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Desires for In Situ Adaptation Versus Out-Migration? The Impact of Flooding and Cyclones on Polder Communities in the Bangladesh Delta

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ABSTRACT

In Bangladesh's delta, rural communities have long held lives inseparable from seasonal flooding, adapting their homes and livelihoods to the annual monsoon. However, land subsidence, changing seasons, severe storms, increased salinity, and rising sea levels are threatening local livelihoods. The objective of this paper is to understand rural residents' perceptions of climate impacts and adaptation measures, focusing on their mobility choices. Through 15 qualitative, semi-structured interviews with 22 representatives from two embanked polder localities in southwest Bangladesh, we explored the following questions: (i) How do local residents perceive recent climate and environmental changes? (ii) How are local residents coping with these changes and what external assistance do they require to maintain their livelihoods; and (iii) How do local residents perceive migration or partial migration as a potential adaptation strategy? While these communities report an increased frequency of extreme climate events and severe flooding, our findings also reveal a lack of external assistance for adaptation solutions. Moreover, most families are either unwilling or unable to completely migrate out of affected areas. Therefore, increased support—the provision of fresh drinking water, money to recoup lost income and assistance rebuilding or reinforcing homes—is essential for building adaptive capacity and increasing local resilience in the face of climate shocks.

1 | Introduction

Over 170 million people live on the world's largest river delta, the Ganges–Brahmaputra–Meghna (GBM) delta, located in Bangladesh and West Bengal, India (Paszkowski et al. 2021). However, despite its dense population, this area faces a mix of climate shocks and both rapid and slow-onset environmental changes that alter the viability of livelihoods for local people. Bangladesh recorded at least 136 meteorological and hydrological events between 2000 and 2024, causing an average of 467 deaths per year (EM-DAT 2025).

Deltas are complex and among the most vulnerable regions to climate change, requiring specific adaptation planning for both their residents and their ecosystems (Eslami et al. 2025). The 710-km coastline of Bangladesh in particular, which spans 47,221 km^2 of land, is considered a zone of intersecting vulnerabilities (Rabby et al. 2019). Many residents live within vulnerable

low-lying floodplains, often ranging from 1.5 to 11.8 m above sea level (Minar et al. 2013). They are at high risk from both independent catastrophic floods (Bangla: *bonna*) caused by cyclone storm surges in addition to the normal seasonal flooding (Bangla: *barsha*) caused by the yearly monsoon.

During the monsoon season between June and September, approximately 1200–2000 mm of rain falls on the country and increases river flow by over an order of magnitude (Ahasan et al. 2010). Bangladesh also faces severe tropical storms approximately once every 3 years (Sonet et al. 2024). These storms often pose significant challenges for disaster management and selecting appropriate adaptation measures to increase the resilience of local residents and develop effective post-cyclone recovery strategies (Sonet et al. 2024). Both types of flooding are also increasingly exacerbated by the impacts of land subsidence and tidal amplification (Pethick and Orford 2013; Steckler et al. 2022; Akter et al. 2024).

To mitigate the effects of these events, between 1960 and 1975, the natural tidal region was converted into a manmade series of 'polders', with 139 new embanked communities being built to help manage life in the GBM delta (Auerbach et al. 2015). These polders sought to protect and improve agriculture by reducing the damage caused by floods, cyclones, tidal waves and more (Auerbach et al. 2015). Initially successful, they were a source of inspiration for development agencies and future governmental projects. However, over time, land subsidence and water-logging issues became more prevalent.

While sedimentation from the country's complex river system currently compensates for some sea level rise across the country (Raff et al. 2023), polders in the southwest of the country experience land subsidence (Steckler et al. 2022) as they are cut off from this sediment supply typically brought by the monsoon. Furthermore, as a result of their embankments, some polders now have elevations 1–1.5 m lower than the surrounding land and rivers (Auerbach et al. 2015). Limited aid, funding and general support provoked public protests (Kulsum et al. 2021), and the residents of this delta have largely managed these issues on their own. Without external resources, some polder residents are beginning to look towards alternative solutions, such as partial or total migration to nearby cities or to the country's capital, Dhaka (Parven et al. 2022).

Despite the growing body of literature on climate change and mobility (e.g., Hoffmann et al. 2020; Beine and Jeusette 2021), the nuances of their relationship are not yet entirely clear, and the factors driving each individual's decisions are always site-specific and multifaceted. In a recent study of rural Bangladesh, Best et al. (2025) conclude that economic inequality at the community level has a significant impact on decision-making for environmental migration. Kaczan and Orgill-Meyer (2020) state that climate extremes limit households' ability to migrate by depleting the resources needed for migration while at the same time, increasing their vulnerability from remaining in place. However, Boas et al. (2022) state that many households also exercise their autonomy and choose to remain in place. It is therefore important that new research on climate mobility pays greater attention to voluntary immobility and relocation, which challenge the conventional frameworks of mass migration. We aim to fill this research gap by focusing on household-level testimony from the polders in the Bangladesh delta.

The main objective of this paper is to understand local perceptions of climate impacts and the different ways in which communities respond to them. Our conceptual framework outlines the aspirational capacity model we work within, and our research utilises qualitative interviews with 22 representatives of these small polder communities in coastal Bangladesh, where land subsidence and saltwater intrusion amplify the impacts of seasonal flooding and cyclones (Haque 2006; Auerbach et al. 2015; Steckler et al. 2022). We specifically qualify first, how local residents perceive recent environmental and climate change; second, how they cope with these changes and what external assistance they need to do so; and finally, to what extent they perceive migration or partial migration as a possible adaptation strategy. In the end, our discussion of these results outlines other potential methods of buffering adaptive capacity within these communities as alternatives to migration in order to increase support and agency for these communities.

1.1 | Conceptual Frameworks

Over the past 15 years, there has been a significant increase in the literature investigating the links between environmental stress and migration in Bangladesh (e.g., Bernzen et al. 2019; Ahsan et al. 2022; Wiig et al. 2023). Local experts recognise the role that climate migration plays within the country as a means of diversifying livelihoods and adapting to local changes (Martin et al. 2014), but there is still a need to further understand the feedback loops and thought processes that spur this movement. Environmental changes alone are very rarely the sole reason for migration (Black et al. 2011; Zhou and Chi 2024), but personal perceptions of this climatic viability may be more significant (Cárdenas-Vélez et al. 2024).

Climate migrants are an increasingly large and diverse population, with one estimate predicting that, by 2050, there will be more than 200 million across the world (Clement et al. 2021). They exist along a variety of spectra according to the duration and distance of their move, the type of environmental change that caused it and their degree of agency (Priovashini and Mallick 2022). Migration can be temporary, seasonal or permanent; can be driven by fast-onset or slow-onset events; and can either be a pre-emptive choice in search of better opportunities or a forcible displacement following a near-total loss (Priovashini and Mallick 2022). However in reality, these categories often overlap. Furthermore, migration choices are compounded by intersectional factors including but not limited to gender and religion (Ayeb-Karlsson 2020).

In our study, we build on the existing climate mobility literature by utilising an aspirational capacity model, distinguishing between migration intentions and actual movement capability (Ekoh et al. 2023). This framework recognises that these factors are often driven by two different sets of considerations (Figure 1), and it values the opinions of both households that have chosen to engage in migration and those who have chosen to remain in place (de Haas 2021). This allows our work to disentangle the complex processes of social transformation,

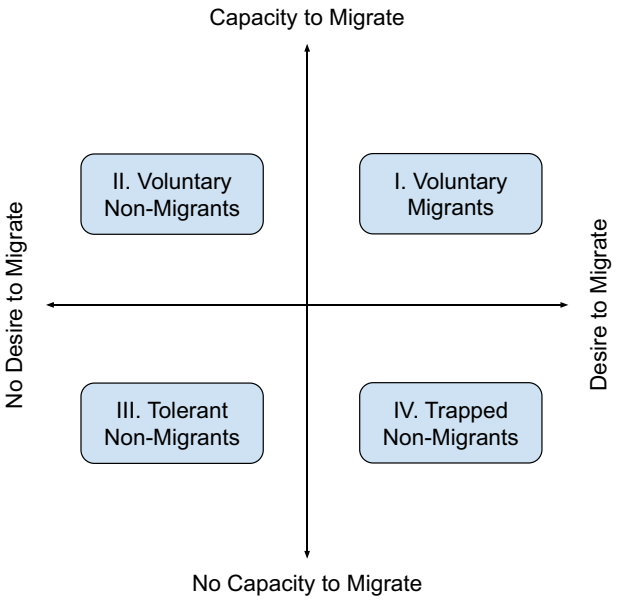

FIGURE 1 | Aspiration-capacity model. Adapted from Carling (2002); Schewel (2015, 2020). The majority of migration literature focuses primarily on people in quadrants I and IV; however, this model expands the scope of research to the experiences of people in quadrants II and III.

environmental change and economic development that shape migration patterns and yields a vision in which moving and staying in an affected area are understood as complementary manifestations of migratory agency (de Haas 2021).

In this study, we expected to interact with respondents who fell into all four categories of the aspiration-capacity model: voluntary migration, voluntary non-migration, tolerant non-migration and trapped non-migration. Within the category of voluntary migrants, we also came across the use of partial migration. Partial migration is an active form of adaptation that allows the rest of the family to remain in their homes while a few family members move to local cities to buffer local loss through remittances (Sakdapolrak et al. 2023). During natural disasters in particular, remittances from unaffected areas are considered to be a stable source of income, increasing household adaptive capacity (Eftimoski and Josheski 2021).

However, migration is not a natural choice for all. By remaining in their homes, families have better access to support from their social networks and the lifestyles they are used to (Adams and Adger 2013; Ahsan et al. 2022). In addition, non-economic ecosystem services—such as cultural connection to the environment—create a sense of place attachment that adds great value to people's lives, even as they may lose economic stability due to climatic events (Adams and Adger 2013). These strategies of voluntary and tolerant non-migration are, therefore, considered active adaptation in their own right, representing both the risks that come with relocation and the social and cultural implications of leaving (Kelman et al. 2019).

Finally, trapped non-migrants are those for whom no one in their household is able to access the resources needed to migrate out of an area, despite a desire to do so. In this context, environmental change does not lead to economic diversification and instead has the exact opposite effect, exposing families to increased vulnerability and an eventual poverty spiral which further reduces local adaptive capacities and future opportunities for migration (Priovashini and Mallick 2022).

From an external perspective, migration can be seen as an immediate solution to environmental destruction, but in many communities, it is not viewed as a desirable option. Recent research has underscored the non-linear impacts that climate shocks have on migration choices, underscoring the multiplicity of drivers and individual opinions on local vulnerability and the relevance of migration as an adaptation strategy (Kaczan and Orgill-Meyer 2020). The factors influencing these decisions in the polders of rural south-western Bangladesh are small-scale and nuanced, so this aspiration-capacity framework guided the development of our interview questions and subsequent coding of results in order to explore in depth the thought processes of these polder community members as the best way to understand their true motivations.

2 | Methods

This study focuses on data collected in interviews in the following two localities in the southwest of Bangladesh: (1) Sreenagar on Polder 32 (22.5° N, 89.4° E), an embanked island adjacent to the Sundarbans Mangrove Forest that became well known for flooding in 2009 (Auerbach et al. 2015); and (2) Kumarkhali on embanked Polder 35/1 (22.3° N, 89.8° E), located in Morrelganj, east of the Sundarbans and along the Baleshwar River (Figure 2). These sites were selected because they are located within the delineated coastal zone in Bangladesh, containing populations that are particularly vulnerable to water salinity fluctuations, cyclones, floods and storm surges (Uddin and Kaudstaal 2003).

In addition, these two locations have historically been the site of other long-term local research projects with this paper's authors and their affiliates (e.g., Auerbach et al. 2015; Raff et al. 2023; Steckler et al. 2024). Sreenagar on Polder 32 was originally selected in 2012 as a study site for measuring land subsidence following devastation from Cyclone Aila in 2009. Kumarkhali in Polder 35/1 was originally identified in 2015 for land surface research due to its increasing tree canopy coverage, but it has also experienced significant flooding. This establishment of local relationships has built a level of comfort and trust with key community members and organisations necessary for research participation and accurate information sharing.

The data for this research are qualitative, obtained from semi-structured, in-depth interviews (Mack et al. 2005) with local Bangladeshi residents on the GBM delta in March of 2023. This study format was chosen in order not to limit or pre-bias the answers given by local residents and allow them to express their ideas and experiences to the fullest possible extent. In total, we interviewed 22 community representatives, with 11 men and 11 women. Respondent age ranged from those in their early 20s to those in their early 70s, with an average age of 46.7. Respondents played a variety of roles within their communities, with the majority of women working as housewives and the majority of men

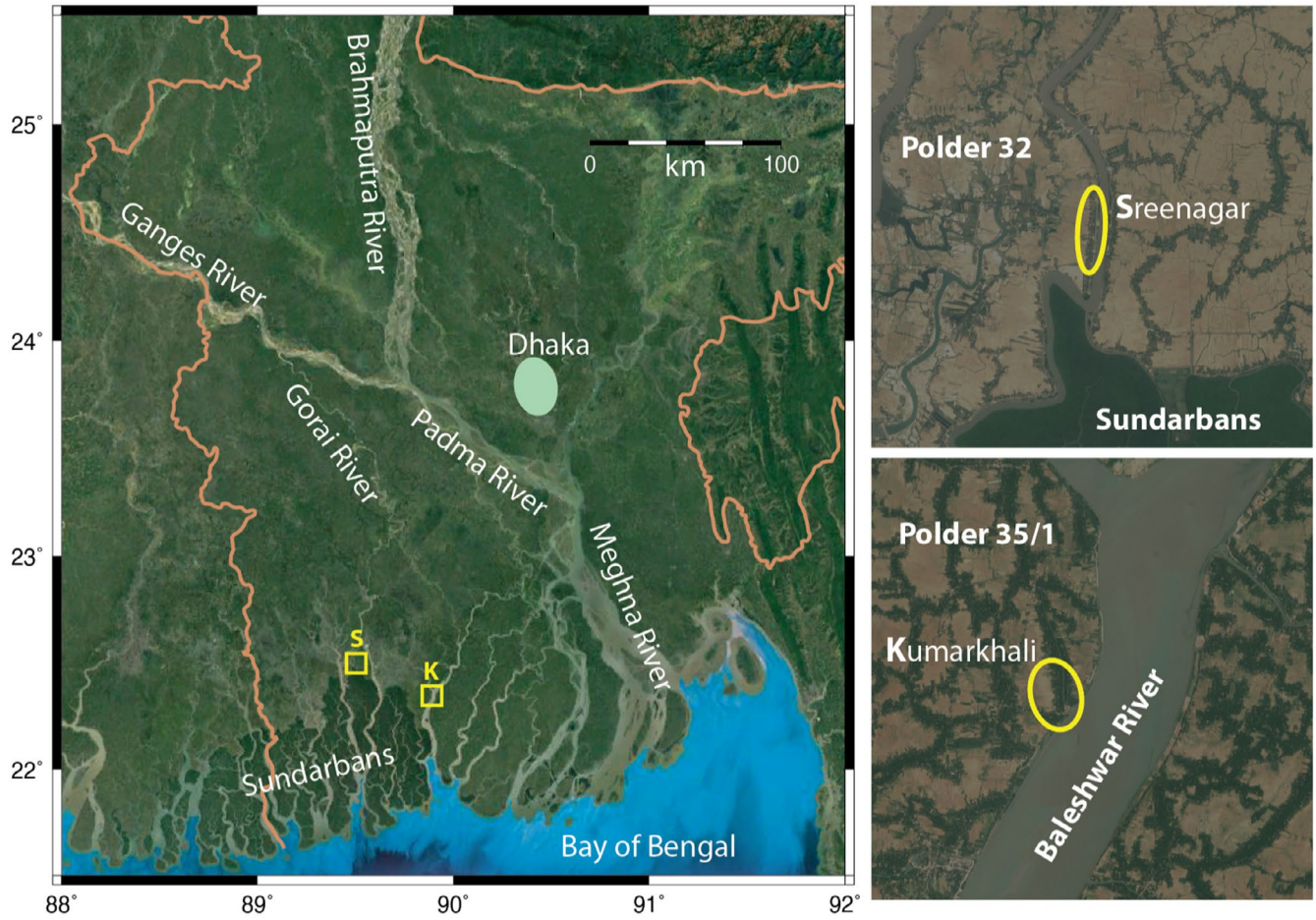

FIGURE 2 | Map of study sites. Sreenagar on Polder 32 (22.5° N, 89.4° E) and Kumarkhali on Polder 35/1 (22.3° N, 89.8° E) are both located on the edge of the Sundarbans Mangrove Forest. Close-up images were captured by the Copernicus Sentinel-2 satellite on 25 March 2023.

working as farmers or day labourers. The average household size was 4.5 family members, and the mean education level for respondents was sixth grade (Table 1).

Interview respondents were found through the identification of household leaders during introductions and preliminary discussions of the topics within each community. We employed purposive sampling, recruiting participants with experience and history in the study area and those whom community members pointed to as being particularly rich in information. The aim of this study—giving voice to the local residents to explain their behaviour and choices in depth—was made possible by the chosen qualitative method utilising a smaller number of respondents. In total, we conducted six interviews on Polder 32 in Sreenagar (Respondents S1A-S6) and nine on Polder 35/1 in Kumarkhali (Respondents K1A-K9).

Many of the interviews were not one-on-one discussions, but rather group conversations with groups of up to five family members contributing their opinions. Opportunistic respondents who contributed most regularly in these group conversations were identified and categorised as unique respondent members within the group, and verbal informed consent was obtained from each participant before every interview. Semi-structured, long-form and qualitative interviews of this sort are common within the literature, even with smaller numbers of respondents. For example, Shakeela and Becken (2015) had 12 respondents, while Stojanov et al. (2016) used 17.

The interviews were divided into three main clusters of questions: (i) local perceptions of seasons and climate change over the past 5–10 years; (ii) adaptation strategies, flooding preparedness and assistance; and (iii) experiences and prospects of migration (Table 2). We prioritised the respondents' comfort by conducting the interviews within or just outside their homes and emphasising the long-form sharing of stories instead of simple yes/no questions. Saturation of interviews in each location was deemed to be reached when the interview themes all started to converge into a coherent narrative and were no longer being referred to other households who would be willing and able to speak on these topics inside these small communities.

Both audio recordings and hand-written notes were taken during each interview, which were translated from Bangla to English by graduate students at Dhaka University. Each translator received a briefing prior to starting the interview process about our study aims and how to preserve detail and avoid paraphrasing in their translations. The questions themselves were also workshopped and simplified with our translators prior to the first interview to increase communicability. For the specific quotations included in this article, the audio clips were translated by multiple individuals to ensure accuracy.

TABLE 1 | Respondent characteristics.

Polder	Code	Gender	Age	Job	Family size	Education
32	S1A	F	60s	Housewife	4	None
32	S1B	F	40s	Housewife	4	10th grade
32	S1C	M	50s	/	4	12th grade
32	S2	M	50s	Farmer	5	10th grade
32	S3	F	20s	Housewife	5	College
32	S4	M	50s	Farmer	4	12th grade
32	S5	M	60s	Farmer	2	6th grade
32	S6	F	40s	Housewife	3	8th grade
35/1	K1A	F	40s	Housewife	5	5th grade
35/1	K1B	M	40s	Day labourer	5	6th grade
35/1	K2A	F	50s	Housewife	6	None
35/1	K2B	F	20s	Housewife	6	None
35/1	K3A	M	30s	Day labourer	4	2nd grade
35/1	K3B	M	30s	Day labourer	3	2nd grade
35/1	K4	M	70s	Storekeeper	4	/
35/1	K5A	F	50s	Housewife	7	/
35/1	K5B	F	30s	Housewife	/	/
35/1	K5C	M	60s	Day labourer	/	/
35/1	K6	M	60s	Farmer	6	Preschool
35/1	K7	M	40s	Fisherman	5	/
35/1	K8	F	30s	Housewife	3	9th grade
35/1	K9	F	/	Day labourer	4	/

After all of the interviews were completed and translated, the results were coded by hand into the following categories: seasonal changes, water access, flooding experiences, aid received, aid desired, and migration perspectives for both study locations (Figure 3). These themes not only encompassed our initial questions but also the natural turn of conversation to the ideas most commonly discussed by the respondents. Within each category, the results were then collated into the predominant themes, taking into account how many respondents agreed or disagreed with one another to highlight the degree of diversity in opinion. Intercoder reliability was ensured through continuous discussion of coding practices during this stage. While the initial coding was carried out by each of the respective interviewers, the results of each individual's work were then reviewed by the first author in order to avoid discrepancies.

This study acknowledges the potential for bias in the selection of interviewees. As we were only able to interview current residents of communities, these individuals may over-represent those that are unwilling or unable to migrate, leaving out households where the entire family has potentially already made the decision to leave. Furthermore, the small sample size limits the ability for overarching statistical analyses to be performed on the data. However, despite the aforementioned limitations, our study provides a rich and nuanced depiction of what life in these communities has been like following extreme climate stresses, greatly contextualising the relationships between such events and the choice to migrate. It is able to illuminate the debates and conversations surrounding environmental migration that occur in these communities at this individual household scale and serve as a guideline for similar studies on a wider scale in the future.

3 | Results

3.1 | Flooding and Environmental Change

Respondents were first asked how they perceive the seasons and climate conditions to be changing around them on their individual polders. The environmental change with the greatest reported impact on daily life was the annual flooding. Both study sites have a long history of yearly inundation, but residents have reported increases in severity over time. During Cyclone Aila in 2009, the embankment surrounding Sreenagar in Polder 32 caved in at several places, and this destruction combined with land subsidence inside the polder allowed flood waters to repeatedly surge in. Respondent

TABLE 2 | Interview questions.

1. PERCEPTIONS OF SEASONS AND CLIMATE CHANGE
1.1 Have you noticed any changes in the length or intensity of the summer or winter?
1.2 Have you noticed any changes in the length or intensity of the monsoon season?
1.3 Do the changes in seasons, if any, change your work or habits?
1.4 What has been your experience of flooding in the past 5–10 years?
1.5 What has been your experience of flooding when you were younger?
1.6 Have you noticed any differences in your everyday life because of these events?
2. ADAPTATIONS AND FLOODING AID
2.1 Are you told or do you know what storms or floods are going to occur?
2.2 Do events such as flooding and cyclones influence your access to food and water?
2.3 Do you think people are supported by external sources when there is flooding?
2.4 Is aid, if any, distributed evenly across your community?
2.5 What resources are most important to receive during these times?
2.6 Do you think many people in your community share this perspective?
3. EXPERIENCES AND PROSPECTS OF MIGRATION
3.1 Have you or has anyone in your family ever moved away from this village?
3.2 If so, what were their reasons for moving and when did they leave?
3.3 Would you ever consider long-term migration out of your community?
3.4 What are some of the factors either stopping you or encouraging you?
3.5 Have you noticed a change in migration rates after storms or floods?
3.6 Do you think migration is a good response to these environmental problems?
3.7 What are some other ways that local people respond to flooding and storms?

S1A said that the tide flooded their village for up to 10 h a day, often leaving her unable to walk around her community. Residents were forced to live on the remaining elevated parts of the embankment for nearly two years before it was fully repaired.

Respondent S2, a farmer who has worked on the land for decades, corroborated that the water level consistently reached 1 m high, and emphasised how damaging it was to his crops. Even now that the embankment has been repaired, due to changes in the timing of the seasons, there is frequent flooding of fields at the time when seedlings are germinating. Farmers can lose entire rice seasons because the plants are not yet hardy enough to withstand the water:

> If it floods near the Ashwin month [September to October in the Bangladeshi calendar], then the plants are very small and the floods ruin everything. ... We, the people who do the farming and have the land suffer more, because we cannot do anything outside of farming. We are dependent on the land.

Non-farmers' livelihoods are also deeply impacted by this flooding. Respondent K4 explained how these floods prevent people from venturing outside to his storefront, and how he often has to close early whenever he hears a flood is coming, losing out on potential revenue. Respondent S3 underscored this, recalling the days when storms could be weathered from within one's own house. Now however, she states that many residents have to travel to storm shelters in order to stay safe from the increasing destruction and water levels, which takes even more time away from their jobs. Respondent S5 has also lost livestock due to his inability to bring animals with him to these storm shelters.

In the nearly two decades since Cyclone Sidr in 2007, which flooded Kumarkhali on Polder 35/1, Respondent K1A said that community members have become much more scared of flooding and its effects. It destroys houses, puts people out of work and forces them to rely on their limited savings, and pollutes their already limited fresh water sources with dirt and oil brought in by the river. Respondent K5 lost her house in Cyclone Sidr and had to save for over 10 years in order to afford a new one, living in a temporary shelter made of aluminium and plastic in the interim. Residents report that severe flooding in this location occurs at least once every six months, with Respondent K4 adding the water can remain high for days or weeks at a time. Although some feel protection from the recently reinforced embankments, residents in Kumarkhali do not have easy access to local cyclone shelters or a hospital. Respondent K1A stated that the nearest hospital is located over 3 km away from their village, and they have no local doctors.

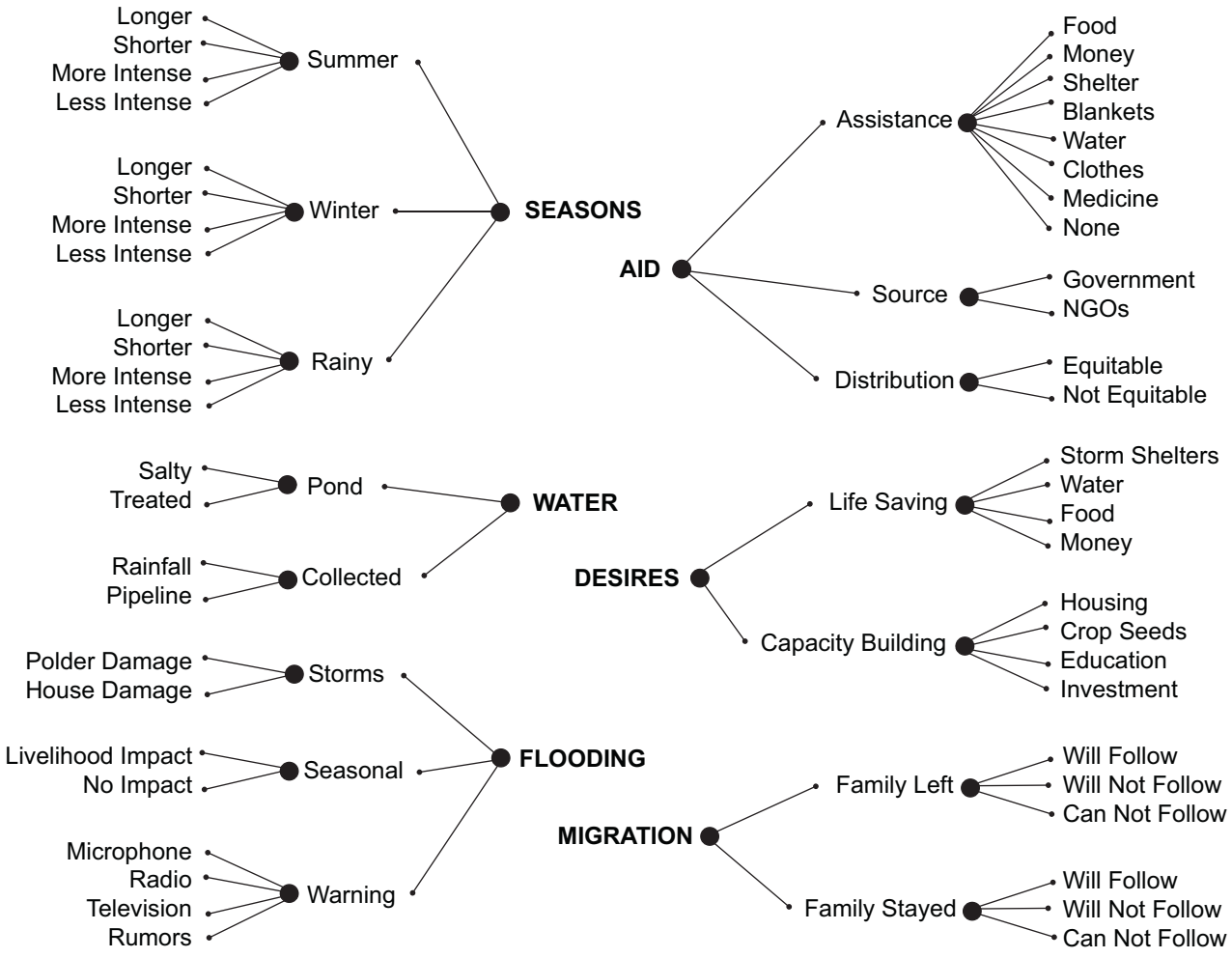

FIGURE 3 | Coding tree. The thematic categories used to code interview responses during data analysis. Each of the six main ideas is divided into two or three subcategories to allow for comparison of specific testimonies.

3.2 | Preparedness and External Support

As flooding and storms continuously impact these small communities, many people have started searching for solutions, both internally and externally. A key part of their decision-making process is the access to life-saving disaster aid that paves the way for their recovery. The primary assistance delivered to these communities after flooding and storms is provided by the national government's public administration program as well as by NGOs, which both offer food, water, clothing and cash handouts (Figure 4). Respondents in both locations also mentioned additional support from a variety of NGOs providing assistance in rebuilding destroyed homes, creating water storage tanks and re-establishing food cultivation and fishing. However, the amount of support that was received varied greatly between families and across locations.

Overall, families reported feeling great dissatisfaction with the little aid they have been provided, and some respondents reported not receiving any aid at all. In Sreenagar, a high level of mutual aid and a strong community sentiment—both within and across villages—have been necessary in filling in these gaps and helping fellow residents cope with severe storms. Respondent S1C, part of a large family living in the polder, reported that in times of need all religious barriers go away, and people do all they can to support one another:

> During that time [Aila], we cooked the food and gave the food to people around here or near the cyclone centre. ... It is such a situation around here that if someone is Muslim, Hindu, or Christian, it doesn't matter. We have a brotherly relationship with each other and try to live peacefully. If someone needs any assistance, we try to help them.

Furthermore, the respondents highlighted that the distribution of relief aid is often uneven, and as a result, it can have a large impact on the migration or adaptation decisions households are able to make. This lack of transparency makes planning future steps extremely difficult for residents. In Sreenagar, Respondent S2 reported that those with fewer resources or those facing higher levels of destruction are more likely to receive support, but that this is not a consistent pattern. After Cyclone Sidr in 2007, despite the high levels of devastation, many residents did not receive enough money in aid to rebuild their houses, leaving

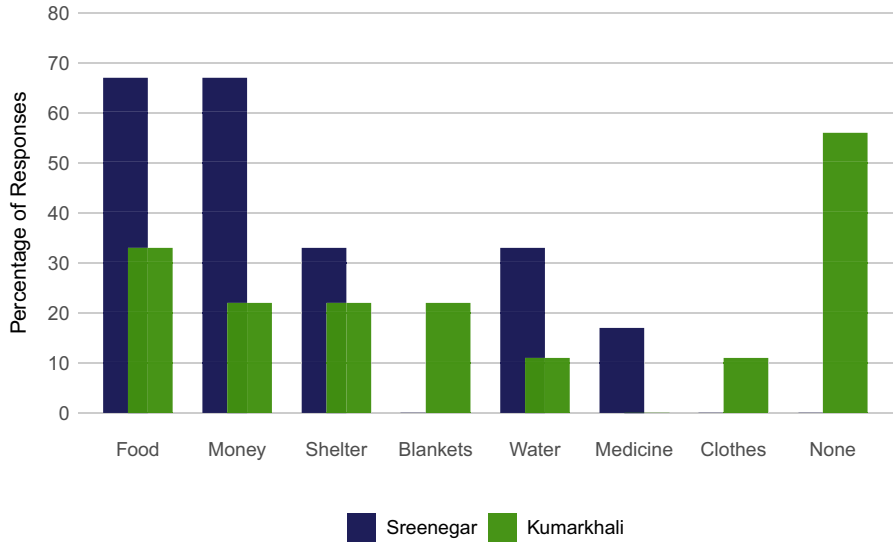

FIGURE 4 | Aid received. Types of aid provided to respondents after flooding by both the government and NGOs. Many respondents in Kumarkhali report not receiving any aid at all, while others received support across multiple categories. Percentages are based on the number of interviews in which each was mentioned instead of the number of individual interviewees.

them with extremely limited resources with which to prepare for future flooding and storms. In Kumarkhali, Respondent K3B explained the way assistance has been distributed based on residents' political affiliations:

> Any government assistance is given to the head of the ward, the chairman, and there is an 'understanding' about the assistance. The assistance is distributed among the people that are part of the chairman's team. They get money, rice, and daal.

When asked exactly what type of aid would be most useful to improve adaptive capacity, most respondents primarily wished for fresh water, cash handouts, and housing support. The provision of clean drinking water is the highest priority for aid, as fresh water is very scarce in these coastal communities. Multiple residents in Kumarkhali deem the lack of water to be the most prominent issue their community currently encounters when faced with this increased flooding. There is no drinkable groundwater shallow enough to be accessible by tube well in either location, and the small family ponds and rainwater collection points quickly become contaminated when the polder embankments are breached. Respondents K6 and K8 both state that they put any cash aid they receive towards water filtration systems for periods of flooding, and Respondent K2A highlighted the heightened difficulties they face during periods of flooding when they do not receive this type of aid, often causing stomach pain for herself and her children:

> When it floods, water saltiness is greater. There is a great deal of dirt or residue left in the rivers. The colour of the water also changes and dirty water flows—different types of water flow together. But we still drink that water. There is no alternative.

3.3 | Experiences of Migration

When outside aid is insufficient to mitigate the effects of flooding and storms, residents must confront the possibility of migration. However, these considerations are not taken lightly and are driven by a wide variety of interacting and compounding factors. Across both study locations, around half of respondents reported to have had close friends or family members who had engaged in migration, which they agreed is an accurate representation of the split of opinions across their communities. However, while these opinions towards flooding and subsequent migration are consistent both within and across these two study locations, they may not entirely reflect the diverse experiences of all communities across the broader GBM region.

Returning to the aspiration-capacity model as a metric of organising respondent motivations and desires, a quarter of our respondents were deemed to be 'trapped non-migrants', wanting to leave but lacking the ability to do so. A fifth of respondents reported active plans to be 'voluntary migrants' and either join family in nearby cities or search for better educations and careers. Finally, over half of respondents stated they would be unwilling to pursue migration themselves, falling into the categories of both 'tolerant non-migrants' and 'voluntary non-migrants' (Figure 5).

In Sreenagar, most residents were displaced from their homes during Cyclone Aila. However, those such as Respondent S2 referenced little desire for future migration. He discussed with pride how all of the profits from his work go towards his daughters' education—both living in bigger cities and studying to become doctors—but that he wished to stay and continue his career as a farmer. On the other hand, despite the great amount of love and pride that Respondent S6 feels for her community, she stated that she is growing increasingly open to the idea of joining her family across the border if flooding gets worse and threatens her safety again:

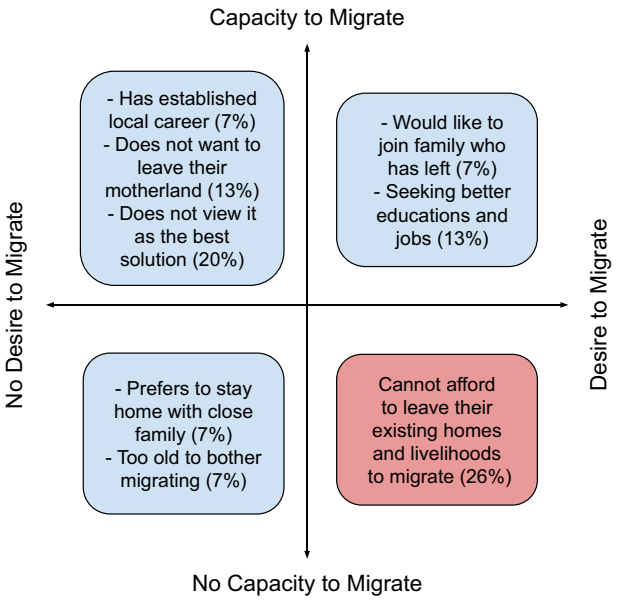

FIGURE 5 | Plans to migrate. Utilising the aspiration-capacity model to classify the motivation of respondents to either migrate or refrain from doing so. Percentages represent the amount of interviews in which each reason was cited. By far, the largest group of answers fall into the category of 'voluntary non-migrant' in the top left hand corner, who would rather seek local adaptations than move away. The red square represents the trapped migrants who wish to leave but are unable.

> If we can't live here, then we do have to leave ultimately. If our barrier to control the flood breaks down, then where can we go?

This split opinion is also found in Kumarkhali, but few respondents viewed long-term climate migration as a viable option. In fact, the idea that it is *not* the most fitting solution to flooding and environmental change was the most popularly cited reason against it (Figure 5). While some are already trapped and could not afford to leave due to the continuous loss of income from environmental shocks, others feel a strong sense of attachment to their local community and are choosing to stay and protect it. Respondent K6 is one of these voluntary non-migrants who stated that even in the face of increased flooding, salinity or financial incentive, he would still never migrate. Kumarkhali is the village of his family, and he has deep personal and religious motivations to stay:

> What is the point of going to the city? God will save us. God will save us here in the village if he wants. What's the point of going? I don't want to go.

Although few respondents demonstrated a true desire to leave their village, others also recognised it as one of their only remaining options in the absence of external support. Respondent K3A said that he would like to move to a nearby city such as Khulna or Bagerhat as soon as he is financially able, so he and his brothers could work as drivers and get a better education for their children. The nearest school to their current home is located over 2 km away. Respondent K2A shared this sentiment of hoping to move to a bigger city. Four members of her family had already engaged in partial migration following Cyclone Sidr, deciding to move to Dhaka in order to earn money that would help them rebuild their house in Kumarkhali. They now hold a variety of jobs, such as garment workers, day labourers and drivers, and Respondent K2A has plans of her own to join them for these economic opportunities as soon as her children are old enough:

> We didn't go before, but we thought we would. Our kids are small, so we can't go with the kids to the garment factory. When we stop breastfeeding the kids, then we will go.

4 | Discussion

4.1 | Climatic Changes

Respondents confirm that they perceive changes in the seasonal occurrence and intensity of climate extremes across both study areas, placing an emphasis on both the flooding associated with the annual monsoon as well as with cyclones. A total of 36 severe cyclones have hit the coast of Bangladesh between 1970 and 2015 (Kibria et al. 2016), and analysis suggests that, while the frequency of cyclones may be decreasing, their intensity is increasing (Saha and Khan 2014).

In 2007, Cyclone Sidr swept through the GBM delta, killing approximately 3500 people and destroying 450,000 homes (Penning-Rowsell et al. 2013). Two years later, Cyclone Aila ravaged the same region (Parvin et al. 2019), and following those back-to-back events, an uptick in migration out of the vulnerable low-lying areas was recorded (Ahsan et al. 2014). The polders most affected by these storms are the very same ones we have selected for our study and residents noted the strong impacts that these events had on their relationships to their surrounding environments.

Polder residents are extremely vulnerable to inundation from storms, despite the surrounding embankments, because these walls can and have been breached, and the land inside them is sinking relative to its surroundings (Auerbach et al. 2015). This vulnerability is also compounded by net elevation loss in the area, with relative sea level rise exceeding sediment deposition rates (Akter et al. 2024). Although Bangladesh as a whole is still gaining land (Raff et al. 2023), this accretion is primarily concentrated away from where Sreenagar and Kumarkhali are located (Steckler et al. 2022, 2024).

4.2 | Buffering Adaptation Ability

The adaptive capacity of communities within these polders to cope with climate shocks remains notably limited (Das et al. 2021). In Khulna, the district in which Polder 32 is located, 30.8% of the population live below the poverty line, a much higher percentage than the national average of 24.3% (Mainuddin et al. 2021). Therefore, many people require financial as well as infrastructural assistance in the event of these floods and climate shocks. Some residents shared household-level adaptation strategies they have developed, such as Respondents S3 and K4

both raising their families' housing foundations, Respondent S4 shifting the crops he plants throughout the year, Respondent K6 planting trees to buffer storm surges or Respondent K5A adding fabric to her house's tin roof to reduce heat in the longer summers. However, these methods alone remain insufficient to prepare communities for future environmental changes.

Many emphasised that they do not seek help to leave, but rather support to strengthen such measures and better prepare for future shocks. Respondents appreciated post-storm aid but underscored the urgency of shifting to proactive and long-term flood preparedness measures over reactive recovery efforts. Respondent S3 noted that access to permanent income sources, such as land or livestock, would greatly improve recovery and security. These insights point towards targeted livelihood restoration as a critical component of future adaptation programming, ensuring resilience is built through strengthened household economies and wide-scale community development.

Furthermore, in recent decades, the building of increased cyclone shelters (Haq et al. 2015) has greatly reduced mortality from this flooding, but much more infrastructure is needed. Despite the life-saving capabilities of these shelters, they are unable to protect people's properties, crops and livestock, which are all key for long-term economic success. As a result, there is a pressing need for increased local support that truly focuses on the needs of these communities (Chowdhury et al. 2022). In Sreenagar, Respondent S3 said that the local cyclone shelter—located in the village school—was not built until 2011, three years after the devastating Cyclone Aila. Across all interview locations, residents feel unsupported by their government and ask for a variety of increased protections to buffer their adaptive capacity.

4.3 | Migration Agency

Most crucially, these interviews seek to contextualise the perception of migration as an adaptation strategy itself, whether it is viewed as a viable response to climatic shocks, and if not, why people still migrate out of these polder communities. It has been shown that individual opinions on local vulnerability inform decisions about whether to migrate or pursue other strategies more so than the specific environmental changes themselves (Kaczan and Orgill-Meyer 2020), so this study has sought to fill in the range of household opinions on the topic. Respondents confirm that migration to cities such as Khulna, Bagerhat or Dhaka is common and primarily due to economic pressures, but further analysis reveals deeply intertwined economic and environmental pressures.

Although the majority of migrants in Bangladesh report moving in search of better employment opportunities, most rural inhabitants are engaged in resource-based livelihoods sensitive to climate shocks, so it is often underlying climatic factors that decrease productivity and work availability and drive residents towards more urban areas (Ahsan et al. 2014; Bernzen et al. 2019). These shocks cause loss of fresh water, food and income, as well as the destruction of homes, roads and livelihoods, leading residents to feel a lack of resources with which to continue pursuing their livelihoods.

Despite this partial and sometimes even total migration, however, the anchoring of families within their communities remains strong in rural Bangladesh and people have strong convictions to stay in their homes (Penning-Rowsell et al. 2013). Prevailing social norms and customs mean that many are unlikely to leave their homes without overwhelming motivation (Ayeb-Karlsson 2020), often placing trust in outside forces such as their religion to help them survive instead (Ayeb-Karlsson et al. 2019). These cultural convictions also lead to deviations in the migration trends between communities of different religions, genders or classes. The Hindu residents of Sreenegar, for example, expressed a strong desire to not lose their religious community by moving elsewhere in the Muslim-dominated country. Furthermore, past research has shown that it is much more difficult for women to find the means or the social acceptance to engage in migration when they typically fulfil jobs within the household (Ayeb-Karlsson 2020).

This study now returns once more to the aspiration-capacity model of migration, distinguishing between one's intentions to migrate and their actual capability to do so (Ekoh et al. 2023). Migration to buffer income loss, as discussed by a wide variety of respondents, is an active strategy of taking control and increasing the adaptive capacity of a household (Sakdapolrak et al. 2023). Yet some families still feel as if they can best adapt to these changes by drawing on their local support networks which they would lose if they tried to seek opportunities elsewhere (Adams and Adger 2013; Ahsan et al. 2022).

Voluntary non-migration as discussed by these respondents represents a strong resistance to external pressures and a love for one's homeland and culture (Kelman et al. 2019). Instead of following the assumption that everyone who has the capability to move automatically has the aspiration to do so as well, the popularity of this idea highlights the diversity of thought processes and values within each of the study communities. Migration in Bangladesh is shaped by complex and multidimensional processes taking into account social, economic, cultural and ecological factors, so it is not a universal solution or even a universally sought-after one. As such, the analysis of migratory capacity and aspirations must be done on a small scale, such as that of this study, taking into account as many individual perspectives and needs as possible (de Haas 2021).

Throughout the past decade, the government of Bangladesh has been working towards solutions that prevent these communities from being forced to leave their homes. The new Bangladesh Delta Plan 2100 has been developed with the goal of implementing long-term sustainable development over the next 75 years, seeking to improve the quality of life across the country at large but also for this vulnerable coastal region (BDP 2100 2018). As these new policies are developed and rolled out, it will be crucial that they take into account this feedback and information from the local communities about what interventions are most important and useful to them (Kulsum et al. 2021). This analysis highlights the importance of decentralised adaptation, such as local water systems and protective infrastructure for the smaller and more isolated communities, targeting the restoration of livelihoods that collapse after climate shocks.

Many respondents in our study stated that they would only consider migration as a form of adaptation after they have exhausted every other path towards the future they are so diligently working. These residents wish for better resources and aid so that they will be able to live securely, whether they choose to migrate or not, laying out paths that the government and NGOs can take in order to reduce migration pressures and enable residents to remain and adapt in place if they so choose.

5 | Conclusion

Through semi-structured in-depth interviews with 22 residents of Sreenagar (Polder 32) and Kumarkhali (Polder 35/1), this study shows that communities in the GBM delta perceive both acute climate extremes—such as floods and cyclones—and gradual changes including sea level rise and saltwater intrusion. While the government and NGOs provide some post-disaster aid, support is insufficient for long-term recovery or preparation, limiting people's capacity to adapt.

Although many families have relatives who have migrated to nearby cities, citing economic drivers, the majority of respondents are voluntary non-migrants who do not see migration as desirable. Instead, they want to sustain their livelihoods at home through stronger protection and adaptive support. Policy priorities should promote livelihood diversification to reduce dependency on climate-sensitive sectors, more timely and equitable aid distribution and fresh water access, and investments in cyclone-resilient housing and embankments. The new Bangladesh Delta Plan 2100 provides an apt vehicle to deliver these changes. NGOs can complement these measures by strengthening local capacity for early warning systems and equitable aid delivery, ensuring marginalised groups are not left out.

The localised evidence from this study underscores the importance of research that speaks directly with affected communities. While site-specific, these findings illuminate broader migration dynamics by showing how gradual environmental change and access to aid shape decision-making. Future work should compare similar results across a greater number of polders and regions; assess the long-term effects of uneven aid; and explore how gender, religion and social status intersect with adaptation and mobility, combining the long-form qualitative methodology utilised here with broader surveys that allow for complementary quantitative analysis. Addressing these gaps will help design research agendas that more directly target the structural issues shaping resilience.

Ultimately, this study highlights that migration is not a universal or preferred solution. Rural polder communities in southwestern Bangladesh largely wish to remain in place but require external support to build diverse adaptive capacities and lasting resilience in the face of environmental change.

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Ethics Statement

This study was approved by the Columbia University Institutional Review Board, New York, United States.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Raw data from interviews are unable to be provided for public access, as it includes sensitive information about respondent identities.

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