig. 2. Disaster types and their effect on temporal variation and spatial pattern of migration.

For study areas experiencing multiple disasters, the auxiliary drivers are discussed separately.

4.2.1. Comparison between auxiliary drivers of slow onset disasters

Auxiliary drivers of disaster induced migration for the present study have been divided into seven main categories, such as economic, agricultural, social, demographic, institutional, environmental, and physical drivers; and sub-categories under these seven drivers are as follows: Economic drivers (no work opportunity, low income, off farm work opportunity, debt, higher chances of future growth); agricultural drivers (loss of land, loss of crop productivity, changed soil/land condition, lack of irrigation facility, loss in livestock, fishery and forestry); social drivers (social discrimination, loss of social network, access to migration network, lack of services like education and health); demographic drivers (family size, age, gender, education level, vocational education, skill level); institutional drivers (resettlement, no subsidy, no post disaster recovery measures, no disaster risk reduction measures); environmental drivers (water scarcity, changed weather pattern, water logging, land or soil degradation); physical drivers (damage to houses, damage to schools, damage to roads, damage to essential infrastructure like dams). The auxiliary drivers for migration perceived by the respondents due to different disasters are shown in Appendix-A. The northwest districts such as Naogaon, Rajshahi & Chapainawabganj encounter drought and riverbank erosion at regular intervals [70]. In the current study, a few unions of southern districts (Khulna and Satkhira) also found as riverbank erosion affected areas. Out of 155, respondents from 36 unions reported that they only encounter drought, while respondents from 15 unions mentioned that riverbank erosion is the sole natural calamity in their area.

Fig. 3 shows the comparison diagram of auxiliary drivers between drought and riverbank erosion. Auxiliary drivers like loss of crop productivity, lower or no work opportunity, off-farm work opportunity in the destination, increased debt, and no subsidies to recover from the impacts of the disasters are linked to migration due to both the slow onset disasters. Apart from these common auxiliary drivers, respondents from both the disaster-affected unions identified other drivers that induce disaster-induced migration. For example, destruction of physical infrastructure like houses, dams, and loss of agricultural land is perceived to lead to migration by the respondents in areas affected by riverbank erosion. Riverbank erosion causes physical damage in both low flow and high flow periods, but the extent increases manifold during the monsoon. Riverbank erosion is a serious natural disaster in some Indian states, and it is a cause of forced migration since it causes a variety of socioeconomic problems and poverty Das et al. [107]. Respondents from, for e.g., Burigoalini, Bishnupur, Protapnagar Union of Satkhira district and Uttar Bedkashi, Sutarkhali, Tildanga, Shorafpur Union from Khulna district and Alatuli, Pucca, Sundorpur Union of Chapainawabganj district and Ashariadaho Union of Rajshahi district mentioned that physical damage caused by riverbank erosion and lack of resettlement

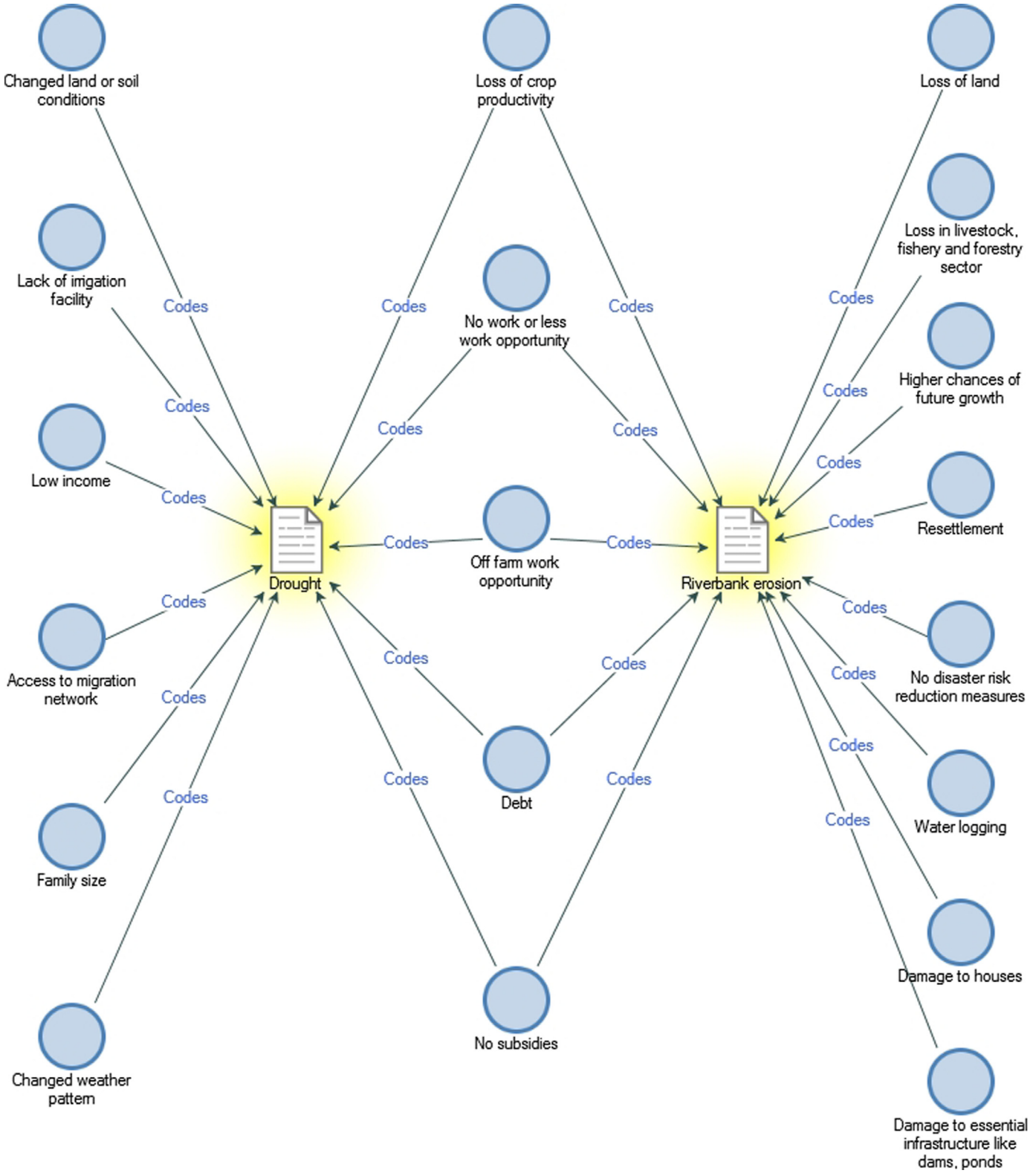

Fig. 3. Comparison diagram of disaster specific auxiliary drivers of migration (Drought and Riverbank erosion).

facility influence their migration decision. The Union Parishad secretary of Padmapukur Union in Satkhira district pointed out,

> "Riverbank erosion caused by heavy tidal flow breaks dams of our union. People of this area are hard-working. Every time they work together to prevent erosion with locally available materials like sand-bags, but this does not work that much. There is no well-constructed road in our area as it was broken a few years back due to river erosion, no repair been made till now. Our area people do not want government relief or financial support after river erosion; they want a sustainable dam to protect their physical assets from erosion.

Every year, many families move permanently to the nearby villages and Sadar Upazila after losing their houses due to river erosion".

M.R. Rahman conducted a study in 2010 at Jamuna riverbank, a place vulnerable to riverbank erosion on a regular basis and found that riverbank erosion causes land loss which is accompanied by infrastructure loss, including flood embankments, schools, hospitals, cultural and religious monuments, and, of course, agricultural lands and assets [108]. Dekaraja and Mahanta [109] conducted a study in Assam, India and found that in the years 2003, 2004, and 2014, a vast area of land was eroded, resulting in the displacement of many villages and families. They also found that, riverbank erosion has cost the victims their property and cropland, as well as their ability to survive in the damaged areas [109].

In case of drought, lack of irrigation facility, changing land and soil properties, changed weather pattern, family size, access to migration network in the destination etc. are perceived to drive migration. For instance, large families require more money and resources to continue their daily lives than smaller families. Drought, being a slow onset disaster, provides time for planned migration and male members of the large families often temporarily migrate during agricultural off-season. One of the key informants from the drought affected Union of Rajshahi district mentioned,

"Unavailability of job during off agricultural season and opportunity for off-farm work in big cities are main causes of migration. Most people migrate for a short period, usually for 2 to 3 months, and again in cropping season, they return home. Not many but few people do not return for many years as if they have debts to different NGOs".

Another key informant from the drought affected Union of Chapainawabganj district mentioned,

"In our Union, acute drought occurs every year; even in the rainy season, no rainfall occurs. Many farmlands are now abandoned, and now we are motivating farmers to cultivate less water-required crops. Moreover, due to climate change, hailstorm, Nor'wester occurrences has increased, and these events cause severe crop damages, which ultimately leads to income loss. Farmers and agricultural labors sometimes change their occupations and work as rickshaw pullers or join the garment industry for higher income; many of these people go to Sadar Upazila or sometimes migrate to big cities such as Rajshahi, Dhaka".

Raihan et al. [110] also found thatextreme weather events such as hailstorms, nor 'westers and thunderstorms have increased significantly in the northern part of Bangladesh. Rajshahi and Chapainawabganj are in the northwest part of Bangladesh where the occurrences as well as severity have drastically increased due to climate change. Sudden crop damage in the dry season (pre-monsoon season) is becoming a common phenomenon almost every year, which makes the farmers vulnerable to poverty because of having no explicit policy to compensate them by the government after the hazard occurrence [110]. Previous findings also proved that with a decrease in income from agriculture, small-holder and marginal farmers having lower level of adaptive capacity to deal with the extreme weather conditions like hailstorms, farmers choose off-farm activities and or alternative adaptation strategies [111] (Raihan et al., 2022).

Though both drought and riverbank erosion are categorized as slow onset disaster, apart from economic drivers like loss of income and increase debt, other auxiliary drivers of migration are found to be quite different for both the disasters.

A comparison between (Fig. 4) the auxiliary drivers of drought and salinity induced migration showed auxiliary drivers which are typical to the damage caused by salinization like scarcity of safe drinking water, land and soil quality degradation and loss in fishery sector apart from the common drivers like loss of income, crop productivity, increased debt etc. The Southwest districts, Khulna & Satkhira, encounter salinization of water and soil, out of 155 Unions in the present study respondents from 9 Unions identified salinity as the prime reason behind migration. The Union Parishad chairman from Kadakati Union of Satkhira district stated,

"In our area, crop cultivation is rare due to high salt content in water and soil. The main occupation is fish farming. For fish cultivation, less labor is required than other agricultural farming, and people often migrate to the cities searching for works. Due to the high level of salt in water, people either collect rainwater or use pond water for drinking and cooking. That's why waterborne diseases are very high among people of our union. Salinity problem increases after few other disasters such as flood, cyclone, etc. due to prolonged saline water stagnation and situation get worsen and as a result, more people become jobless and migrate to capital city".

With influx of seawater during high tides, storm surges, flooding etc. and the consequent water logging conditions, the salinity level of both soil and water increases [112]. Chen and Mueller [85] in their study reported a large and significant impact of soil salinity on internal migration. As the study highlighted, there has been a shift from crop cultivation to aquaculture due to the suitability and profitability in these saline-affected areas. Chen and Mueller discovered that migration to adjacent countries decreases with short-term adverse weather conditions but increases with soil salinity in Bangladesh [85]. However, practicing shrimp farming requires deliberate retention of saltwater which itself driv.e further salinization of water and soil [113]. Union Parishad member from Senhati Union of Khulna district pointed out,

"Eighty to ninety percent people of our union seasonally migrate to Dhaka, Chittagong and Khulna city in search of a job. The salinity problem is very high in our union, resulting in no agricultural production except shrimp cultivation, where labor requirement is less. Usually, with the help of his family members, the farm owner continues shrimp cultivation, so they do not appoint labors. So, routine economic migration is part of our life".

4.2.2. Comparison between rapid onset disasters

With an aim to know the differences in auxiliary drivers of migration between two rapid onset disasters, we made comparison between cyclone and flood induced migration. For both disasters, several auxiliary drivers are found to lead to migration of which economic drivers are reported to be the major push behind people's migration. In case of flood, loss of land, scarcity of safe drinking water and higher chances of future growth in the destination are important drivers behind migration (Fig. 5).

In flood affected area like Tentulia union of Satkhira and Enayetpur union of Naogaon relatively younger people (age 25–40) are reported to migrate temporarily by the respondents. Scarcity of safe drinking water is very common in Bangladesh in case of flood as all the drinking water sources get inundated [114]. Union Parishad secretary from Uttar Bedkashi Union in Khulna district said that,

"Our union is most badly affected union of cyclone Aila in 2009. Cyclone Aila caused massive destruction of the physical property, and every family of our union suffered after that event. Flood water came along with cyclones that remained for one month, which increased mass miseries. No food, no job at that time, the trauma of such strong events made people helpless. Roads are broken, the scenery of the whole union has changed after cyclone Aila. Water stagnation forced people to remain at home, which increased their economic burden. At that time, many affected people migrated to the city area to continue their daily lives".

Union Parishad member of Gazirhat Union of Khulna district mentioned that,

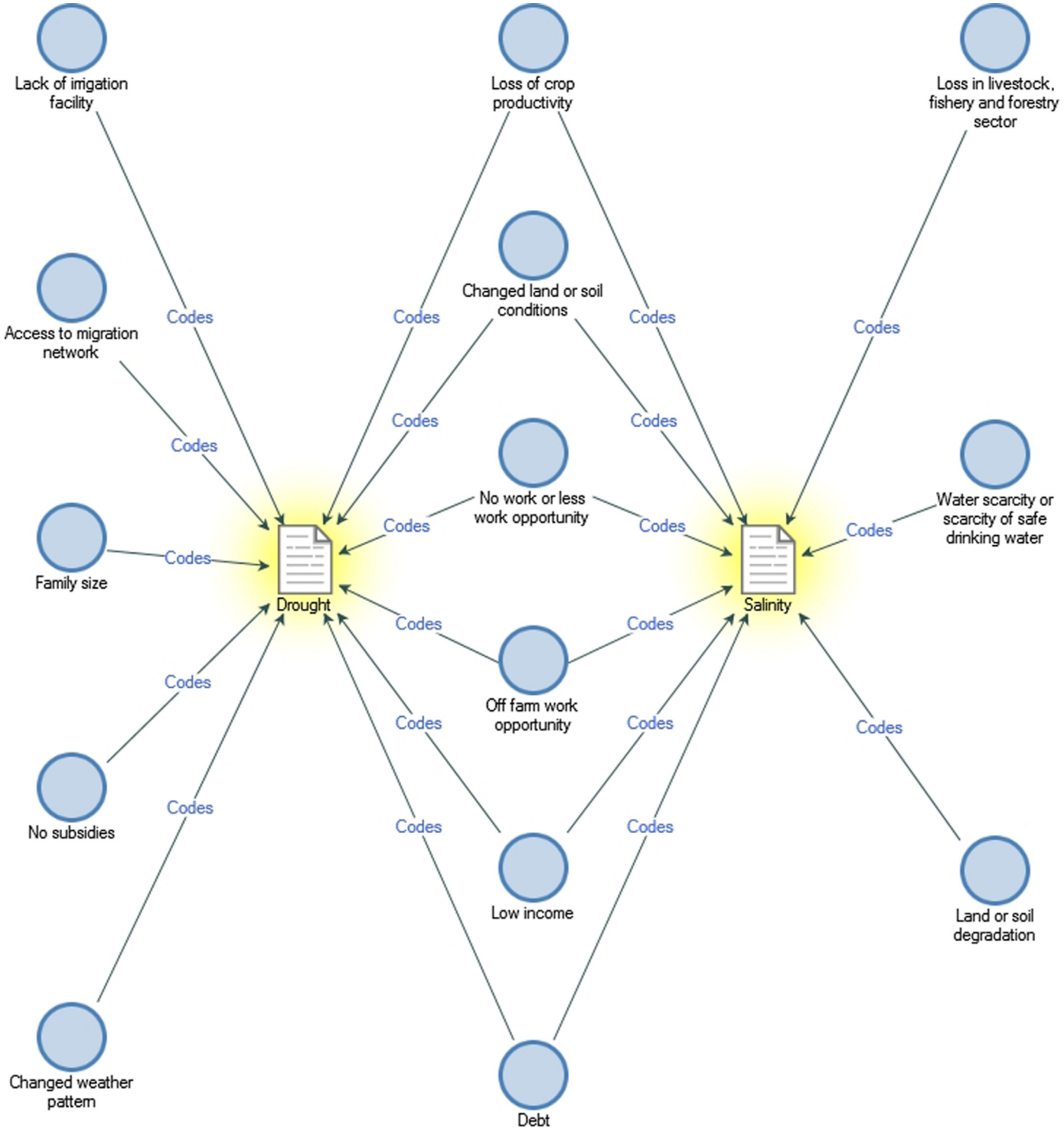

Fig. 4. Comparison diagram of disaster specific auxiliary drivers of migration (Drought and Salinity).

"Crisis of safe drinking water during the flood is a very serious issue as most of the drinking water sources get inundated. Hence people are sometimes migrating to upland areas for temporary basis".

Another impact of the flood is the prolonged stagnation of water in the land that damages soil property and leads to loss of cultivable land, which ultimately leads towards migration. Union Parishad member from Khajur Union in Naogaon district said,

"Half of our union people migrate during or after a flood. Water stagnation during flood hampers people's daily lives and causes standing field crop loss. People cannot do their daily activities smoothly. Low-income group people, especially those who earn daily, are in trouble. Sick people, pregnant women face problems during the flood as they do not get emergency health services due to water stagnation; so, they seek shelter in relatives' houses until the floodwater goes down. Many houses get damaged due to stagnant water, and then they have no other choices than to migrate".

Smith and McCarty [115] in their study in the USA regarding hurricane Andrew reported a similar finding that, "infrastructural damage"

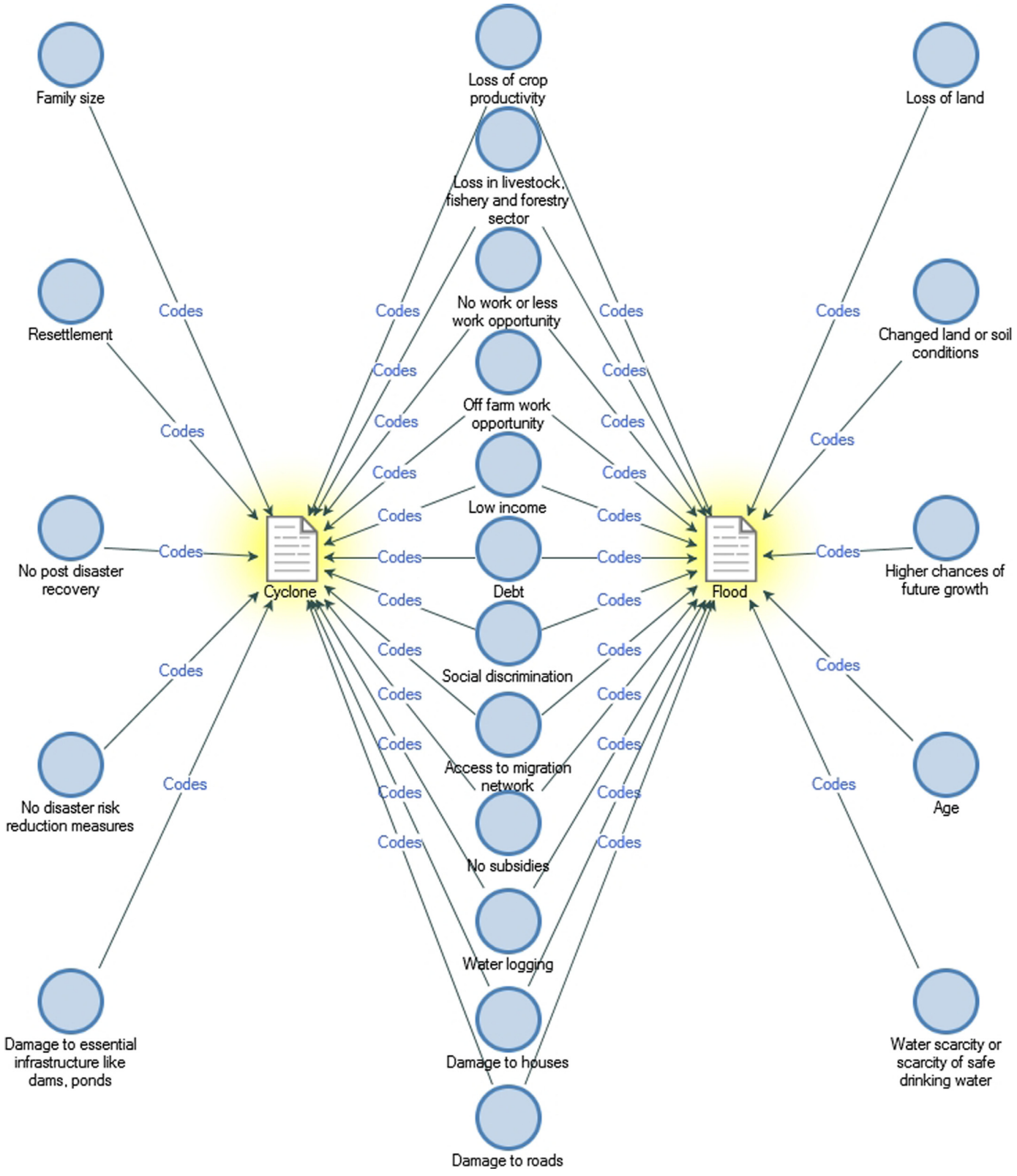

Fig. 5. Comparison diagram of disaster specific auxiliary drivers of migration (Cyclone and Flood).

and "loss of utilities" (such as power, water services etc.) were mentioned by 80 to 90% of survey respondents as the key reasons for first leaving their homes. Amadi [116] conducted a study in Nigeria regarding flood disaster and found that, production of rice, maize, cassava crops decrease due to land quality degradation caused by flooding.

On the contrary in cyclone affected area, apart from the economic drivers and other common drivers, family size, resettlement, no post disaster recovery, no disaster risk reduction measure, damage to essential infrastructure is found to drive migration. Cyclone often comes with tidal surge and cause severe damage to weak infrastructure like

dams which leads to saline water intrusion from the sea into the locality and agricultural field. Cyclone also causes significant physical damage to properties and the interview participants claimed that there is no well-organized DRR measures and no resettlement plan for the affected population which cause mass population migration. Bhurulia, Tarali, Khalilnagar Unions of Satkhira and Bhandercote, Jalma, Bajua, Jogipol, Atalia Unions of Khulna district clearly mentioned how cyclone induced drivers lead to migration. Union Parishad member from Sholadana Union of Khulna district mentioned,

> "Every year 2/3 times cyclone affect our Union, and almost 50% of our union people migrate. Strong or moderate strength cyclone strikes our Union, but there is not enough cyclone center here after the disaster people get government support but not enough compared to the damage. Few non-government organizations come forward, which gives temporary relief, but longer period, there is no support from an authority, but life does not stop after the disaster, right? Those who face more loss due to disaster and whose house is broken need to migrate. Sometimes people choose to migrate permanently as they are tired of experiencing repeated disasters".

In another study on cyclone (typhoon) induced migration in Sanghai province of China reported that, 61.7% of the migrants mentioned damage to critical infrastructure, 82.6% mentioned damage to transportation network affected their life [117].

4.2.3. Comparison between rapid and slow onset disasters

To clearly understand the difference in auxiliary drivers, if any, between rapid and slow onset disasters, we made comparison diagram between cyclone and salinity induced migration (Fig. 6).

For both cyclone and salinity induced migration, economic drivers like agricultural loss, loss of income, increased debt, off-farm work opportunities etc. were found to drive migration. In study areas affected by increased salinity, the respondents pointed out the change in land and soil properties as well as the resulting degradation as one of the main drivers behind migration from these areas, in addition to the lack of safe drinking water. While in the case of study areas frequented by cyclones, social drivers like access to migration networks and social discrimination, physical drivers like damage to houses, roads and essential infrastructures, demographic drivers like household size have significant influence on migration decisions in addition to a lack of post-disaster recovery measures, no disaster risk reduction measures, and no subsidies. Though Unions like Noapara, Khalilnagar, kushulia, and Ratanpur in Satkhira district face both cyclonic events and salinization of soil and water, it is perceived by the respondents that the drivers behind migration decisions are different. The Union Parishad chairman from Kashimari Union in Satkhira district highlighted that,

> "During cyclone Aila and Amphan, dam, school infrastructure, houses, ponds used for fish cultivation all destroyed. Inundation due to cyclones caused physical damage. After the cyclone Amphan comprising electricity and road damage, almost 700 crore BDT loss occurred, but to build a strong dam, we need only 6,7 crore BDT, which we are not getting from government or non-government organizations. 50% of the development work of last five years destroyed due to Amphan. We do not want food as relief, we want strong dam, our union people are hardworking and can work hard to maintain livelihood, but the frequent occurrences of disaster are the main obstacle on their way of growth".

4.3. Impacts of disaster-induced migration

Fig. 7 demonstrates the perceived impacts of disaster-induced migration as responded by the key informants. Irrespective of the types of disaster, migration is perceived to improve the economic status of the household by increasing the household income and decreasing the monetary debts, which enables the household to provide better education to its children as well as improve the overall lifestyle of the household. Migrants of the study area are mostly poor and have no financial backup, so they either borrow money from close relatives or make loan in NGOs or sometime sell small assets for migration. Migration in the study area taking place after disaster when people become jobless, massive crop and property damage occurs. People choose to migrate as alternative strategy of livelihood. Migrants when get good job in destination they send remittances to family living in origin and that's how household income increases and utilizing these remittances family members can repay the debts, they can invest more money on their children's education, they can fulfill daily necessities and their lifestyle improves. On the contrary, Yun and Waldorf [118] found from a study in the United States after Hurricanes Katrina and Rita that people were forced to migrate, and it led to double victimization as their current income was reduced significantly and they were forced to accept less payment at their destination Yun and Waldorf, [118]. Singh and Basu [119] conducted research in India and explored that children's education is being adversely affected by parents' migration as school dropout and left behind children occurrences are very common in the study area (Singh and Basu, 2019).

However, in flood-affected Unions like Aihai, Patichara, Dibor, Paril, Borogacha, Kashimpur of Naogaon district; Shyampur, Ujirpur, Daldali Unions of Chapainawabganj district and Dakshin Bedkashi Union of Khulna district, the key informants perceived those children of the flood migrants' families are not getting better education facility and the reason is multiple and permanent migrations. After severe floods, people first migrate to the nearest villages, but those villages get inundated, then people decide to migrate far. During this multiple-time migration, sometimes children miss an academic year, and their studies get hampered. Union Parishad member from the Aihai Union of Naogaon district, which is frequently affected by flood pointed out,

> "Flood occurs every year in our area and causing crop damage, hampers the work of day labors. Nearly half of the union population migrate at the time of flood as most of our people are very poor. Both husband and wife, a family migrate temporarily, leaving children with grandparents, and many migrated permanently. In our union, job opportunities are less and wages are also less than cities, so those who migrate to cities are definitely earning more than here".

Cyclone affected migrants, sometimes, get good job in the destination and they stay there for longer period of time. Many people change their profession from on farm to off farm as they are tired of continuous fight against disaster. Few migrants can make good savings and after returning to the origin they often buy a small piece of agricultural land or a cow or agricultural tools, thus increasing their household assets. In a cyclone affected Bagali Union of Khulna district, Union Parishad secretary clearly mentioned that,

> "After storms, many people migrate from our union to other union or sometimes to cities, most of them work in the brick factory. Usually, men migrate with their teenage children to contribute to family income. Children's education is badly hampered as most school-going children work as child laborers. In our area, women want to work outside, but there is no suitable job for them. Many people decide to migrate far to get a better job like some of them working in the construction sector in Dhaka city, and many are earning more. Many migrant families can save some money and later repay their debts, and some people can start a small business".

However, respondents also identified decrease in household assets when the migrant fail to get a proper livelihood in the destination like in case of Godaipur Union from Khulna district. The key informant clearly mentioned that,

"Many people of our union sell their things like livestock or jewelry for arranging money they need for migration, but when they cannot manage a good job with sufficient wages then after few days, they return home with empty hands. Migrants sometimes borrow money from rel-

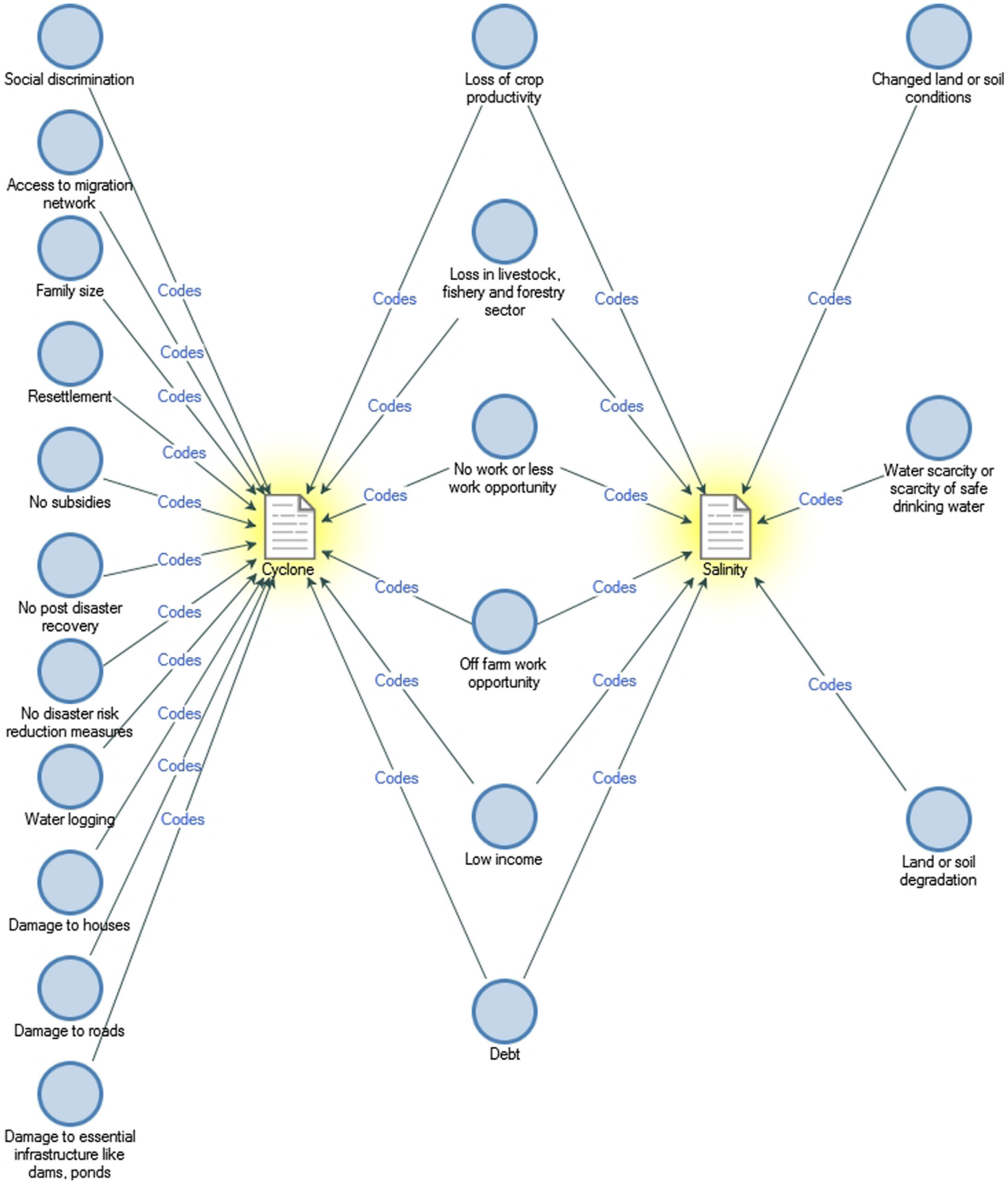

Fig. 6. Comparison diagram of disaster specific auxiliary drivers of migration (Cyclone and Salinity).

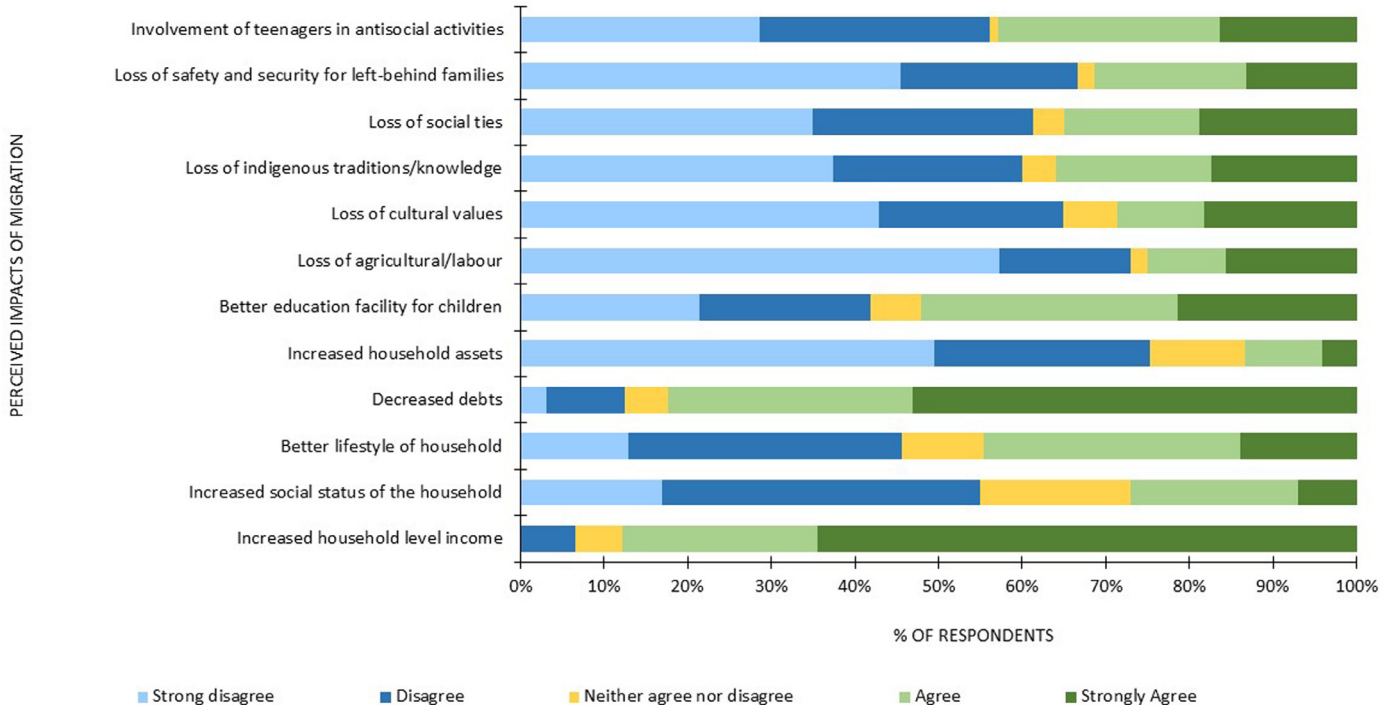

Fig. 7. Impacts of disaster-induced migration as perceived by the respondents.

atives or non-government organizations on interest, making them even poorer. To repay the debts, they need to sell all other assets. Some migrants earn enough to live hand to mouth but no extra savings for the future or to pay their loans".

In case of improvement in lifestyle, more than 29.5% respondents have agreed that with increasing income after migration, the left behind family can afford three times meals, buy necessary daily belongings, and the family can also save some money from the remittance.

Top of Form

Though tangible benefits are clearly perceived by the respondents after disaster-induced migration, the extent of loss of intangible values is yet not clear. Apparently, disaster-induced migration is perceived to have no significant influence on social status of households, irrespective of the types of disaster. Union Parishad member of Magurkhali Union of Khulna district affected by cyclone and flood mentioned that,

"Loss of tradition is prevalent in our place. People get in touch with city lights, speaking in different accents and wearing different clothes. When people return home after a few months or a year, their bond with friends may get changed or weaker than before. Though using a mobile phone to get in touch with friends and family is easier than before, physical absence still matters in maintaining social ties. The occurrence of polygamy among migrants' men is more than that of non-migrants which also indicates loss of social ties. Sometimes left behind young growing children get involved in drug and antisocial activities, but we try out best to stop them from these unethical activities. Due to disaster, poverty increases and that's why crimes like stealing are increasing in recent days, which is more often found among young people".

Majority of the key informants from cyclone affected areas like Atalia, Jogipol, Bajua, Sreeula or Tarali Union have mentioned about the loss of cultural value, loss of social ties and decreased level of safety of left behind family. With frequent migration for a longer period, the migrant/s often have less contact with family and friends at origin. As perceived by some key informants from Laudob, Surkhali Union from Khulna district, changes in language and lifestyle are observed in the migrant/s. Many of them try to express themselves like foreigners and are observed to be less connected to their traditions or cultures. Union Parishad member of Kapilmuni Union frequently affected by flood and riverbank erosion clearly stated,

> "After flood and riverbank erosion, many people have migrated permanently to a new place, so they are adopting the culture of the new place. Sometimes they come to visit their origin, and we can see the changes in clothing and language. Even after short-term migration, when people return home, as we are local leaders, sometimes we meet them to know their current situation. Not too many, but we have found, few migrants have become addicted to drugs".

As perceived by respondents from the districts of Khulna and Satkhira, teenagers of migrants' families often get involved in antisocial activity. The probable reason might be the location of this districts near international border (India and Myanmar) and drugs smuggling business is a big problem issue in the border area. Teenagers have easy access to illegal drugs, sometimes they consume those drugs and also get involved in drug business. Therefore, in absence of household heads, teenagers of a family often deviate and get involved in illegal activities.

5. Conclusion

This research has attempted to contribute to the migration literature by exploring the local leaders' perceptions of disaster-induced migration, their patterns, drivers, and impacts of migration in Bangladesh, which have broader implications for disaster-prone developing nations, especially those in the global south with similar socioeconomic conditions and disaster exposure. By conducting semi-structured interviews with Union-level key informants, our findings revealed that, in the face of natural disasters such as drought, riverbank erosion, salinity intrusion, floods, and cyclones, male out-migration is dominant with a family left behind in origin. Spatially, disaster-induced migration is found to be predominantly domestic and from rural to urban areas.

To the best of the author's knowledge, this is the first attempt to compare the disaster specific auxiliary drivers of migration (relationship between and among disasters) where respondents linked various auxiliary drivers like economic, social, institutional, environmental, agricultural,

physical, institutional, and demographic drivers to individuals' migration decisions. Slow onset disaster induced migration are often linked to economic (i.e., debt, low income, no work, job opportunity) and agricultural (crop loss, degradation of cultivable land) drivers, whereas migration due to rapid onset disasters are more associated with physical (i.e., damage to infrastructure) and institutional drivers (lack of post disaster recovery, resettlement, lack of disaster risk reduction policy). In case of disasters, economic and institutional drivers like lack of post-disaster subsidies, proper disaster risk reduction measures, or post-disaster recovery plans are perceived as common drivers of migration. These auxiliary drivers also vary within slow-onset disasters and within rapid-onset disasters as the process of disaster occurrences, the nature and extent of damage, and the way of disaster recovery determine the auxiliary drivers that lead to human migration. The key informants perceived that out-migration has a positive impact on household income, loan payment, and education of children from left-behind families, but migration may cause loss of cultural value and indigenous knowledge, loss of social ties, and loss of agricultural labor. This demonstrates the need for more integrated local-level disaster recovery plans, specific to disasters, to minimize the negative impacts of disaster induced migration as well as to provide better livelihood to the households that will prevent them from migrating to urban areas.

These findings have policy implications for the management of disaster-induced human migration. This study emphasizes the need for more integrated disaster recovery planning at the local level to lessen disaster effects and improve household livelihoods in order to prevent urban migration. Even if one member migrates, alternative livelihood training, particularly for women, can improve the socioeconomic position of a family. Developing an efficient plan for post-disaster recovery may stimulate return migration once the effects of the disaster have subsided, hence restricting urban population growth. Nonetheless, the current study yields significant findings that reveal the spatial and temporal patterns of disaster-induced migration and the auxiliary drivers that exacerbate household migration decisions; it serves as a foundation for future research on disaster-induced migration decision making and the vulnerability of the trapped population in disaster-prone areas of Bangladesh.

The study relied on perceptions of local-level key personnel, which may have led to some bias in the data. This limitation can be overcome by a detailed household-level study on migration decision-making in the future. The impact of migration as perceived by local leaders can also differ if the data is collected primarily from the migrants and their families. In terms of the replicability of this study, future research can refer to the methodology of this study. Required information may include data on the spatial and temporal patterns of migration, auxiliary drivers of disaster-induced migration, and the impact of migration. However, the result may differ according to the perception-based methodology employed in this study. If a sufficient number of examples exist, a comparative study is a reasonable option (cross region, cross country, etc.).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The first author is grateful to the Ministry of Education, Sports, Science, and Technology (MEXT) of Japan for financial support and civil administration, agriculture department, and to the Union council leaders and officials of Chapai Nawabganj, Rajshahi, Naogaon, Khulna, and Satkhira districts of Bangladesh, for their cooperation and support in conducting field studies. The first author would like to express her deepest appreciation to Dr. Md Lamiur Raihan for his technical supports during data collection and helpful comments.

Appendix-A

Table: Perceived auxiliary drivers for disaster-induced migration.

	Economic Drivers					Agricultural Drivers					Social Drivers				Demographic Drivers						Institutional Drivers				Environmental Drivers					Physical Drivers			
Name of Disaster	NW	OF	LI	D	HF	LL	LC	CL	LI	LF	SD	LS	AM	LE	FS	A	G	EL	MS	VE	R	NS	NP	ND	WS	CW	LP	WL	LD	DH	DS	DE	DR
Flood	√	√	√	√	√	√	√	√		√	√		√			√						√			√			√	√	√			√
Drought	√	√	√	√			√	√		√			√		√							√				√							
Riverbank erosion	√	√		√	√	√	√		√	√											√	√		√				√		√		√	
Salinity	√	√	√	√			√	√		√															√				√				
Cyclone	√	√	√	√	√		√			√	√		√		√						√	√	√	√				√		√		√	√

Note:

Economic Drivers	Agricultural Drivers	Social Drivers	Demographic Drivers	Institutional Drivers	Environmental Drivers	Physical Drivers
NW= No work or less work opportunities OF= Off-farm work opportunities LI= Low income *D*= Debt HF= Higher chances of future growth	LL= Loss of land LC= Loss of crop productivity CL= Changed land/soil conditions LI= Lack of irrigation facility LF= Loss in livestock, fishery and forestry sector	SD= Social discrimination LS= Loss of social network AM= Access to migration network LE= Lack of services like education and health	FS= Family size *A*= Age *G*= Gender EL= Education level MS= Marital status VE= Vocational education/skill level	*R*= Resettlement NS= No subsidies/ incentives NP= No post-disaster recovery ND= No disaster risk reduction measures	WS= Water scarcity or scarcity of safe drinking water CW= Changed weather patterns LP= Loss of provisioning services WL= Water logging LD= Land/soil degradation	DH= Damage to houses DS= Damage to schools DE= Damage to essential infrastructure like dams, ponds DR..= Damage to roads

References

[1] IFRC. (2021). Global natural disaster assessment report, academy of disaster reduction and emergency management, ministry of emergency management - ministry of education national disaster reduction center of china, ministry of emergency management, international federation of red cross and red crescent societies.

[2] IPCC. (2012). National systems for managing the risks from climate extremes and disasters. In Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change (Vol. 9781107025). 10.1017/CBO9781139177245.009.

[3] W.N. Adger, R.S. de Campos, S.N.A. Codjoe, T. Siddiqui, S. Hazra, S. Das, M. Abu, Perceived environmental risks and insecurity reduce future migration intentions in hazardous migration source areas, One Earth 4 (1) (2021) 146–157.

[4] M. Szmigiera, (2021). National disasters with the most economic damage worldwide in 2019 (in billion dollars). Statista. Retrieved from https://www.statista.com/statistics273895natural-disasters-with-the-mostdamage?fbclidIwAR3AZyqwcm91EjEOtztjWZXCGKsSmEhjKilVnMBoMPV3trQEdkihP2Uc.

[5] CRED. (2020). The international disaster database (EM-DAT).

[6] IPCC. (2018). Global warming of 1.5C. An IPCC special report on the impacts of global warming of 1.5C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty (https://www.ipcc.ch/sr15/).

[7] IPCC, AsiaIn International Encyclopedia of Human Geography, IPCC, 2007, doi:10.1016/B978-008044910-4.00250-9.

[8] United Nations Development Programme. Bureau for Crisis Prevention. (2004). Reducing disaster risk: a challenge for development-a global report. U. N.

[9] UNHCR. (2006). General assembly. Episodes, 29(4), 305–305. 10.18814/epiiugs/2006/v29i4/009.

[10] N. Myers, Environmental refugees: a growing phenomenon of the 21st century, Philos. Trans. R. Soc. B Biol. Sci. 357 (2002) 609–613 1420, doi:10.1098/rstb.2001.0953.

[11] Brown, O. (2008). Migration and climate change. Geneva: international organization for migration.

[12] S. Castles, Migration, crisis, and the global labour market, Globalizations 8 (2011) 311–324 3, doi:10.1080/14747731.2011.576847.

[13] F. Gemenne, Climate-induced population displacements in a 4°C+ world, Philos. Trans. R. Soc. A.369 (2011) 182–195 http://doi.org/10.1098/rsta.2010.0287.

[14] S. Behrman, A. Kent, Climate refugees: Beyond the Legal Impasse?, Routledge, Abingdon, 2018.

[15] K. Petrova, Natural hazards, internal migration and protests in Bangladesh, J. Peace Res. 58 (1) (2021) 33–49.

[16] S. Shakya, S. Basnet, J. Paudel, Natural disasters and labor migration: evidence from Nepal's earthquake, World Dev. 151 (2022) 105748.

[17] L.M. Hunter, Migration and environmental hazards, Popul. Environ. 26 (4) (2005) 273–302, doi:10.1007/s11111-005-3343-x.

[18] R. Black, A. Bellagamba, E. Botta, et al., Migration drivers and migration choice: interrogating responses to migration and development interventions in West Africa, CMS 10 (2022) 10, doi:10.1186/s40878-022-00283-3.

[19] R. Black, S. Bennett, S. Thomas, et al., Migration as adaptation, Nature 478 (2011) 447–449, doi:10.1038/478477a.

[20] B. Mallick, J. Vogt, Population displacement after cyclone and its consequences: empirical evidence from coastal Bangladesh, Nat. Hazards 73 (2) (2014) 191–212, doi:10.1007/s11069-013-0803-y.

[21] K.K. Zander, T. Wilson, S.T. Garnett, Understanding the role of natural hazards in internal labour mobility in Australia, Weather Clim. Extrem. 29 (2020) 100261 Article.

[22] IOM. (2018). Migration, environment and climate change (MECC) division. Retrieved from https://www.iom.int/migration-and-climate-change.

[23] J. DeWaard, L.M. Hunter, M.C. Mathews, et al., Operationalizing and empirically identifying populations trapped in place by climate and environmental stressors in Mexico, Reg. Environ. Chang. 22 (2022) 29 Eckstein, D., Künzel, V., Schäfer, L., & Winges, M. Global Climate Risk Index 2020. Bonn: Germanwatch, doi:10.1007/s10113-022-01882-7.

[24] L.M. Hunter, J.K. Luna, R.M. Norton, Environmental dimensions of migration, Annu. Rev. Sociol. 41 (2015) 377–397.

[25] Edited by R. McLeman, F. Gemenne, Environmental migration research: evolution and current state of the science, in: R. McLeman, F. Gemenne (Eds.), Routledge Handbook of Environmental Migration and Displacement, Routledge, 2018, pp. 3–16. Edited by.

[26] K. Schewel, Understanding immobility: moving beyond the mobility bias in migration studies, Int. Migr. Rev. 54 (2020) 328–355, doi:10.1177/0197918319831952.

[27] R. Black, D. Kniveton, K. Schmidt-Verkerk, Migration and climate change: towards an integrated assessment of sensitivity, Environ. Plan. A 43 (2) (2011) 431–450, doi:10.1068/a43154.

[28] A. De Sherbinin, L.K. VanWey, K. McSweeney, R. Aggarwal, A. Barbieri, S. Henry, L.M. Hunter, W. Twine, R. Walker, Rural household demographics, livelihoods and the environment, Glob. Environ. Chang. 18 (3) (2008) 38–53.

[29] D. Karemera, V.I. Oguledo, B. Davis, A gravity model analysis of international migration to North America, Appl. Econ. 32 (2000) 1745–1755.

[30] E. Piguet, The migration/climate change nexus: an assessment, in: Proceedings of the International Conference on Rethinking Migration: Climate, Resource Conflicts and Migration in Europe, 2011 www.network-migration.org and www.geographie.uni-bremen.de.

[31] M.R. Islam, Climate change, natural disasters and socioeconomic livelihood vulnerabilities: migration decision among the char land people in Bangladesh, Soc. Indic. Res. 136 (2) (2018) 575–593.

[32] M. Moore, D. Wesselbaum, Climatic factors as drivers of migration: a review, Environ. Dev. Sustain. (2022) 1–21.

[33] J. Stoler, A.L. Pearson, A.Y. Rosinger, A.E. Lee, R. Bombardi, A. Brewis, R.A. Tutu, The role of water in environmental migration, Wiley Interdiscip. Rev. Water (2022) e1584.

[34] D.J. Kaczan, J. Orgill-Meyer, The impact of climate change on migration: a synthesis of recent empirical insights, Clim. Chang. 158 (3) (2020) 281–300 Springer, vol.pages.

[35] X. Lu, D.J. Wrathall, P.R. Sundsøy, M. Nadiruzzaman, E. Wetter, A. Iqbal, T. Qureshi, A. Tatem, G. Canright, K. Engø-Monsen, L. Bengtsson, Unveiling hidden migration and mobility patterns in climate stressed regions: a longitudinal study of six million anonymous mobile phone users in Bangladesh, Glob. Environ. Chang. 38 (2016) 1–7.

[36] E. Füssell, L.M. Hunter, C.L. Gray, Measuring the environmental dimensions of human migration: the demographer's toolkit, Glob. Environ. Chang. 28 (2014) 182–191.

[37] P. Dasgupta, J.F. Morton, D. Dodman, B. Karapinar, F. Meza, M.G. Rivera-Ferre, A. Toure Sar, K.E. Vincent, Rural areas climate change 2014: impacts, adaptation, and vulnerability. Part A: global and sectoral aspects, 2014.

[38] IOM. (2019). Glossary on migration No. 34. International migration law, 234. http://medcontent.metapress.com/index/A65RM03P4874243N.pdf%5Cn http://www.epim.info/wp-content/uploads/2011/01/iom.pdf.

[39] F. Castelli, Drivers of migration: why do people move? J. Travel Med. 25 (2018) VolumeIssue 1, tay040, doi:10.1093/jtm/tay040.

[40] E. Lee, A theory of migration, Demography 3 (1966) 47–57.

[41] S. Castles, H. de Haas, M.J. Miller, The Age of Migration: International Population Movements in the Modern World, Palgrave Macmillan, Basingstoke, 2014.

[42] O. Stark, D.E. Bloom, The new economics of labor migration, Am. Econ. Rev. 75 (2) (1985) 173–178.

[43] ForesightMigration and global environmental change, report for the government office for science, London, 2011 Report for The.

[44] G. Kibreab, Climate change and human migration: a tenuous relationship? Fordham Environ. Law Rev. (2009) 357–401.

[45] F. Laczko, C. Aghazarm, Migration, Environment and Climate Change: Assessing the Evidence, International Organization for Migration, 2009 IOM.

[46] S.O. Stapleton, R. Nadin, C. Watson, J. Kellett, Climate change, migration and displacement: the need for a risk-informed and coherent approach, Overseas Development Institute, 2017.

[47] M. Abu, S.N.A. Codjoe, J. Sward, Climate change and internal migration intentions in the forest-savannah transition zone of Ghana, Popul. Environ. 35 (2014) 341–364, doi:10.1007/s11111-013-0191-y.

[48] C. Cattaneo, et al., Human migration in the era of climate change, Rev. Environ. Econ. Policy 13 (2019) 189–206.

[49] D.K. Bardsley, G.J. Hugo, Migration and climate change: examining thresholds of change to guide effective adaptation decision-making, Popul. Environ. 32 (2010) 238–262.

[50] C. Tacoli, Crisis or adaptation? Migration and climate change in a context of high mobility, Environ. Urban. 21 (2) (2009) 513–525, doi:10.1177/0956247809342182.

[51] S. Ayeb-Karlsson, When we were children we had dreams, then we came to Dhaka to survive': urban stories connecting loss of wellbeing, displacement and (im)mobility, Clim. Dev. 13 (4) (2021) 348–359, doi:10.1080/17565529.2020.1777078.

[52] Y. Li, D. López-Carr, W. Chen, Factors affecting migration intentions in ecological restoration areas and their implications for the sustainability of ecological migration policy in arid Northwest China, Sustainability 6 (2014) 8639–8660, doi:10.3390/su6128639.

[53] C. Zickgraf, S. Vigil, F. de Longueville, P. Ozer, F. Gemmene, The impact of vulnerability and resilience to environmental changes on mobility patterns in West Africa, KNOMAD Working Paper 14, 2016.

[54] S. Ayeb-Karlsson, 'I do not like her going to the shelter': stories on gendered disaster (im)mobility and wellbeing loss in coastal Bangladesh, Int. J. Disaster Risk Reduct. 50 (2020) 101904, doi:10.1016/j.ijdrr.2020.101904.

[55] R. Black, N.W. Arnell, W.N. Adger, et al., Migration, immobility and displacement outcomes following extreme events, Environ. Sci. Policy 27 (2013) S32–S43, doi:10.1016/j.envsci.2012.09.001.

[56] R. Black, W.N. Adger, N.W. Arnell, S. Dercon, A. Geddes, D. Thomas, The effect of environmental change on human migration, Glob. Environ. Chang. 21 (2011) S3–S11.

[57] V. Koubi, G. Spilker, L. Schaffer, T. Böhmelt, The role of environmental perceptions in migration decision-making: evidence from both migrants and non-migrants in five developing countries, Popul. Environ. 38 (2) (2016) 134–163, doi:10.1007/s11111-016-0258-7.

[58] B. Mallick, K.G. Rogers, Z. Sultana, In harm's way: non-migration decisions of people at risk of slow-onset coastal hazards in Bangladesh, Ambio (2021), doi:10.1007/s13280-021-01552-8.

[59] R. Black, M. Collyer, Trapped" populations: limits on mobility at time of crisis, in: S.F. Martin, S. Weerasinghe, A. Taylor (Eds.), Humanitarian Crises and Migration, Routledge, London, 2014, pp. 287–305.

[60] S.N.A. Codjoe, F.H. Nyamedor, J. Sward, et al., Environmental hazard and migration intentions in a coastal area in Ghana: a case of sea flooding, Popul. Environ. 39 (2017) 128–146, doi:10.1007/s11111-017-0284-0.

[61] C. McMichael, et al., A review of estimating population exposure to sea-level rise and the relevance for migration, Environ. Res. Lett. 15 (2020) 123005.

[62] K. Warner, T. Afifi, Where the rain falls: evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity, Clim. Dev. 6 (2014) 1–17.

[63] H. Adams, Why populations persist: mobility, place attachment and climate change, Popul. Environ. 37 (2016) 429–448, doi:10.1007/s11111-015-0246-3.
[64] M. Lewicka, Place attachment: how far have we come in the last 40 years? J. Environ. Psychol. 31 (2011) 207–230, doi:10.1016/j.jenvp.2010.10.001.
[65] C.E. Anton, C. Lawrence, Home is where the heart is: the effect of place of residence on place attachment and community participation, J. Environ. Psychol. 40 (2014) 451–461.
[66] J. Carling, Migration in the age of involuntary immobility: theoretical reflections and Cape Verdean experiences, J. Ethn. Migr. Stud. 28 (1) (2002) 5–42, doi:10.1080/13691830120103912.
[67] A. Di Masso, D.R. Williams, C.M. Raymond, et al., Between fixities and flows: navigating place attachments in an increasingly mobile world, J. Environ. Psychol. 61 (2019) 125–133, doi:10.1016/j.jenvp.2019.01.006.
[68] G.D. Bhatta, P.K. Aggarwal, S. Poudel, D.A. Belgrave, Climate-induced migration in South Asia: migration decisions and the gender dimensions of adverse climatic events, J. Rural Community Dev. 10 (4) (2015).
[69] Immobility C. Zickgraf, F. Gemenne, R. McLeman, Immobility, in: Routledge Handbook of Environmental Displacement and Migration, Edited By Robert McLeman, François Gemenne, 1st ed., Routledge, London, 2019, pp. 71–84.
[70] M.E. Kabir, S. Serrao-Neumann, P. Davey, M. Hossain, M.T. Alam, Drivers and temporality of internal migration in the context of slow-onset natural hazards: insights from north-west rural Bangladesh, Int. J. Disaster Risk Reduct. 31 (2018) 617–626 January, doi:10.1016/j.ijdrr.2018.06.010.
[71] MoEF. (2015). Intended nationally determined contributions (INDC) ministry of environment and forests (MOEF) government of the people 's Republic of Bangladesh. 1–15.
[72] M.S. Hossain, L. Hein, F.I. Rip, J.A. Dearing, Integrating ecosystem services and climate change responses in coastal wetlands development plans for Bangladesh, Mitig. Adapt. Strateg. Glob. Chang. 20 (2) (2015) 241–261, doi:10.1007/s11027-013-9489-4.
[73] A.M. Rahman, S. Rahman, Natural and traditional defense mechanisms to reduce climate risks in coastal zones of Bangladesh, Weather Clim. Extrem. 7 (2015) 84–95, doi:10.1016/j.wace.2014.12.004.
[74] G. McBean, I. Ajibade, Climate change, related hazards and human settlements, Curr. Opin. Environ. Sustain. 1 (2) (2009) 179–186, doi:10.1016/j.cosust.2009.10.006.
[75] Ahmed, M., & Suphachalasai, S. (2014). Assessing the costs of climate change and adaptation in South Asia. Asian Development Bank.
[76] B. Mallick, B. Ahmed, J. Vogt, Living with the risks of cyclone disasters in the south-western coastal region of Bangladesh, Environments 4 (1) (2017) 1–17 MDPI, doi:10.3390/environments4010013.
[77] A. Bernzen, J.C. Jenkins, B. Braun, Climate change-induced migration in coastal Bangladesh? A critical assessment of migration drivers in rural households under economic and environmental stress, Geosciences 9 (2019) 51 (Basel), doi:10.3390/geosciences9010051.
[78] K. Burrows, P.L. Kinney, Exploring the climate change, migration and conflict nexus, Int. J. Environ. Res. Public Health 13 (2016) 443, doi:10.3390/ijerph13040443.
[79] A. Strauss, J. Corbin, Basics of Qualitative Research, Sage Publications, London, 1998 https://us.sagepub.com/en-us/nam/basics-of-qualitative-research/book235578.
[80] L. Quynh, L. Thao, (2005). Cultural attitudes of Vietnamese migrants on health issues. Retrieved from http://apha.confex.com/apha/viewHandout.epl?uploadid=591.
[81] A. Haque, S. Jahan, Regional impact of cyclone Sidr in Bangladesh: a multi-sector analysis, Int. J. Disaster Risk Sci. 7 (3) (2016) 312–327, doi:10.1007/s13753-016-0100-y.
[82] B.K. Paul, Why relatively fewer people died? The case of Bangladesh's cyclone Sidr, Nat. Hazards 50 (2) (2009) 289–304, doi:10.1007/s11069-008-9340-5.
[83] B. Mallick, J. Vogt, Cyclone, coastal society and migration: empirical evidence from Bangladesh, Int. Dev. Plann. Rev. 34 (3) (2012) 217–240, doi:10.3828/idpr.2012.16.
[84] IPCC. (2007b). Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel On Climate Change. Cambridge, Cambridge University Press.
[85] J. Chen, V. Mueller, Coastal climate change, soil salinity and human migration in Bangladesh, Nat. Clim. Chang. 8 (11) (2018) 981–987, doi:10.1038/s41558-018-0313-8.
[86] R. Sarkar, J. Vogt, Drinking water vulnerability in rural coastal areas of Bangladesh during and after natural extreme events, Int. J. Disaster Risk Reduct. 14 (2015) 411–423, doi:10.1016/j.ijdrr.2015.09.007.
[87] IOM. (2010). World migration report. International Organization for Migration.
[88] G. Rayhan, Coping with floods: does rural-urban migration play any role for survival in rural Bangladesh? J. Identity Migr. Stud. 1 (2) (2007) 82–98 http://www.e-migration.ro/jims/Vol1_no2_2007/JIMS_vol1_no2_2007.pdf#page=84.
[89] U. Habiba, R. Shaw, Y. Takeuchi, Farmer's perception and adaptation practices to cope with drought: perspectives from Northwestern Bangladesh, Int. J. Disaster Risk Reduct. 1 (1) (2012) 72–84, doi:10.1016/j.ijdrr.2012.05.004.
[90] A.R.M.T. Islam, A. Tasnuva, S.C. Sarker, M.M. Rahman, M.S.H. Mondal, M.M.U. Islam, Drought in northern Bangladesh : social, agroecological impact and local perception, Int. J. Ecosyst. 4 (3) (2014) 150–158, doi:10.5923/j.ije.20140403.07.
[91] C. Gray, V. Mueller, Drought and population mobility in rural Ethiopia, World Dev. 40 (1) (2012) 134–145, doi:10.1016/j.worlddev.2011.05.023.
[92] T.H. Mollah, J. Ferdaush, Riverbank erosion, population migration and rural vulnerability in Bangladesh (A case study on Kazipur Upazila at Sirajgonj District), Environ. Ecol. Res. 3 (5) (2015) 125–131, doi:10.13189/eer.2015.030502.
[93] D. Hutton, C.E. Haque, Human vulnerability, dislocation and resettlement: adaptation processes of river-bank erosion-induced displacees in Bangladesh, Disasters 28 (1) (2004) 41–62, doi:10.1111/j.0361-3666.2004.00242.x.
[94] T. Chumky, M. Basu, K. Onitsuka, S. Hoshino, The current research landscape of disaster-induced migration: a systematic review and bibliometric analysis, Int. J. Disaster Risk Reduct. 74 (102931) (2022) 102931, doi:10.1016/j.ijdrr.2022.102931.
[95] M.A. Call, C. Gray, M. Yunus, M. Emch, Disruption, not displacement: environmental variability and temporary migration in Bangladesh, Glob. Environ. Chang. 46 (2017) 157–165 August, doi:10.1016/j.gloenvcha.2017.08.008.
[96] M. Sharma, H. Zaman, Who migrates overseas and is it worth their while?: an assessment of household survey data from Bangladesh, J. Dev. Areas 47 (1) (2013) 281–302, doi:10.1353/jda.2013.0019.
[97] M.A.M. Joarder, P.W. Miller, Factors affecting whether environmental migration is temporary or permanent: evidence from Bangladesh, Glob. Environ. Chang. 23 (6) (2013) 1511–1524, doi:10.1016/j.gloenvcha.2013.07.026.
[98] IOMMigration, Development and Poverty Reduction in Asia, Academic Foundation, 2008.
[99] M.R. Islam, M. Shamsuddoha, Socioeconomic consequences of climate induced human displacement and migration in Bangladesh, Int. Sociol. 32 (3) (2017) 277–298, doi:10.1177/0268580917693173.
[100] M. Mauri, T. Elli, G. Caviglia, G. Uboldi, M. Azzi, RAWGraphs: a visualisation platform to create open outputs, in: Proceedings of the ACM International Conference, 2017 Proceeding Series, Part F1313, doi:10.1145/3125571.3125585.
[101] J. Baez, G. Caruso, V. Mueller, C. Niu, Droughts augment youth migration in Northern Latin America and the Caribbean, Clim. Chang. 140 (2017) 423–435 016-1863-2, doi:10.1007/s10584.
[102] C.C. Makondo, D.S.G. Thomas, Environmental change and migration as adaptation in rural economies: evidence from Zambia's rural–rural migration, Migr. Dev. (2019) 1–29, doi:10.1080/21632324.2019.1646534.
[103] C. Bradatan, Where do we go from here? Climate change as a human affair, Int. Sociol. 28 (5) (2013) 496–501, doi:10.1177/0268580913496914.
[104] M.R. Islam, M. Hasan, Climate-induced human displacement: a case study of Cyclone Aila in the south-west coastal region of Bangladesh, Nat. Hazards 81 (2) (2016) 1051–1071, doi:10.1007/s11069-015-2119-6.
[105] M.M. Islam, J. Herbeck, Migration and translocal livelihoods of coastal small-scale fishers in Bangladesh, J. Dev. Stud. 49 (6) (2013) 832–845, doi:10.1080/00220388.2013.766719.
[106] A. Poncelet, F. Gemenne, M. Martiniello, H. Bousetta, A country made for disasters: environmental vulnerability and forced migration in Bangladesh, Environment, Forced Migration and Social Vulnerability, in: T. Afifi, J. Jager (Eds.), Springer-Verlag, 1Berlin and Heidelberg, 2010.
[107] T.K. Das, H.K. Halder, I.D. Gupta, Impact of riverbank erosion: a case study, Australas J. Disaster Trauma Stud. 21 (2) (2017) 73.
[108] M.R. Rahman, Impact of riverbank erosion hazard in the Jamuna floodplain areas in Bangladesh, J. Sci. Found. 8 (1–2) (2010) 55–65.
[109] D. Dekaraja, R. Mahanta, Riverbank erosion and migration inter-linkage: with special focus on Assam, India, Environ. Syst. Res. 10 (1) (2021) 1–10.
[110] M.L. Raihan, K. Onitsuka, M. Basu, N. Shimizu, S. Hoshino, Rapid emergence and increasing risks of hailstorms: a potential threat to sustainable agriculture in northern Bangladesh, Sustainability 12 (2020) 5011.
[111] M.L. Raihan, M. Basu, K. Onitsuka, S. Hoshino, Determinants of farmers' risk perceptions of hailstorms in northern Bangladesh: is adaptive capacity the major concern? Pol. J. Environ. Stud. 31 (1) (2022) 257–270, doi:10.15244/pjoes/135699.
[112] M.M.H. Khan, I. Bryceson, K.N. Kolivras, F. Faruque, M.M. Rahman, U. Haque, Natural disasters and land-use/land-cover change in the southwest coastal areas of Bangladesh, Reg. Environ. Chang. 15 (2) (2015) 241–250, doi:10.1007/s10113-014-0642-8.
[113] Y. Lam, P.J. Winch, F.A. Nizame, E.T. Broaddus-Shea, M.G.D. Harun, P.J. Surkan, Salinity and food security in southwest coastal Bangladesh: impacts on household food production and strategies for adaptation, Food Secur. (2021), doi:10.1007/s12571-021-01177-5.
[114] A.C. Shimi, G.A. Parvin, C. Biswas, R. Shaw, Impact and adaptation to flood: a focus on water supply, sanitation and health problems of rural community in Bangladesh, Disaster Prev. Manag. Int. J. (2010).
[115] S.K. Smith, C. McCarty, Housing damage and population displacement during Florida's 2004 Hurricane season, J. Florida Stud. 1 (1) (2011).
[116] L. Amadi, Climate change, peasantry and rural food production decline in the Niger delta region: a case of the 2012 flood disaster, J. Agric. Crop Res. 1 (6) (2013) 94–103.
[117] M.Z. Wang, M. Amati, F. Thomalla, Understanding the vulnerability of migrants in Shanghai to typhoons, Nat. Hazards 60 (3) (2012) 1189–1210, doi:10.1007/s11069-011-9902-9.
[118] S. Do Yun, B.S. Waldorf, The day after the disaster: forced migration and income loss after hurricanes Katrina and Rita, J. Reg. Sci. 56 (3) (2016) 420–441.
[119] C. Singh, R. Basu, Moving in and out of vulnerability: interrogating migration as an adaptation strategy along a rural–urban continuum in India, Geogr. J. 186 (1) (2019) 87–102.