Chapter 12
Adaptation of Behavior to Overcome Natural Disasters

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Abstract This chapter deals with how people adapt their lives to natural disasters, such as flood, cyclone, extreme weather events, earthquake, and sea level rise. With the changing global climate, the disasters would appear more frequently and seriously. However, it is still uncertain where the disasters will occur nearby personal daily activity areas, and how great the impacts on human life will be. Surprisingly, literature review suggests that relevant studies are very limited, especially in the context of developing countries. Targeting Bangladesh, one of the most vulnerable countries in the world to climate and the sixth most vulnerable to floods, this chapter describes three case studies on people's adaptation behaviors under the impacts of different flooding and cyclone scenarios in future by focusing on intercity travel behavior, job and residential location choice behavior, and tourism behavior respectively. Various findings are derived, which are useful to help identify the barriers to the adoption of adaptation measures, the roles of different stakeholders in implementing adaptation measures, and the directions of adaptation measures in the future.

Keywords Climate-related disasters · Flood · Cyclone · Bangladesh · Adaptation behavior · Residential behavior · Intercity travel · Tourism behavior · Stated preference survey · Discrete choice models

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12.1 Natural Disasters and Adaptation Behavior

There has been an increasing trend in the number of natural disasters over recent years. Climate-related disasters are the most common disaster events, and they have long affected human lives in various ways (Begum et al. 2014). The National Research Council (2008) has identified five types of climate-related disasters: very hot days and heat waves, increases in arctic temperature, rising sea levels, intense precipitation, and extreme hurricanes. These disasters are predicted to appear more frequently and to become more severe this century. According to Peterson et al. (2008), there is a greater than 90 % probability that more intense, longer, and more frequent periods of extreme heat and heat waves will occur in the United States. The IPCC (2007) has predicted that arctic warming and rising sea levels at the global level are virtually certain with a probability of greater than 99 %; more intense and frequent precipitation events will occur in the United States with over 90 % probability, and more intense tropical storms are likely (with over 66 % probability) around the globe in the next century. These climate-related disasters may increase the vulnerability of many societies and communities worldwide, especially those that are already vulnerable (UNDP 2011). To address such vulnerability issues, both disaster risk management (disaster risk reduction and disaster management) and climate change adaptation are required to make individuals, communities, and societies more resilient and less vulnerable to disasters (GAR 2011; Field et al. 2012; Johansson et al. 2013). There is connection between disaster risk management and climate change adaptation; however, this chapter only focuses on climate change adaptation.

The IPCC (2007) defines climate change adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (p. 750). At the individual/household level, agriculturalists may adapt various practices through techniques such as agronomic management, crop intensification, increasing food production based on suitable environmental conservation techniques, and water resource exploitation (Oluoko-Odingo 2011; Habiba et al. 2012). After a natural disaster, fish farmers may temporarily suspend fishing activities to help recover fishery resources and ecosystems, and/or transfer their aquaculture cages from high-risk areas to waters unaffected by the disaster (Chang et al. 2013). Households may migrate to other places (Klaiber 2014), elevate their ground floors to avoid exposure to water and change their travel modes (Ling et al. 2015), secure food and income (Nguyen and James 2013), enhance their adaptation ability through education and employment and with the support of social capital (Ding et al. 2014), and so on. Through such adaptations, people attempt to alleviate or avoid the negative impacts of climate-related disasters.

From a policy-making perspective, adaptations to climate-related disasters include responses in operations, design, planning, investment, and land use control (Transportation Research Board 2008). It is of great importance to understand people's behavior in adapting to disasters associated with climate change.

Government policies, investments, construction, shelters, and other measures should assist people to adapt to the impacts of climate-related disasters. However, the mismatch between people's needs/behavior and adaptation measures in practice could result in ineffective and failed responses to disasters. For example, people may have different preferences and make dissimilar decisions concerning residential relocation in response to disasters of varying types and intensity. Governments should be aware of these behavioral differences, propose population migration policies, and plan shelters accordingly. Another example is the adaptation of daily travel to disasters. Transportation infrastructure and travel activities are especially exposed to climate-related disasters and people's travel behavior may differ according to types of natural disasters and their impacts on transportation infrastructure. As a result, the planning, design, and construction of transportation infrastructure, as well as traffic management, should include behavioral responses so that such adaptation is more effective. Another important form of behavior that is easily affected by climate-related disasters is tourism. Tourists may simply cancel trips to an affected destination and go somewhere else; however, in this case, the affected destination will suffer from a serious reduction in tourism revenue, which may worsen the adaptation of the region to disasters. Tourists may delay visits, but this affects the planning and management of tourist destinations.

The purpose of this chapter is to understand how people will respond to future climate-related disasters. We focus on three types of adaptation behavior in the context of Bangladesh: (1) intercity travel, (2) residential relocation and job changes, and (3) tourism.

12.2 Case Study Area: Bangladesh

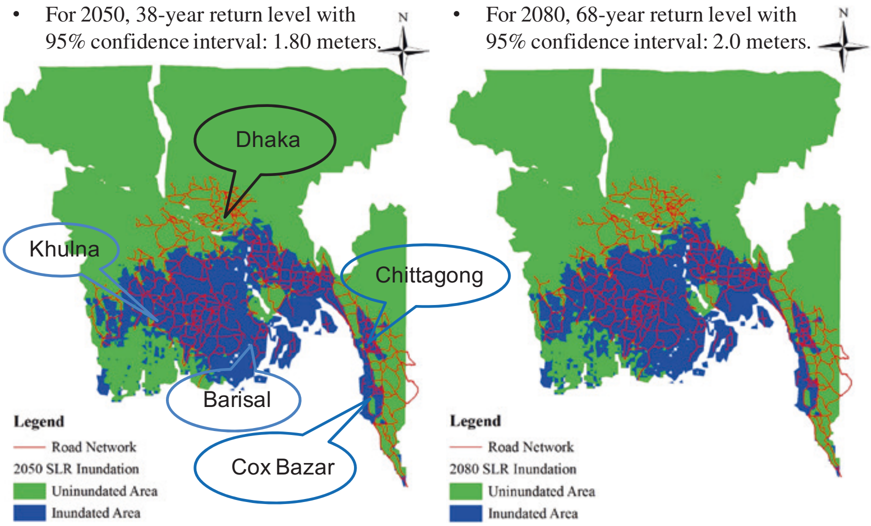
Bangladesh is one of the most vulnerable countries in the world to climate, and the sixth most vulnerable to floods based on the number of deaths per 100,000 people exposed to cyclones or floods (UNDP 2004). Floods, tropical cyclones, storm surges, and droughts are likely to become more frequent and severe in the coming years. Bangladesh's high vulnerability to climate change is due to a number of hydrogeological and socioeconomic factors, which include: (a) geographical location in South Asia; (b) flat deltaic topography with very low elevation; (c) extreme climate variability, governed by monsoons, which results in acute differences in water distribution over space and time; (d) high population density and poverty incidence; and (e) the dependence of the majority of its population on crop agriculture, which is strongly influenced by climate variability and change (Ahsan 2006). Most parts of Bangladesh are located on the delta of three of the largest rivers in the world. The flood plains of its three large rivers cover about 80 % of the country's land, while 25 % is flooded every year (Alam et al. 2002). Only 10 % of Bangladesh is one meter or more above the global mean sea level and one-third is under tidal influence (Karim and Mimura 2008). It is susceptible to river and rainwater flooding, and in lower lying coastal areas, to tidal flooding during storms. The most common water-related and climate-induced natural disasters on a deltaic floodplain such as those in Bangladesh are caused by floods. On average 6000 people die from flooding and storms each year (Schiermeier 2014). Flooding in Bangladesh is a result of a complex series of factors. These include a huge inflow of water from upstream catchment areas coinciding with heavy monsoon rainfall in the country, a low floodplain gradient, congested drainage channels, the convergence of major rivers inside Bangladesh, tide and storm surges in coastal areas, and polders that increase the intensity of floods outside protected areas. Different combinations of these factors give rise to different types of flooding. The most recent exceptional flood in 2007 inundated 62,300 km^2 of land (42 % of the total area) and caused severe damage to lives and property, and the most serious mega flood occurred in 1998, causing nearly 70 % of land to be inundated (Dasgupta et al. 2010). The impacts of sea level rise (SLR) are also serious. There are approximately 31 million people living along the coastal area, and it is estimated that about half of the population lives within the risk area.[1]

As shown in Fig. 12.1, it is predicted that the average SLR in Bangladesh in the future will be 1.8 meters in 2050 and 2.0 m in 2080 (Lee[2] 2013). Note that both global warming and storm surges were incorporated into the prediction. Based on the predicted sea levels, it is further predicted that 60.61 and 62.86 % of roads along the coastal area will be affected in 2050 and 2080, respectively, and the corresponding percentages for the whole country will be 23.48 and 24.35 %, respectively. Thus, the impacts of disasters resulting from climate change in Bangladesh are huge, and will become even worse in the future.

Mahmud and Prowse (2012) investigated the impacts of cyclone Aila in 2009 in Kulna, Bangladesh, and estimated that 99 % of households suffered losses. Nelson (2003) assessed the environmental health impact of floods, SLR, storm surges, and cyclones in Bangladesh caused by global climate change using the disability-adjusted life-year method, and found that children and young people are particularly vulnerable to its health impacts. To understand future SLR impacts in western Bangladesh, Karim and Mimura (2008) created eight flooding scenarios, identified the high-risk areas, and estimated the number of additional shelters needed to accommodate the affected people. In Bangladesh, the government has constructed a large number of refugee shelters and embankments in coastal areas, while the early warning system needs further improvement and more shelters are required for people at risk (Karim and Mimura 2008). Mahmud and Prowse (2012) investigated the adaptation measures taken in Bangladesh before and after cyclone Aila and concluded that predisaster interventions such as early

[1]See http://www.cegisbd.com/.

[2]Dr. Lee was a collaborating researcher on an interdisciplinary research project led by the second author, supported by the Global Environmental Leaders (GELs) Education Program for Designing a Low-Carbon World, MEXT Special Coordination Funds for Promotion of Science and Technology, from October 2008 to September 2012. He made this prediction during that project.



SLR impacts on road infrastructure of the costal areas

Scenarios	Affected Road Segments	Total Length (Km)	Total Study Area Road Length (Km)	Percentage (%)
1.8 m (2050)	1935	4745.02	7828.47	60.61
2.0 m (2080)	2007	4920.97	7828.47	62.86

SLR impacts on road infrastructure of the whole country

Scenarios	Affected Road Segments	Total Length (Km)	Total National Road Length (Km)	Percentage (%)
1.8 m (2050)	1935	4745.02	20205.96	23.48
2.0 m (2080)	2007	4920.97	20205.96	24.35

Fig. 12.1 Predicted sea level rise (=global warming + storm surge) in future Bangladesh

warning systems and disaster preparedness training gave better results than post-disaster relief. Because of climate-related disasters in Bangladesh, transportation networks are frequently interdicted, creating barriers to economic activities and having huge impacts on people's daily lives. Ecosystems (e.g., wetlands, forests, and coastal areas) could also be seriously influenced by climate disasters. From a long-term perspective, mitigation measures in both Bangladesh and other countries around the world are definitely required, but these appear to be difficult to achieve. Accordingly, adaptation measures should be given a higher priority in the medium and short term.

In this study from the end of January to the beginning of March 2013, we conducted two questionnaire surveys with respect to adaptation to future climate-related disasters in inland and coastal areas of Bangladesh. The first survey concerns travel behavior, residential relocation, and job changes, while the second survey investigates tourist behavior. Both surveys concern floods and cyclones as climate-related disasters.

In the first survey, question items include people's experiences and understanding of climate disasters, predisaster adaptive behavior, responses during disasters, and postdisaster recovery. It covers barriers and important factors for behavior in the above circumstances, and future adaptation behavior (travel, residential relocation, and job change) in different disaster scenarios, household and individual attributes, and other factors. Approximately 1000 respondents participated in the survey.

The question items in the second survey include tourists' travel schedules for their current trip to Bangladesh and their subjective evaluation of destinations visited (when they were interviewed), adaptation to previous climate disasters, travel experiences during the previous year, stated preferences regarding their responses as visitors to Bangladesh to various flood and cyclone scenarios, as well as information such as their individual and household characteristics. As a result, 1000 valid questionnaires were obtained. It was observed that 64.3 % of the respondents were male, of whom three-quarters were under 40 years old, almost half were international tourists, and about two-thirds were traveling with family or friends.

Detailed explanations of the above surveys are provided in Sects. 3 and 4.

12.3 Literature Review

Because of differences in individual characteristics such as knowledge, education, income, and government policies, people's choices in adapting to disasters resulting from global climate change also differ. Patt and Schoter (2008) found that people rarely choose evacuation and resettlement to adapt to floods because of their perceptions of climate change. Artur and Hilhorst (2012) analyzed the adaptation measures adopted by people in the flood-prone areas of Mozambique, and pointed out that people's adaptive strategies, ranging from flood-proofing houses to everyday behavior such as investment strategies, are much more diverse than those mentioned by Osbahr et al. (2008). Sahin and Mohamed (2013) consulted three types of stakeholders. Residents preferred improved building design and protective structures, politicians favored improved building design and resettlement, and the experts believed that improved building design and public awareness were the best choices.

Various factors affect individual choices concerning adaptation to climate change disasters. Adger et al. (2003) stated that adaptation to climate change was a function of individuals' access to resources, and that access to information played an important role in choosing resources (Phillips 2003). A stronger perception of climate change risks prompts stronger responses to adapt to climate change (Barnett and Adger 2003; Hess et al. 2008). Adaptation is also affected by psychological factors such as ambiguity aversion (fear) and ambiguity seeking (hope) (Viscusi and Chesson 1999). Grothman and Patt (2005) focused on the psychological factors of people's risk perceptions and perceived adaptive capacity as the main factors influencing individuals' adaptation choices, and showed the importance of sociocognitive factors in adaptation behavior. Other factors, such as personal experience, values, morals, and culture also play important roles in adaptation choices, including those of experts and decision makers (Sundblad et al. 2007). Adaptation responses entail people adjusting their behavior to cope more effectively with the impacts of climate change disasters (Mozumder et al. 2011). Jin and Francisco (2013) found that people as well as local governments in the Zhejiang coastal area of China have little knowledge about SLR and adaptation strategies, and that their knowledge increases and attitudes change significantly when they are provided with information brochures.

12.3.1 Analysis of Intercity Travel Behavior Associated with Climate-Related Disasters

Travelers are completely exposed to the weather and disasters during extreme weather events. During adverse or serious weather events, people adjust their travel plans to avoid or alleviate the impacts. Travel plans may be canceled or changed, and travel may be delayed. It is important to understand changes in travel behavior caused by climate change because transportation network performance depends largely on responses to traffic conditions (Khattak and Palma 1997; Lu and Peng 2011; Lu et al. 2012). Travel behavior analysis under adverse weather conditions attracts the most attention from the literature reviewed for this study. Khattak and Palma (1997) reported that half of the automobile travelers among their respondents changed their travel patterns under adverse weather conditions in Brussels, Belgium, and observed that bad weather had a stronger influence on departure time than did route and mode changes. Heavy rain was found to reduce traffic volume in Melbourne, Australia by 2–3 % (Keay and Simmonds 2005), and the impacts of weather on travel demand have also been noted in other studies (e.g., Van et al. 2006). Moreover, weather information was found to change the behavior of travelers in Flanders, Belgium significantly (Cools and Creemers 2013), and these changes depended greatly on trip purpose (Cools et al. 2010). A study in Toronto, Canada confirmed the significant impact of weather on mode of travel, especially walking and cycling among younger travelers (Saneinejad et al. 2012). Ahmed et al. (2013) found that weather conditions are a paramount factor in decisions made about cycling in Victoria, Australia. Evidence was also found for a correlation between climate change and choice of transport and distance traveled in the metropolitan Randstad region of the Netherlands. Switching from open-air modes of travel such as cycling and walking to alternatives such as private cars and mass transit rail is an especially common effect of climate change (Böcker et al. 2013b). There is little doubt that people's travel behavior is affected by climate change, and daily travel behavior is changed accordingly.

However, it is agreed that because of the diversity of climate change regimes and culture/habituation in different countries, travel behavior in response to climate change differs between regions (Khattak and de Palma 1997; Böcker et al. 2013b; Cools and Creemers 2013). As shown above, adaptation of travel behavior to climate change is mainly researched in developed countries. As a global threat, climate change poses the same or even greater risks on developing countries, and the capacity of those countries to adapt may be much lower than that of developed countries because of poor transportation planning and infrastructure as well as their developing economies (Lu et al. 2014). Thus, understanding travel responses to climate change in developing countries may be as important as it is in developed countries or even more so. Furthermore, even in the same country, people in coastal areas may respond to climate change events such as intense storm surges, hurricanes, and SLR in a different way to those in inland regions. In addition, almost all the literature reviewed addresses the behavioral adaptation of intracity travel, emphasizing the use of private cars, buses, bicycles, and walking (Aultman-Hall et al. 2009; Elieas et al. 2013); changes in intercity travel receive less attention. Moreover, intercity travel differs from intracity travel in terms of distance, purpose, and alternative routes (that is, there are fewer redundant travel routes in intercity than in intracity travel), and intercity transportation infrastructure may have greater exposure to climate change because there are fewer buildings and shelters (Böcker et al. 2013a). These all make travel behavior under conditions of climate change different from intracity travel.

12.3.2 Analysis of Life Adaptation to Climate-Related Disasters

In recent years, changes of residence and job location have attracted scholars' attention, especially in connection with changes in the environment. Mortreux and Barnett (2009) divided the factors influencing residence or job location choice into three groups: factors at the point of origin including the environment, the economy, or government policies; factors at the destination involving social networks, the economy, or government policies; and intervening obstacles such as distance or institutional constraints. From an agent-based simulation model, Kniveton et al. (2011) found that the migration or change in residential location is obviously affected by the environment, that is, whether it is dry or wet. They also suggested that the impact of rainfall on choice of location is expressed via its influence on other drivers such as employment opportunities, access to natural resources, national policies and incentives, ecological vulnerability, political instability, and infrastructure. Joarder and Miller (2013) discussed four groups of factors that affect temporary and permanent migration as a result of environmental change, and found that more factors have significant effects on temporary migration than on decisions concerning permanent migration. After a review of empirical research on migration and climate change, Klaiber (2014) confirmed that household relocation arises because of changes in economic opportunities and climate amenities resulting from climate change. Saldana-Zorrilla and Sandberg (2009) found that declining income, better education, and an increasing number of natural disasters led to higher levels of out-migration in response to climate-related disasters in Mexico. On the basis of evidence from two communities in Canada, Wolf et al.

(2013) argued that values such as tradition, freedom, harmony, safety, and unity shape different interpretations of climate change impacts, and as a result lead to distinct adaptation decisions, including migration or relocation. Transportation between residence and job location is an important factor in residence or job location choice. In transportation studies, residence or job location choice are usually addressed in terms of factors such as their relationship with public transport accessibility, travel costs, travel modes, traffic congestion, and departure times (Arentze and Timmermans 2007; Nurlaela and Curtis 2012). However, in reality, decisions to change residence or job location depend on many other socioeconomic factors, such as personal or family attributes and government policies. For example, the balance of residence and job location choices is found to be associated with the population patterns of cities and traditional residence and job location policies (Wang and Chai 2009; Loo and Chow 2011). The influences of physiological factors and gender on residence location choice have also been investigated in the literature (Sermons and Koppelman 2001; Choocharukul et al. 2008). Other studies have investigated many other factors or reasons, and have identified factors such as lack of education, strong attachments to land, age, family size, and the availability of transport infrastructure (Mortreux and Barnett 2009; Doevenspeck 2011; Gray 2011). It could be concluded that although factors that influence decisions to change residence or job location may vary between studies or countries, there is little doubt that people's relocation behavior is associated with climate change.

Most of the above literature focuses on household or residence location choice in response to climate change. However, people may consider changing job location first and residence location thereafter because it is more difficult to move families. There is a consensus that because of the diversity of climate change regimes and culture/habituation in different countries, people's location choice behavior under conditions of climate change may differ (Cools et al. 2010; Böcker 2013a, b). Thus, understanding such choices in different countries is necessary, especially those of developing and vulnerable countries. Given the uncertainties of climate change, people's residence and job location change choice decisions may vary according to different climate change scenarios or in response to events such as rain, river or coastal flooding, and cyclones. All these issues should be addressed with detailed investigations of people's preferences for location choices in various climate change and impact scenarios.

To address the above research gaps, we aim to identify factors that explain the connected choices of residence and job location, including personal and family socioeconomic factors and previous experiences in Bangladesh.

12.3.3 *Adaptive Behavior of Tourists Associated with Climate-Related Disasters*

The World Tourism Organization (2003) has identified extreme weather events resulting from climate change as a critical threat to tourism, especially in coastal regions and developing countries. Damage to destination infrastructure and ecosystems has a devastating impact on tourism demand and may ultimately influence the long-term sustainability of tourism destinations (Gómez Martín 2005; Nicholls 2006).

With regard to the influence of extreme weather events on tourist behavior, most of the existing studies have focused on risks perceived by tourists. Some researchers have found that the perceived influence of travel risks resulting from climate change varies among tourists according to their sociodemographic variables (Lepp and Gibson 2003; Park and Reisinger 2010; Gössling et al. 2012). For instance, some studies show that older people are more sensitive to the risk of weather extremes than younger people (Moreno 2010). Perceptions of weather risks during travel were found to differ according to family status, with single tourists far more resilient to weather than families with children (Limb and Spellman 2001). A study conducted by Denstadli et al. (2011) revealed that foreign tourists perceived the risks from weather conditions to be higher than domestic tourists did. In addition, some external factors have been found to influence tourists' risk perceptions. For example, media coverage of extreme weather events can create a negative image of a destination (Gómez Martín 2005; Perry 2006).

However, tourists' actual and potential response to the impacts of extreme weather events is still an under-researched area (Gössling and Hall 2006; Eugenio-Martin and Campos-Soria 2010; Moore 2010). With increases in the frequency and intensity of extreme weather events (floods, cyclones, droughts, etc.) in recent years, the importance of understanding the impacts of extreme weather events on tourist behavior in policy decisions on future risk management in the development of the tourism industry has been recognized (Law 2006; Gössling et al. 2012). Therefore, this study aims to fill the gap by investigating the adaptation of tourist behavior to climate disasters in the context of Bangladesh.

12.4 Residents' Adaptation Behavior in Bangladesh: Survey

Focusing on climate-related disasters in Bangladesh, we attempt to clarify how people adapted in the past and will adapt in the future to the effects of such disasters. For this purpose, we designed a questionnaire survey that covers people's experiences and understanding of climate disasters, predisaster adaptive behavior, response behavior during disasters, postdisaster recovery behavior, barriers to and important factors in the above behavior, and future adaptive behavior in different disaster scenarios, as well as variables such as household and individual attributes. We administered the survey to residents in the coastal and inland areas in January and February 2013.

12.4.1 Survey Design and Implementation

Here, the term “climate-related disasters” refers to floods, cyclones, storm surges, SLR, tornados, droughts, and other events. The following items are included in the questionnaire survey.

(1) Experience of climate-related disasters: impacts of flood, cyclone, and tornado experienced in the past; number of injured family members, average monetary loss in terms of livestock, housing, farmland, crops, and other property; depth, duration and date of the most serious river flood, rainfall flood, and SLR; frequency that house and land were affected by floods or cyclones, and the average cost of damage on each occasion.
(2) Understanding of climate-related disasters: perception of negative impacts of disasters on quality of life, and perception of frequency and seriousness of disasters in recent years.
(3) Adaptation of behavior to damage.

- Predisaster adaptation behavior.
    - Concern about future risks of disasters to family, house, property, etc.
    - Response measures to the potential risks of disasters: (1) do not prepare, (2) elevate the house, (3) strengthen the house, (4) protect the house using walls, dikes, or similar structure, (5) move to a cyclone/flood shelter, (6) move family, livestock, and property to a safe place, and return after the flood/cyclone, (7) consider a permanent move to a safe place, (8) consult experienced people, and (9) take other measures.
    - Confidence in preparation.
    - Cost of preparation.
- Adaptation during disasters (with respect to the most serious disasters).
    - Measures adopted in addition to those above.
    - Places to move in the case of measures (6) or (7) above: homes of relatives or friends/colleagues, the roadside, a place provided by the government, or another place.
    - A source of disaster information: newspapers, cellphone, radio, TV, Internet, or other sources.
    - Information providers: government, community, neighborhood, own experience, etc.
    - The timing of information: when disaster information is received.
    - Means of evacuation: walking, carts, ox carts, bicycles, rickshaws, and/or motorized vehicles.
    - Help from the government, community, and neighborhood: rescue, food, tents, quilts, clean water, money, and shelter, or no help was received.

    - Help offered to the neighborhood: rescue, food, tents and quilts, clean water, money, or shelter, or no help was offered.
    - Cost of responses during a disaster.

  – Predisaster adaptation behavior.

    - Concern about future risks of disasters to family, house, property, etc.
    - Response measures to the potential risks of disasters: (1) do not prepare, (2) elevate the house, (3) strengthen the house, (4) protect the house using walls, dikes, or similar structure, (5) move to a cyclone/flood shelter, (6) move family, livestock, and property to a safe place, and return after the flood/cyclone, (7) consider a permanent move to a safe place, (8) consult experienced people, and (9) take other measures.
    - Confidence in preparation.
    - Cost of preparation.

(4) Satisfaction with the measures before, during, and after a flood inundation, cyclone, SLR, sea water intrusion, drought, tornado, or other events (if they had had no such experience, respondents did not need to answer).
(5) The relative importance of predisaster preparation, responses during a disaster, and postdisaster recovery.
(6) The greatest difficulties in adapting to the impacts of disasters: lack of money, lack of knowledge, lack of government policy, lack of help from the government, lack of help from the community, lack of help from the neighborhood, etc.
(7) The relative importance of the roles of government, community, neighborhood, and self-help throughout the process of resisting disasters.
(8) Priority levels of the following measures for different stakeholders (government, community, and neighborhood): predisaster measures (building dikes/seawalls, elevated roads, or shelters, elevating houses, or establishing an early warning system), responses during a disaster (reinforcing houses, evacuation assistance, moving to safe places, sourcing quilts and groceries, medical care, or money), and postdisaster actions (repairing houses, finding vacant land for relocation, finding jobs in the city, or finding jobs abroad).
(9) Future plans to adapt to natural disasters.

  – Possible adaptation choices: (1) do not prepare, (2) elevate the house, (3) strengthen the house, (4) protect the house using walls, dikes, or similar, (5) move to a cyclone/flood shelter, (6) move family, livestock, and property to a safe place, and return after the flood/cyclone, (7) consider a permanent move to a safe place, (8) consult experienced people, etc.
  – Estimation of the impact of disasters when constructing or retrofitting houses.
  – Estimation of the potential impact of disasters when choosing a new job.
  – Important factors affecting the choice of adaptation measures: cost, effectiveness, ease of implementation, level of risk, previous experience, etc.

– Willingness to accept compensation from the government if it could not properly protect the respondents' house, land, and/or work from disasters.

(10) Stated adaptation behaviors in various flood or cyclone scenarios with respect to intercity travel and life choices: 16 scenarios were designed for floods or cyclones, based on a stated preference (SP) survey. Each respondent was asked to report their adaptation choices with respect to both floods and cyclones, each with four scenarios. In other words, the above 16 scenarios were divided into four groups to reduce the burden on respondents. For detailed descriptions, refer to Sect. 5.

We administered the survey to residents living in the coastal and inland areas of Bangladesh from the end of January to the beginning of March 2013. In the SP survey, future scenarios of disasters are assumed with respect to floods and cyclones separately, based on an orthogonal experiment, where SP attributes include frequency and intensity of floods and cyclones, and four attributes describing flood/cyclone impacts (inundation, damage to residential areas, damages to roads, and salinity intrusion). Note that salinity intrusion is only introduced into the coastal scenarios. In total, 16 SP profiles are derived. To reduce the answering burden, each respondent was randomly assigned four SP profiles. These attributes and their levels were assumed based on historical data in Bangladesh. Under each scenario, every respondent was requested to choose one out of six choices: Choice 1 (do not change job, do not change residential location, and do not reinforce the house), Choice 2 (do not change job, do not change residential location, but reinforce the house), Choice 3 (change job, do not change residential location, and do not reinforce the house), Choice 4 (change job, do not change residential location, but reinforce the house), Choice 5 (do not change job, but change residential location), Choice 6 (change job and change residential location). A total of 998 respondents participated in the survey.

There were three survey teams. Each team consisted of one supervisor and several interviewers who conducted the survey in various parts of Bangladesh. Each survey team had one local interpreter to avoid communication difficulties in the local language. We conducted the survey in the following 14 districts, which are frequently affected by cyclone and flood disasters: Chittagong, Cox's Bazar, Khulna, Bagerhat, Satkhira, Barisal, Noakhali, Faridpur, Patuakhali, Bhola, Jessore, Bogra, Gaibandha, and Sirajgonj (see Fig. 12.2).

Most cities are located in the central southern area, along the east coast and its largest river, which are the country's low-lying areas. The nine coastal cities lie on the central eastern coast; they include Chittagong, the nation's second biggest city, and Cox's Bazar, a tourism city. The western coastal region is a mangrove area, and no city in that area was included. The five inland cities include three in the eastern part of the country, one in the north, and one in the west.

Because many of the respondents could not read and/or write, we decided to ask interviewers to interview respondents and fill in the questionnaire forms themselves instead of asking respondents to do so. The respondents were given gifts in the form of food/clothing in return for their time on the survey. For difficult

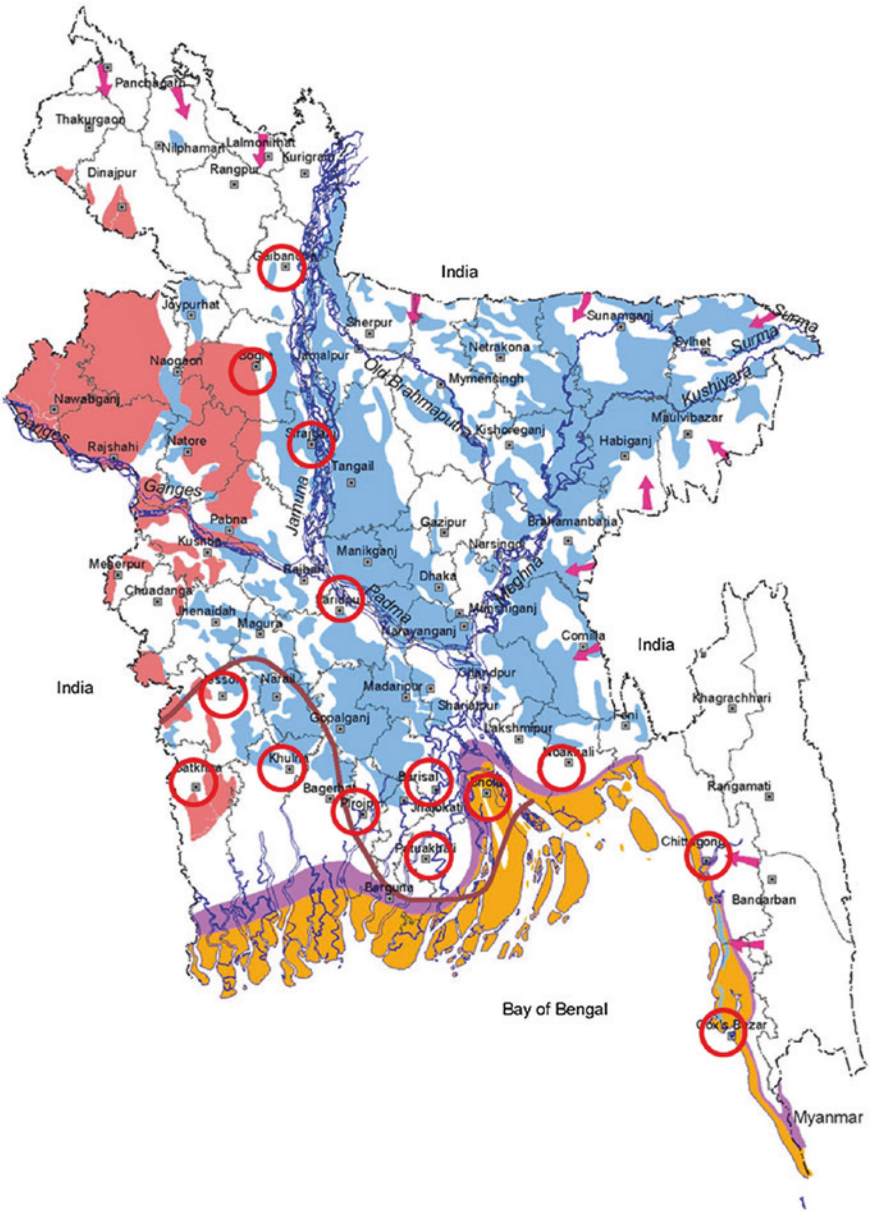


Fig. 12.2 Distribution of survey areas in disaster-prone regions in Bangladesh

questions (e.g., the SP parts, or those on perceptions and capability), the questions were first explained with examples before the respondents answered.

Profiles of respondents and their households are shown in Fig. 12.3. As for the respondents' ages, 27 % were in their 20s, 32 % were in their 30s, and 22 % were

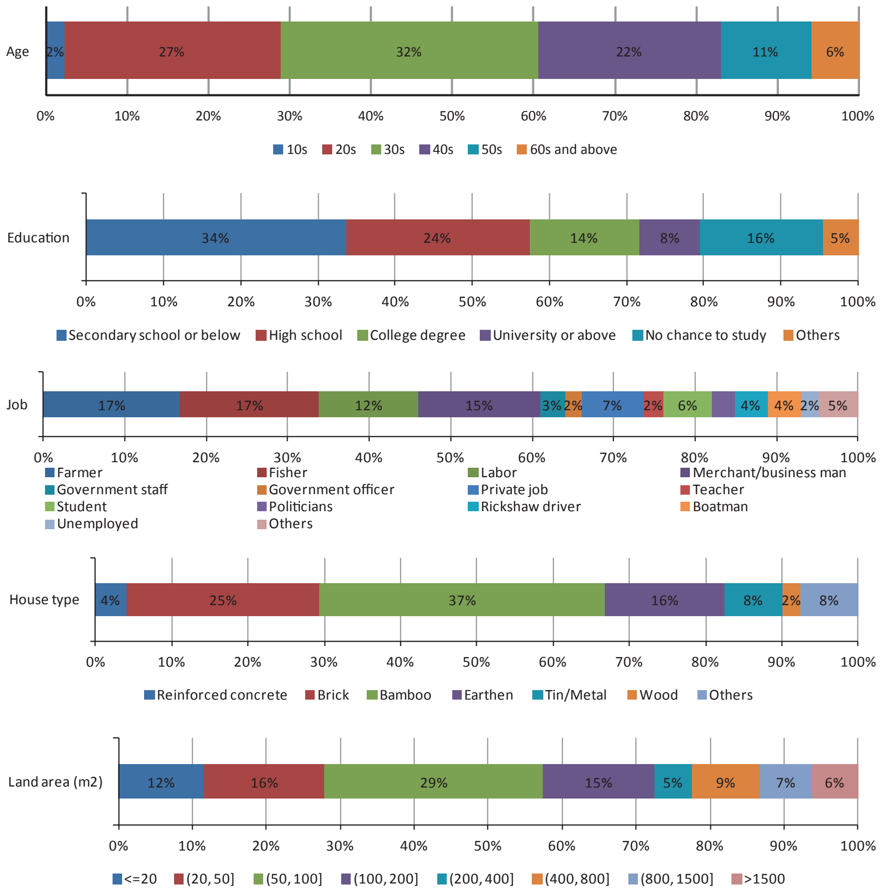


Fig. 12.3 Profiles of respondents and their households

in their 40s. The largest group of respondents were those with secondary school education or less (34 %), and 16 % had had no opportunity to study. High school graduates were the second largest group of respondents (24 %). Those who had graduate or postgraduate education accounted for just 22 %. Concerning occupation, farmers and fishers each accounted for 17 %; 12 % were laborers, 15 % were merchants and businessmen, 4 % were rickshaw drivers, and only 5 % of respondents worked in government offices. Among the respondents, 37 % lived in bamboo houses (the largest group), 25 % in brick houses, and 16 % in earthen houses. Only 4 % of respondents lived in reinforced concrete houses. Among the respondents, 28 % had a piece of land of no more than 50 m^2 in area. Respondents with between 50 and 100 m^2 of land were the largest group, and 22 % of respondents owned more than 400 m^2 of land.

12.4.2 Aggregation Analysis

We start with an analysis of people's understanding and experience of natural disasters, and then explore how people prepared for and adapted to natural disasters in the past. After that, we examine how people intend to adapt to future natural disasters in different scenarios. Here we aim to identify the barriers to adaptation measures in Bangladesh, the roles of stakeholders in implementing adaptation measures, and future directions for adaptation measures.

Experiences and Understanding of Climate Change Disasters

The numbers of people injured by floods, cyclones, and tornados in the past are shown in Fig. 12.4. Floods and tornados injured similar numbers of people: 8 % of respondents had one injured family member, 4 % had two, and 1 % had three or more family members who had suffered injury.

Regarding damages to property caused by floods, cyclones, and tornados, respectively, (1) 47, 62, and 15 % of households suffered loss of livestock; (2) 53, 73, and 22 % of households suffered damage to their houses, and (3) 44, 57, and 13 % of households suffered from farmland and crop damage.

The incidences of houses and land being affected by floods and cyclones are shown in Fig. 12.5. We found that only 2–3 % of respondents had not been affected frequently by floods and cyclones, and 47 % were affected by floods and 41 % by cyclones at least once a year. Even though cyclones do not occur every year, a large number of respondents still report damage. This surely indicates the seriousness of water disasters, but at the same time, it suggests misunderstandings about cyclones. As for impacts on life as a whole, we asked respondents "to what extent do you think disasters negatively affect your quality of life, including daily travel?" (see Fig. 12.6). Almost all the coastal people endure the impacts of disasters, and more than 80 % of them are at least seriously affected. This is different from the answers of the inland people, of whom only half report more serious effects, and more than 20 % report that their quality of life is not affected at all. More than three times the number of respondents in the coastal area report negative effects than in the inland area. As a result, there are obvious differences between coastal and inland areas in the answers to the first question. As for future

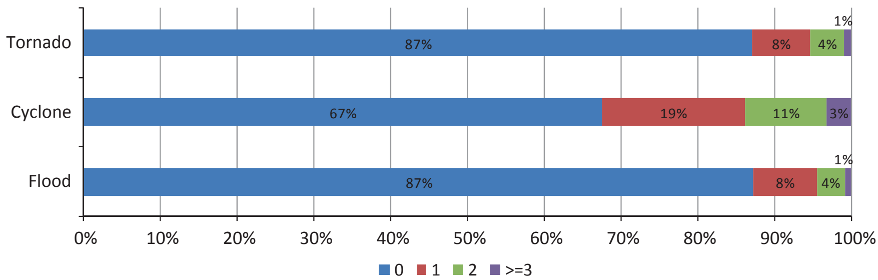


Fig. 12.4 Numbers of injured people caused by flood, cyclone, and tornado in the past

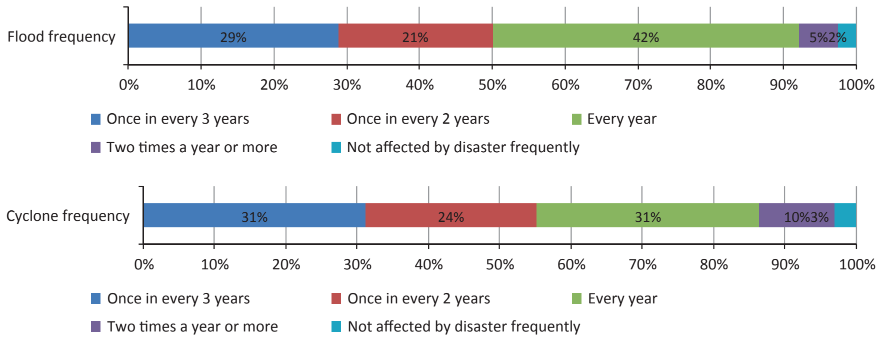
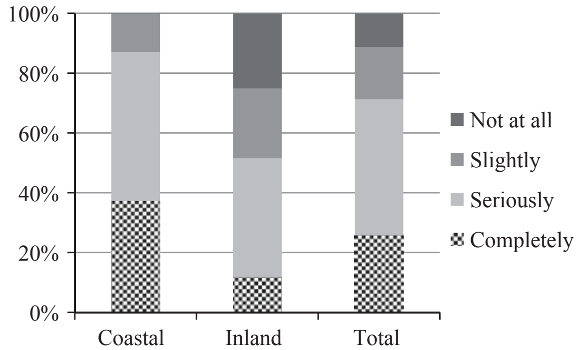


Fig. 12.5 Frequencies that houses and land are affected by flood and cyclone

Fig. 12.6 Flood impacts on people's quality of life



impacts, we asked one further question: "Do you think that climate-related disasters have become more frequent and severe in recent years?" (Fig. 12.7). More than 60 % of people believed that disasters were becoming more frequent and severe in both areas, and this percentage was slightly higher in the inland areas than in the coastal area. However, fewer people on the coast are sure about their responses, whereas a higher percentage of people gave a negative answer in the inland area. This indicates that the climate varies much more on the coast than in the inland area, and the inland people are more sensitive to climate change and accept the reality of more frequent and serious disasters in recent years. Comparing the answers of coastal and inland people, we find more differences in Fig. 12.6 than in Fig. 12.7. A general conclusion drawn from the above results is that most people are affected by disasters related to climate change and believe the impacts are more serious in the coastal areas than in the inland areas of Bangladesh.

Adaptation Measures

Adaptation measures taken before disasters are shown in Fig. 12.8. It is found that more than 30 % of respondents did not prepare for climate disasters. Of those who

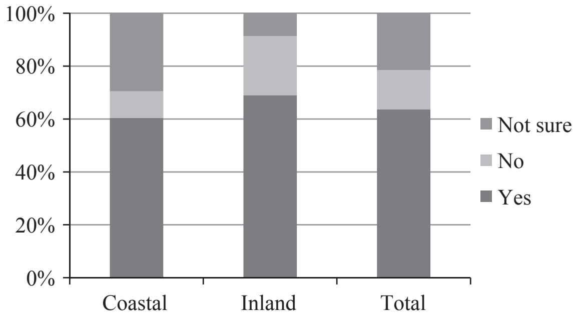


Fig. 12.7 People's attitude towards climate change

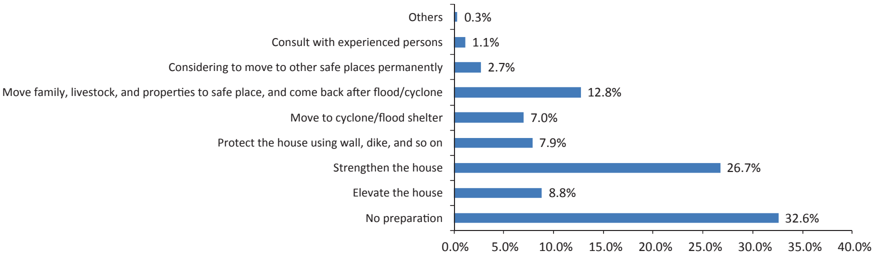


Fig. 12.8 Adaptation measures prepared before disasters

did, 26.7 % strengthened their houses; 12.8 % moved their families, livestock, and property to safe places and returned after a disaster; 8.8 % elevated their houses; and 7.9 % protected their houses using walls, dikes, and similar measures.

Unlike the measures taken before disasters, 32.6 % of respondents, which is the largest proportion, moved their families, livestock, and property to safe places and returned after a disaster; 15.1 % moved to cyclone/flood shelters; and 27.9 % strengthened their houses and remained there (14.2 %), protecting their houses using walls, dikes, and similar measures (8.8 %), or elevating their houses (4.9 %). These percentage values are shown in Fig. 12.9. As for the means of evacuation during disasters (see Fig. 12.10), 64.5 % of respondents evacuated on foot; only 7.6 % used motorized vehicles, and others used very slow travel modes including carts (4.2 %), cattle (4.2 %), bicycles (5.3 %), and rickshaws (14.3 %). Figure 12.11 shows help received and offered during disasters. It is observed that 21.0, 35.1, and 70.9 % of respondents did not receive any help from the government, the community, and the neighborhood. It is also revealed that 79.0 % provided no help to their neighbors. Nearly 40 % of respondents received food, but only 22.4 % received it from the community. As for clean water, 23.4 and 22.5 % of respondents received clean water from the government and communities, respectively. Mutual help within neighborhoods was not popular in the sense that only a very low percentage of respondents received help from and provided help

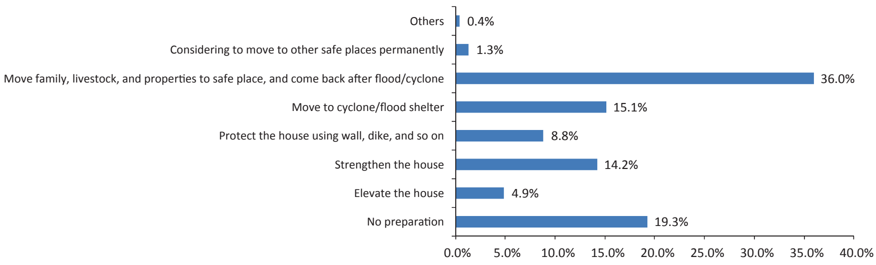


Fig. 12.9 Adaptation measures taken during disasters

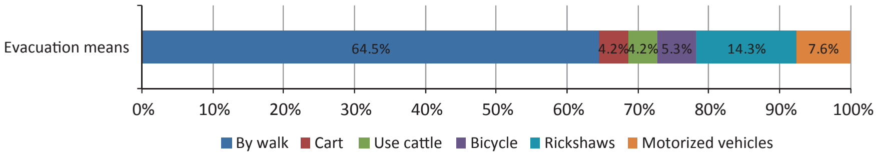


Fig. 12.10 Evacuation means during disasters

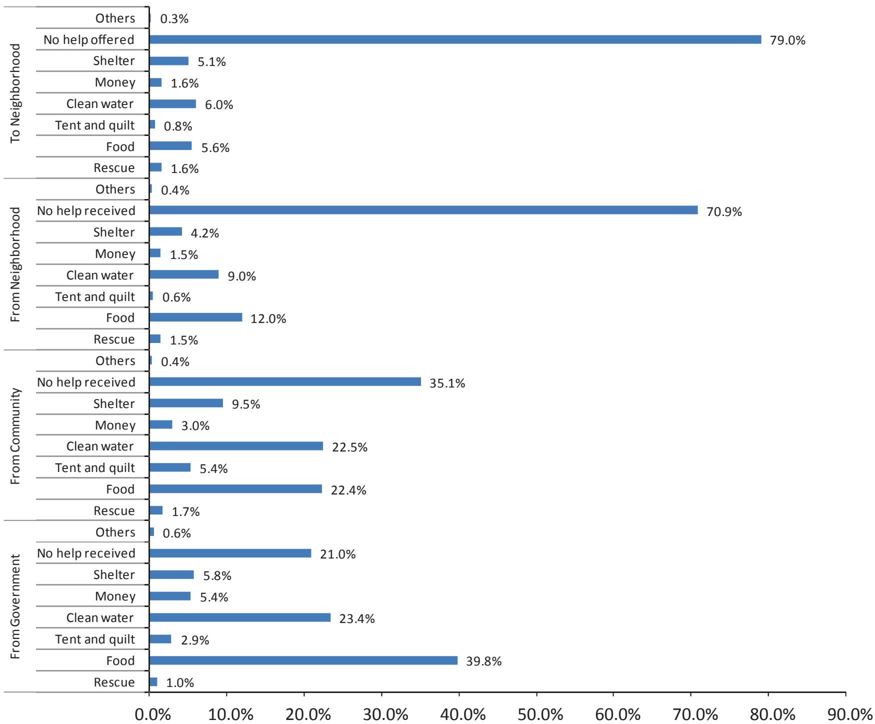


Fig. 12.11 Help received/offered during disasters

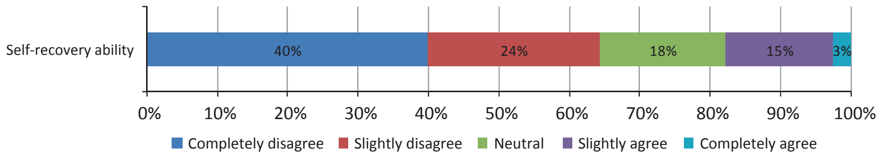


Fig. 12.12 Evaluation of self-recovery ability

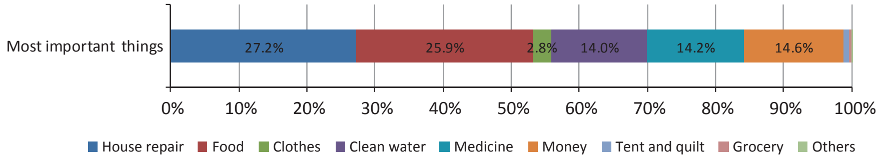


Fig. 12.13 The most important things during the recovery evaluated by respondents

to their neighbors. Communities provided shelter to 9.5 % of respondents, but the government provided it to only 5.8 %.

Figure 12.12 shows the respondents' evaluations of their ability to recover after disasters. We found that only 18 % of respondents are capable of recovering. Respondents reported that the most important aspects of recovery are house repairs (27.2 %), food (25.9 %), money (14.6 %), medicine (14.2 %), and clean water (14.0 %) (see Fig. 12.13). As time passes after a disaster, more people receive help from the government and communities (those who received no help decreased to 13.9 and 24.9 %, respectively, compared with the periods during disasters), but not from neighborhoods (which increased to 77.8 %, compared with the periods during disasters) (see Fig. 12.14).

As for future adaptation plans (Fig. 12.15), it is found that 26.0 % of respondents want to strengthen their houses; 16.8 % want to move their families, livestock, and property to safe places and return after disasters; but 24.6 % were unprepared.

Comparisons among predisaster adaptation measures, those during disasters, and those planned for the future are shown in Fig. 12.16, from which the item "consult with experienced people" before disasters is deleted and the percentages of other items recalculated. We found that past experiences encourage more people to protect their houses using measures such as walls and dikes (the corresponding share of respondents increases from 8.0 % before disasters and 8.8 % during disasters to 13.6 in the future) and to consider moving to other safe places permanently (the share increases from 2.7 % before disasters and 1.3 % during disasters to 4.8 % in the future), but discourage more people from moving to cyclone/flood shelters (the percentage decreases from current before and during disasters of 7.1 and 15.1 % to future 5.6 %). A moderate proportion of respondents make adaptation plans for the periods before and during disasters with respect to other measures.

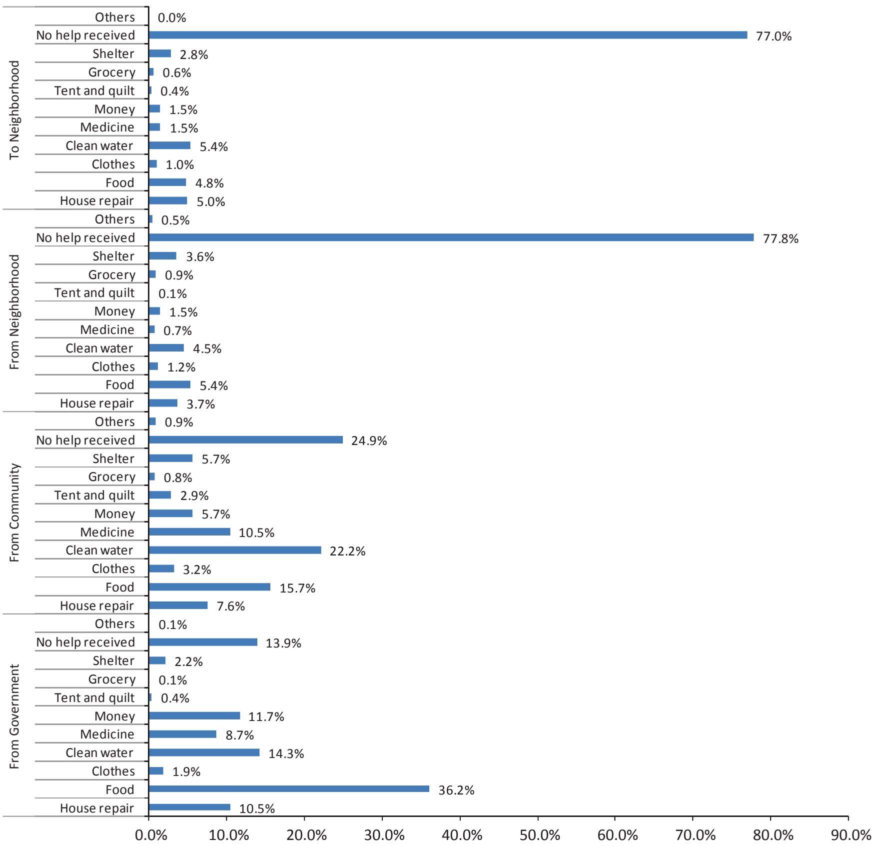


Fig. 12.14 Help received/offered after-disasters recovery

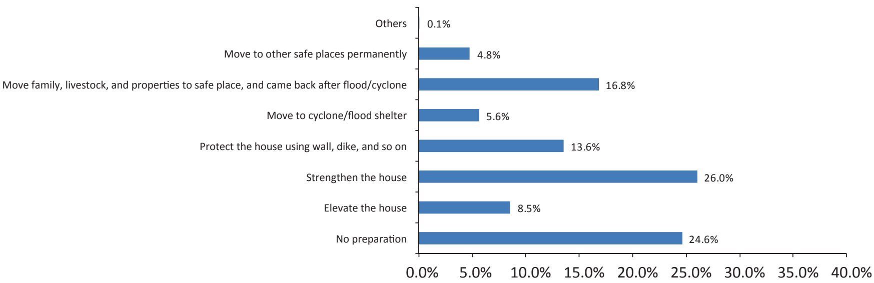


Fig. 12.15 Future adaptation plans

Barriers and Capability of Adaptation Measures

It is observed (see Fig. 12.17) that the current major difficulties in adapting to the impacts of climate disasters include lack of money (reported by 32.9 % of

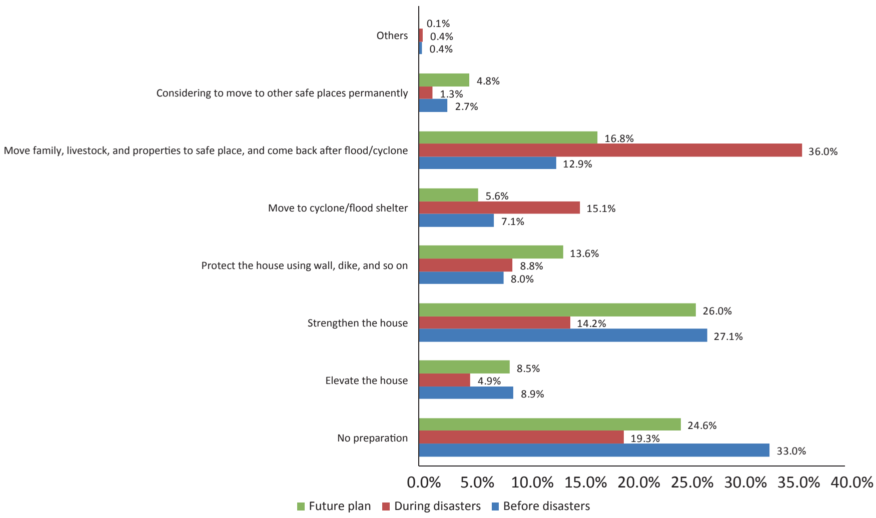


Fig. 12.16 Comparisons between before-disasters, during-disasters, and future adaptation measures

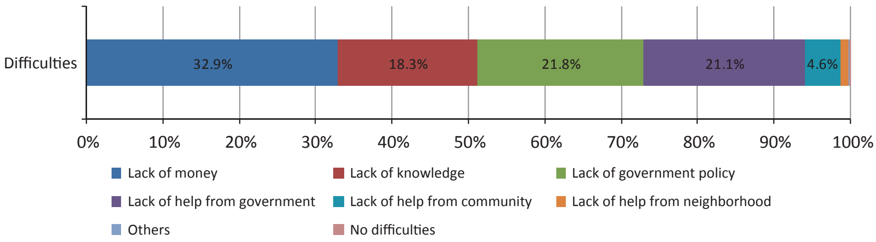


Fig. 12.17 Current major difficulties in adapting to the impacts of climate disasters

respondents), lack of government policy (21.8 %), lack of help from the government (21.1 %), and lack of knowledge (18.3 %). It is obvious that more than 40 % of difficulties come from the government side.

Figure 12.18 shows that some respondents are capable of dealing with adaptation measures in terms of finances, physical strength, family structure, help from neighbors, knowledge of countermeasures, and time. It is confirmed that 53.1 % of respondents are entirely unable to manage financially, and for 47.6 % of respondents no such help is available from neighbors. Figure 12.17 shows that very few people report difficulties arising from lack of help from neighbors, probably because no such help is available. In other words, this may indicate that many people have only limited resources for themselves, so they cannot provide any help for their neighbors. Other capability indicators show that about 10–20 %

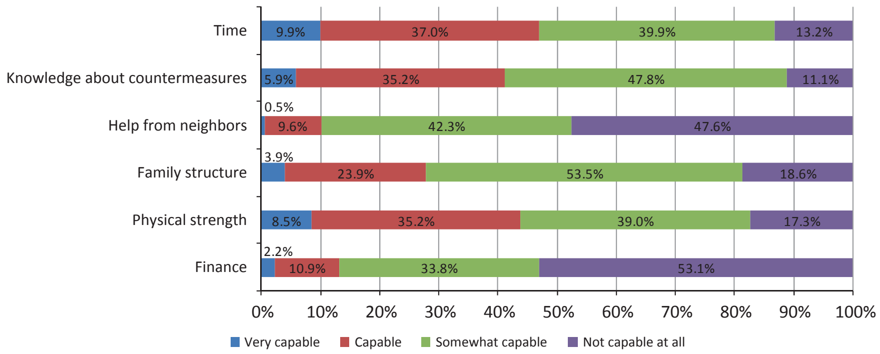


Fig. 12.18 Capabilities in dealing with adaptation measures

of respondents surely have insufficient capability, and few people are confident in their capabilities in terms of family structure compared with other indicators.

12.5 Stated Household Adaptation to Disasters in Bangladesh

In the above questionnaire survey, household adaptation is divided into two types: intercity travel and more general life adaptation (including job, residential location, and housing). Here, only the SP data are used to understand how households will adapt to future floods and cyclones. Because the impacts of these climate-related disasters may differ considerably between the coastal area and the inland area, we conducted the survey in both areas.

12.5.1 Stated Intercity Travel Behavior Analysis

To quantify the influence of future disasters on intercity travel behavior, we designed an SP survey. Because cyclones often occur in the coastal areas of Bangladesh, we prepared future scenarios for both floods and cyclones for respondents residing in the coastal area, but only flooding scenarios for the inland respondents.

First, as for the choice set in the SP survey, respondents were asked to choose one of the following five alternatives for various disaster scenarios:

(1) continue to travel as usual;
(2) cancel the trip;
(3) change the travel mode/route;

(4) change the destination;
(5) change the departure time.

Second, the disaster scenarios are designed as follows. The SP attributes were selected based on the common flooding impacts that people in Bangladesh are currently enduring, those observed in various streams of literature, and future predictions by Lee (2013).

Flood scenarios are defined by the following attributes at different levels:

– frequency (three levels): once every year, every two years or every three years;
– intensity represented in terms of water depth (three levels): on an adult of average size; water reaches knees, waist, or chest or above;
– whether permanent/frequent inundation occurs (two levels): yes or no;
– whether the residential area is isolated by water (two levels): yes or no;
– whether roads to other cities are destroyed permanently (two levels): yes or no.

Cyclone scenarios are defined by the following attributes at different levels:

– frequency (three levels): twice a year, every year, once every two years;
– intensity (three levels): some structural damage to houses, complete collapse of some houses, or complete failure of many houses;
– whether permanent/frequent inundation occurs (two levels): yes or no;
– whether the residential area is isolated by water (two levels): yes or no;
– whether roads to other cities are destroyed permanently (two levels): yes or no.

Based on an orthogonal experiment, we obtained a total of 16 disaster scenarios. To reduce the burden on respondents, these 16 scenarios were divided into four groups. Each respondent received only one group of four scenarios. The four groups were distributed equally among the survey respondents, so that each scenario would be presented to a quarter of the total sample during the implementation stage. Unfortunately, at the data collection stage, equal sample sizes for groups could not be guaranteed. For each scenario, the respondent was asked to choose one of the aforementioned five alternatives: i.e., (a) continue to travel as usual, (b) cancel the trip, (c) change the travel mode/route, (d) change the destination, or (e) change the departure time.

Before the questions on intercity travel behavior were answered, current behavior was also reported with respect to three main destinations (destination name, trip purpose, frequency of visits, main travel mode, travel cost, and travel time).

12.5.1.1 Aggregation Analysis

Figure 12.19 shows the results of people's intercity travel behavior responses as a whole, in all given disaster scenarios derived from the orthogonal experiment design. Among all the travel choices under flooding, more people in both coastal and inland areas chose "(a) continue to travel as usual" than other alternatives. A higher percentage of people in the coastal area indicated they would not change

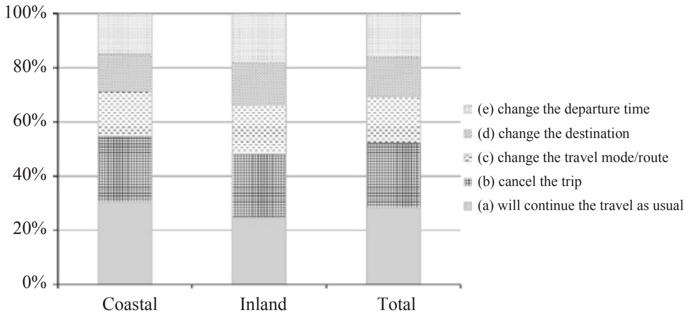


Fig. 12.19 Discriptive of people's intercity travel choice under flooding as a result of climate change

their behavior, indicating that coastal people are more passive and accustomed to the impacts of flooding. The proportions that chose other travel choices such as "(c) change travel mode/route" and "(e) change departure time" were slightly higher in the inland area, but the proportion of respondents who chose "(b) cancel the trip" was similar in both areas. This suggests that people in the inland area are slightly more inclined to change their travel plans if flood conditions change, and coastal people may be more sophisticated in adapting their travel behavior. However, the area makes no difference in the choice to cancel trips. Generally, more people would either travel with no change or cancel trips than make other changes, as the "(a) continue to travel as usual" and "(b) cancel the trip" choices account for more than 50 % of the responses.

Figures 12.20, 12.21 and 12.22 show the reported adaptations to intercity travel behavior associated with different impacts of disasters.

Comparing these three figures, one can easily observe that in many cases, "(a) continue to travel as usual" shows the largest proportion of respondents. In other words, even in severe disasters, a large proportion of people would still continue their intercity trips as usual. This suggests that participating in these intercity trips as usual is important to their lives. Similarly, the proportion that chose "(b) cancel the trip" is also high. For disaster frequency, there is a larger gap between the proportions selecting alternatives (a) and (b), associated with "once every three years", "once every two years", and "every year."

The alternatives "(c) change the travel route", "(d) change the destination", and "(e) change the departure time" indicate that people continue to make intercity trips, but change the way they do so. These three alternatives account for the largest share of responses, and in many cases their total share exceeds 50 %. Among the three alternatives, "(e) change the departure time" is influenced less by disasters than are the other two alternatives.

As for trip cancelation, when the flood reaches the waist of an average-sized adult in the inland area, the largest proportion of trip cancelations is reported (40 %). This may be because in the inland area, if the water level just reaches the

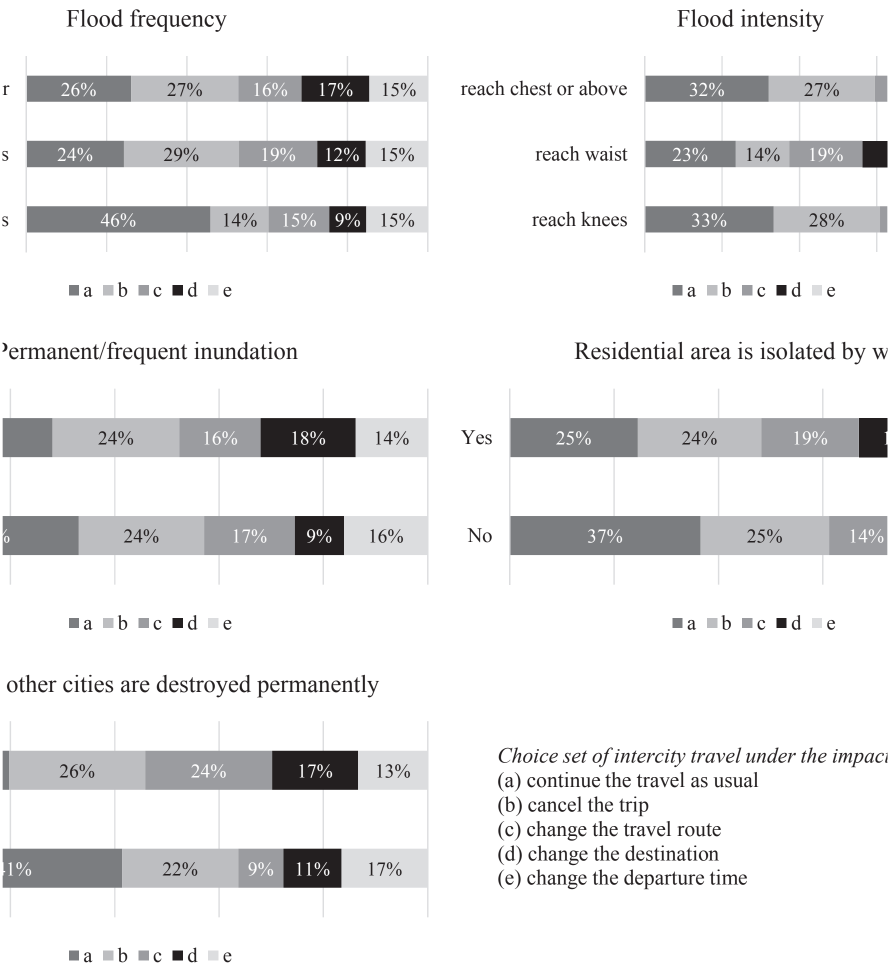


Fig. 12.20 Intercity travel adaptation behavior in the coastal area and flood

knees of an average-sized adult, continuing the intercity trip may not be as difficult as expected, while if the water level reaches the chest or above, suggesting deep water, people in the inland area may use boats for intercity trips. The lowest rate of cancelation was observed with respect to floods “once every three years” in the inland area (cancelation: 12 %) and the impact of flood intensity where the water “reaches the waist” “once every three years” in the coastal area (rate of cancelations in both cases: 14 %).

In short, people in Bangladesh show diverse patterns of adaptation to climate-related disasters. As expected, the impacts of disasters seem large; however, the above aggregation analysis cannot inform policy makers about the extent of adaptation to different aspects of disasters, which are expected to be linked to different policies for mitigating the impacts of disasters.

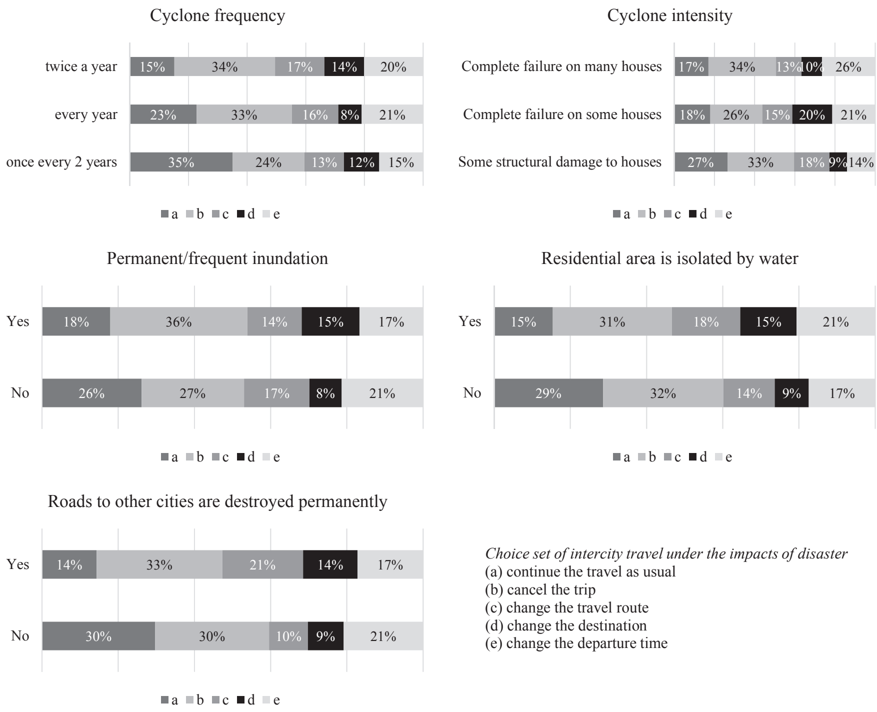


Fig. 12.21 Intercity travel adaptation behavior in the coastal area and cyclone

12.5.1.2 Modeling Analysis

In this section, a multinomial logit (MNL) model was used to represent intercity travel adaptation in the following three cases: floods and cyclones in the coastal area, and flooding in the inland area. In the model estimation, "(e) change the departure time" is treated as a reference alternative for estimating unknown parameters. In addition, the following variables are used as explanatory variables:

- Flood and cyclone attributes: all SP attributes including disaster frequency (once a year, once every two years, once every three years), disaster intensity (floods: on an average-sized adult reaches knees, reaches waist, reaches chest or above; cyclones: some structural damage to houses, complete collapse of some houses, complete collapse of many houses), permanent salinity intrusion (yes or no: only for life adaptation behavior in the coastal area), permanent or frequent inundation (yes or no), whether residential area is isolated by water (yes or no), whether roads to other cities are destroyed permanently (yes or no);
- Self-help variables: financial ability (1. very capable, 2. capable, 3. somewhat capable, 4. not capable at all), physical strength (1. very capable, 2. capable, 3. somewhat capable, 4. not capable at all), capability of family structure

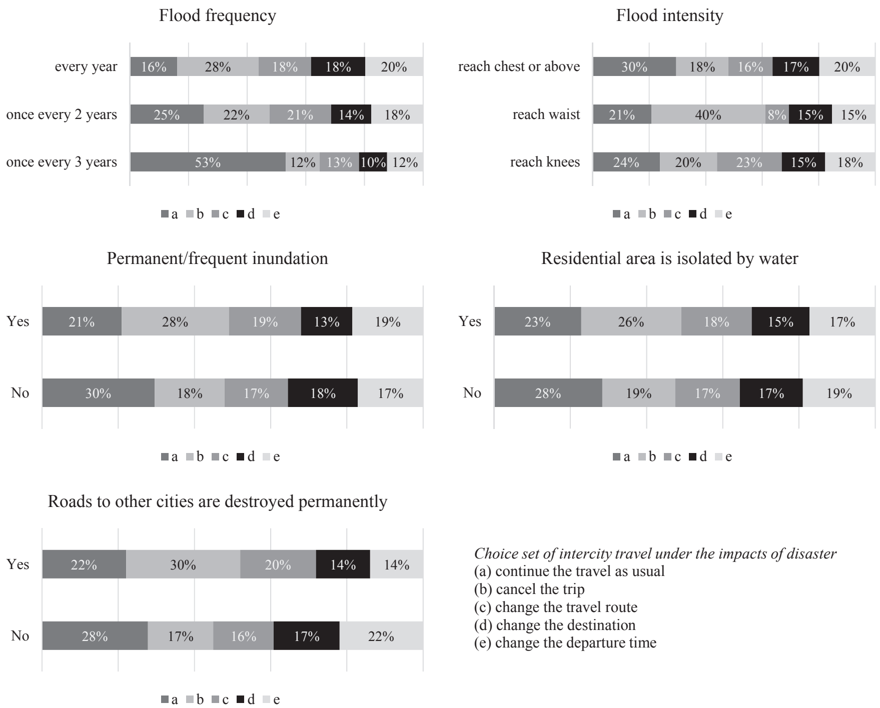


Fig. 12.22 Intercity travel adaptation behavior in the inland area and flood **a** Flooding and cyclone frequency. **b** Flooding and cyclone intensity. Note: IFLF means inland flood frequency which decreases from IFLF1 to IFLF3; CFLF denotes coastal flood frequency which decreases from CFLF1 to CFLF3; CLF means coastal cyclone frequency which decreases from CLF1 to CLF3; IFLI denotes inland flood intensity which increases from IFLI1 to IFLI3; CFLI means coastal flood intensity which increases from CFLI1 to CFLI3; CLI denotes coastal cyclone intensity which increases from CLI1 to CLI3

(1. very capable, 2. capable, 3. somewhat capable, 4. not capable at all), help available from neighbors (1. very available, 2. available, 3. somewhat available, 4. not available at all), knowledge of countermeasures against disaster (1. much knowledge, 2. moderate knowledge, 3. a little knowledge, 4. no knowledge), time available (1. much time, 2. some time, 3. little time, 4. no time);

- Mutual help and public help variables (i.e., social capital variables): help from government during the recovery period, help from community during the recovery period, and help from neighborhood during the recovery period in terms of: 1. house repair, 2. food, 3. clothes, 4. clean water, 5. medicine, 6. money, 7. tent and quilts, 8. grocery, 9. shelter, 10. no help received, 11. other help;
- Recovery variables: recovery time, recovery cost (recover to normal life from the impacts of disaster).

As a measure of model accuracy (see Tables 12.1, 12.2 and 12.3), McFadden's rho-squared values range between 0.1047 and 0.1071. This is not sufficiently high,

Table 12.1 Estimation results of household intercity travel adaptation behavior model: flood at the coastal area

Reference alternative in estimation: (e) change the departure time	(a) will continue the travel as usual				(b) cancel the trip			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	1.945	2.813	**		−1.301	−1.784	+	
Disaster frequency	−0.684	−3.004	**	7.2	0.566	2.409	*	9.8
Disaster intensity	−0.109	−1.325		1.8	−0.107	−1.276		2.7
Inundation	−0.011	−0.078		0.01	0.232	1.667	+	4.8
Isolated by water	−0.682	−4.764	**	22.6	−0.258	−1.781	+	5.9
Road destroyed	−0.572	−4.145	**	15.8	0.427	3.049	**	12.6
Financial ability	0.189	1.670	+	3.1	0.251	2.156	*	10.7
Physical strength	0.098	0.931		1.0	0.139	1.279		4.3
Capability of family structure	−0.176	−1.574		2.9	−0.095	−0.822		1.6
Available help from neighborhood	−0.159	−1.452		1.7	−0.149	−1.318		3.5
Knowledge about disaster	0.372	3.461	**	12.1	0.203	1.865	+	7.8
Available time to tackle disaster	0.061	0.645		0.4	0.240	2.442	*	10.8
Help from government during recovery	−0.454	−2.200	*	7.8	−0.208	−0.960		2.6
Help from community during recovery	−0.493	−2.832	**	10.7	−0.432	−2.423	*	14.7
Help from neighborhood during recovery	−0.671	−3.542	**	9.6	−0.333	−1.739	+	5.1
Recovery time	0.003	1.187		2.0	0.003	0.993		2.9
Recovery cost	−0.066	−1.073		1.2	0.025	0.379		0.3
Reference alternative in estimation: (e) change the departure time	(c) change the travel route				(d) change the destination			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	−0.924	−1.167			−1.189	−1.435		
Disaster frequency	−0.041	−0.159		0.03	0.977	3.516	**	13.9
Disaster intensity	−0.123	−1.297		1.5	0.014	0.140		0.02
Inundation	0.085	0.558		0.3.	0.782	4.809	**	24.9
Isolated by water	0.067	0.428		0.2	−0.011	−0.067		0.01
Road destroyed	1.288	8.099	**	74.3	0.594	3.685	**	14.3
Financial ability	0.219	1.765	+	4.3	0.017	0.132		0.02
Physical strength	−0.192	−1.646	+	4.8	−0.282	−2.330	*	8.7
Capability of family structure	0.000	0.002		0.00	−0.009	−0.073		0.01

Table 12.1 (continued)

Reference alternative in estimation: (e) change the departure time	(c) change the travel route				(d) change the destination			
Available help from neighborhood	0.079	0.658		0.4	0.327	2.588	**	6.1
Knowledge about disaster	0.133	1.117		1.5	0.309	2.486	*	7.3
Available time to tackle disaster	0.085	0.801		0.8	−0.079	−0.719		0.6
Help from government during recovery	−0.021	−0.092		0.01	−0.055	−0.233		0.1
Help from community during recovery	−0.207	−1.063		1.6	−0.457	−2.318	*	8.0
Help from neighborhood during recovery	0.126	0.637		0.5	−0.295	−1.347		2.1
Recovery time	0.005	1.720	+	4.0	−0.001	−0.149		0.02
Recovery cost	−0.120	−1.837	+	5.7	−0.187	−2.838	**	14.0

Initial log-likelihood: −3836.900; Final log-likelihood: −3435.248; McFadden's Rho-squared: 0.1047; Adjusted McFadden's Rho-squared: 0.0983; Sample size: 2384 SP responses
Note + Signicant at the 10 % level; *Signicant at the 5 % level; **Signicant at the 1 % level; *VR* variance ratio in the total variance

Table 12.2 Estimation results of household intercity travel adaptation behavior model: Cyclone at the coastal area

Reference alternative in estimation: (e) change the departure time	(a) will continue the travel as usual				(b) cancel the trip			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	3.142	4.442	**		−0.211	−0.331		
Disaster frequency	−0.682	−6.269	**	23.6	0.039	0.398		0.2
Disaster intensity	−0.501	−5.798	**	19.0	−0.296	−4.040	**	22.9
Inundation	−0.139	−1.011		0.6	0.615	4.975	**	33.0
Isolated by water	−0.866	−5.831	**	20.2	−0.114	−0.879		1.2
Road destroyed	−0.618	−4.361	**	10.0	0.375	3.005	**	2.5
Financial ability	0.217	1.840	+	2.5	0.136	1.324		3.4
Physical strength	0.015	0.143		0.01	0.017	0.173		0.1
Capability of family structure	−0.041	−0.355		0.1	0.038	0.376		0.2
Available help from neighborhood	−0.232	−2.031	*	2.2	−0.210	−2.115	*	7.0
Knowledge about disaster	0.184	1.695	+	1.9	0.060	0.634		0.7
Available time to tackle disaster	−0.014	−0.145		0.0	0.162	1.885	+	5.1

Table 12.2 (continued)

Reference alternative in estimation: (e) change the departure time	(a) will continue the travel as usual				(b) cancel the trip			
Help from government during recovery	−0.695	−3.470	**	12.2	−0.194	−1.040		2.2
Help from community during recovery	−0.295	−1.738	+	2.4	−0.010	−0.068		0.01
Help from neighborhood during recovery	−0.586	−2.939	**	4.3	−0.083	−0.494		0.4
Recovery time	0.003	1.049		0.8	0.005	1.978	*	9.5
Recovery cost	−0.029	−0.484		0.2	0.057	1.054		1.8
Reference alternative in estimation: (e) change the departure time	(c) change the travel route				(d) change the destination			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	−0.807	−1.051			−0.352	−0.437		
Disaster frequency	−0.050	−0.430		0.2	0.129	0.996		2.0
Disaster intensity	−0.432	−4.790	**	26.6	−0.163	−1.664	+	4.0
Inundation	0.170	1.162		1.6	0.860	5.347	**	45.7
Isolated by water	0.205	1.359		2.3	0.301	1.788	+	5.7
Road destroyed	1.005	6.712	**	49.1	0.662	4.145	**	28.3
Financial ability	0.085	0.702		0.8	−0.001	−0.012		0.00
Physical strength	0.008	0.075		0.01	−0.141	−1.171		3.5
Capability of family structure	0.213	1.785	+	5.1	−0.089	−0.696		1.0
Available help from neighborhood	0.028	0.240		0.1	−0.086	−0.701		0.8
Knowledge about disaster	−0.136	−1.204		2.1	0.082	0.664		0.8
Available time to tackle disaster	0.021	0.208		0.1	0.011	0.097		0.02
Help from government during recovery	−0.007	−0.031		0.00	−0.206	−0.894		2.1
Help from community during recovery	0.140	0.771		0.9	0.186	0.962		2.0
Help from neighborhood during recovery	−0.131	−0.656		0.5	−0.194	−0.900		1.6
Recovery time	0.006	2.365	*	9.7	0.002	0.676		0.8
Recovery cost	−0.049	−0.794		1.0	−0.058	−0.911		1.8

Initial log-likelihood: −3836.900; Final log-likelihood: −3425.993; McFadden's Rho-squared: 0.1071; Adjusted McFadden's Rho-squared: 0.1007; Sample size: 2384 SP responses
Note + Signicant at the 10 % level; *Signicant at the 5 % level; **Signicant at the 1 % level; *VR* variance ratio in the total variance

Table 12.3 Estimation results of household intercity travel adaptation behavior model: flood at the inland area

Reference alternative in estimation: (e) change the departure time	(a) will continue the travel as usual				(b) cancel the trip			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	1.738	2.387	*		−3.041	−3.916	**	
Disaster frequency	−2.344	−6.802	**	39.0	0.325	0.940		1.4
Disaster intensity	−0.038	−0.370		0.1	−0.004	−0.039		0.00
Inundation	−0.213	−1.128		0.9	0.246	1.314		2.9
Isolated by water	−0.434	−2.314	*	3.7	0.575	3.057	**	14.5
Road destroyed	0.367	2.008	*	2.7	0.977	5.408	**	45.2
Financial ability	0.054	0.411		0.2	0.345	2.576	**	14.3
Physical strength	−0.027	−0.216		0.04	0.194	1.551		6.6
Capability of family structure	−0.327	−2.555	*	6.0	0.059	0.453		0.5
Available help from neighborhood	−0.079	−0.635		0.3	−0.031	−0.248		0.1
Knowledge about disaster	0.398	2.856	**	7.1	−0.008	−0.062		0.01
Available time to tackle disaster	0.470	4.105	**	16.1	0.148	1.308		3.9
Help from government during recovery	−0.656	−2.672	**	7.8	−0.212	−0.857		2.0
Help from community during recovery	0.233	1.112		1.1	−0.118	−0.569		0.7
Help from neighborhood during recovery	−0.148	−0.568		0.2	−0.182	−0.696		0.7
Recovery time	0.016	2.726	**	13.0	0.008	1.344		6.5
Recovery cost	−0.097	−1.653	+	1.9	0.047	0.767		0.8

Reference alternative in estimation: (e) change the departure time	(c) change the travel route				(d) change the destination		
Explanatory variable	Param	t-score		VR (%)	Param	t-score	VR (%)
Constant term	0.171	0.216			−1.536	−1.863 +	
Disaster frequency	−0.972	−2.706	**	10.8	0.194	0.517	1.1
Disaster intensity	−0.358	−3.345	**	14.7	−0.014	−0.127	0.1
Inundation	0.358	1.854	+	4.7	−0.379	−1.890 +	15.2

(continued)

Table 12.3 (continued)

Reference alternative in estimation: (e) change the departure time	(c) change the travel route				(d) change the destination		
Explanatory variable	Param	t-score		VR (%)	Param	t-score	VR (%)
Isolated by water	0.003	0.015		0.00	0.084	0.431	0.7
Road destroyed	0.833	4.413	**	25.4	0.298	1.526	9.4
Financial ability	−0.076	−0.539		0.5	0.091	0.616	1.8
Physical strength	0.003	0.024		0.00	−0.139	−0.992	6.8
Capability of family structure	−0.234	−1.713	+	4.2	−0.075	−0.539	1.4
Available help from neighborhood	0.107	0.793		0.9	0.232	1.643	11.3
Knowledge about disaster	0.181	1.234		2.7	0.080	0.529	1.4
Available time to tackle disaster	0.243	1.968	*	6.3	0.283	2.253 *	27.4
Help from government during recovery	0.002	0.008		0.00	−0.086	−0.307	0.6
Help from community during recovery	0.912	3.986	**	25.6	0.330	1.424	10.5
Help from neighborhood during recovery	−0.182	−0.667		0.6	0.280	1.090	5.7
Recovery time	−0.002	−0.274		0.1	−0.014	−1.612	6.0
Recovery cost	−0.089	−1.448		3.4	−0.022	−0.360	0.7

Initial log-likelihood: −2303.106; Final log-likelihood: −2058.804; McFadden's Rho-squared: 0.1061; Adjusted McFadden's Rho-squared: 0.0953; Sample size: 1431 SP responses
Note + Signicant at the 10 % level; *Signicant at the 5 % level; **Signicant at the 1 % level; *VR* variance ratio in the total variance

but acceptable as a model, to identify influential factors. There are many statistically significant parameters, and most parameters have the expected sign (positive or negative). All these results suggest that the MNL model is still applicable to such adaptation behavior, although it suffers from the Independence of Irrelevant Alternatives (IIA) property.

(1) ***Intercity travel adaptation behavior in the coastal area: Flood scenarios***

Table 12.1 shows that flood affects most of a household's choice alternatives for intercity travel. The permanent destruction of roads to other cities is among the three most influential factors in terms of statistical significance and variance ratio on intercity choice alternatives. The permanent destruction of roads is estimated to result in trip cancelations, changes of travel route and destination, and to hinder people from making their usual intercity trips. Destruction of roads is especially decisive in relation to the "(c) change the travel route" alternative because it explains 74.3 % of the total variance. These findings reconfirm that roads are a crucial form of infrastructure that support daily life. Isolation of residential areas by water markedly reduces the likelihood that a household will continue intercity travel as usual, because it shows the largest variance ratio (22.6 %) of the total variance of the alternative “(a) continue to travel as usual”. Inundation mostly affects “(d) change the destination” (variance ratio: 24.9 %): people are more likely to change the destination of their intercity trips if inundation occurs, while the effect of disaster frequency is ranked in the second place (13.9 %), together with that of recovery cost (14.0 %). Disaster intensity does not influence any alternative of the intercity trip. Disaster frequency does not affect “(c) change the travel route”, while inundation is not related to “(a) continue to travel as usual” and “(c) change the travel route” because their parameters are all insignificant.

Trip cancelation should be regarded as having the most serious impact on household life. In line with this, the alternative “(b) cancel the trip” is mostly influenced by help from the community during the recovery period (house repairs, food, clothes, clean water, medicine, money, tents and quilts, groceries, shelter, or other assistance), for which the variance ratio (VR) is 14.7 % and which has a negative influence. This suggests that receiving help from the community during the recovery period may mitigate the impacts of floods markedly, because households are less likely to cancel intercity trips. In other words, if households cannot obtain help from the neighborhood during the recovery period, they mostly cancel their intercity trips. Household capability (mainly time available to respond to the impacts of disasters and financial ability) is also strongly associated with trip cancelation. Households with lower financial capacity and less available time are more likely to cancel intercity trips, suggesting that policies to improve household capability in the face of disasters should be promoted to mitigate the impacts of disasters on people’s lives.

Regarding social capital, help from the government, communities, and neighborhoods have the greatest influence on decisions to “(a) continue to travel as usual” and “(b) cancel the trip” than on other choices. Recovery time and cost are irrelevant to “(a) continue to travel as usual” and “(b) cancel the trip”.

(2) ***Intercity travel adaptation behavior in the coastal area: Cyclone scenarios***

As shown in Table 12.2, in contrast to the case of flooding, the most influential factors are all cyclone-related attributes. This result is intuitive. The top three factors in decisions to “(a) continue to travel as usual” are disaster frequency (VR = 23.6 %), isolation by water (VR = 20.2 %), and disaster intensity (VR = 19.0 %), while those on “(b) cancel the trip” are inundation (VR = 33.3 %), disaster intensity (VR = 22.9 %), and the destruction of roads (VR = 12.5 %). The option “(c) change the travel route” is affected most strongly by the destruction of roads (VR = 49.1 %) and disaster frequency (26.6 %), while “(d) change the destination” is affected most by inundation (VR = 45.7 %) and the destruction of roads (28.3 %). Again, we reconfirm the critical influence of roads on people’s lives because of the larger variance ratios. The influence of household capacity is very limited, because only six of 24 relevant parameters are statistically significant. Help from the government, community and neighborhood only affect "(a) continue to travel as usual". Households experiencing longer recovery time are more likely to cancel their trips and/or change their travel route in response to cyclones.

(3) ***Intercity travel adaptation behavior in the inland area: Flood scenarios***

As Table 12.3 shows, influential factors in intercity travel are similar to those of floods in the coastal area. There are four groups of factors: disaster related, household capability related, external help, and recovery time and cost. It is observed that some factors from all four groups affect intercity travel behavior. Unlike the flood case in the coastal area, the impacts of flooding are not extensive. We only found significant influences of disaster frequency (VR = 39.0 %) on "(a) continue to travel as usual", road destruction (VR = 45.2 %) and isolation by water (VR = 14.5 %) on "(b) cancel the trip", road destruction (25.4 %) and disaster frequency (VR = 10.8 %) on "(c) change the travel route", and inundation on "(d) change the destination". Larger influences are observed for household capability with respect to time available to respond to the impacts of disasters on "(a) continue to travel as usual" (VR = 16.1 %) and on "(d) change the destination" (VR = 27.4 %), financial ability (VR = 14.3 %) on "(b) cancel the trip", and available help from neighborhood (VR = 11.3 %) on "(d) change the destination".

(4) ***Summary***

A comparison of the three cases above shows that people living in the coastal area of Bangladesh are more vulnerable than those in the inland area. This is partly because the land nearby the coastal area is very low, and consequently more easily inundated by water. Improving household capability to adapt to the impacts of floods and cyclones is more effective in the coastal area than in the inland area. Help from the government, community, and neighborhood has a stronger influence on adaptation to the impacts of floods in the coastal and inland areas; in contrast, the influence of help on adaptation to cyclones is very limited. Limited influences are also observed with respect to recovery time and cost.

12.5.2 Stated Adaptation to Floods and Cyclones in Bangladesh

We investigated household life adaptation behavior in the SP survey by asking respondents to choose one of the following six alternatives in different disaster scenarios:

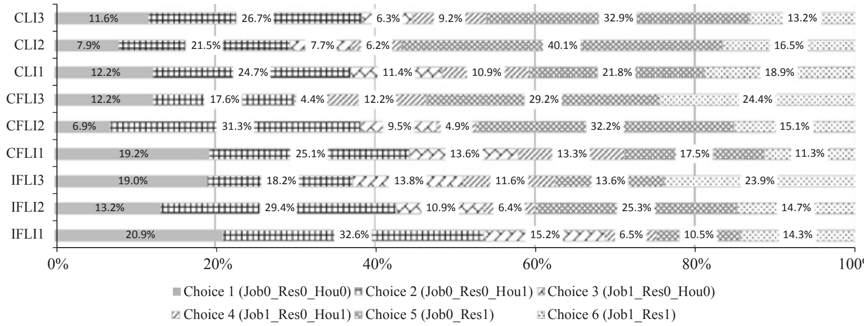
(a) change neither job nor residential location, and do not reinforce the house (Choice 1: Job0_Res0_Hou0);
(b) change neither job nor residential location, and reinforce the house (Choice 2: Job0_Res0_Hou1);

(c) change jobs, do not change residential location, and do not reinforce the house (Choice 3: Job1_Res0_Hou0);
(d) change jobs but not residential location, and reinforce the house (Choice 4: Job1_Res0_Hou1);
(e) do not change jobs, but change residential location (Choice 5: Job0_Res1);
(f) change both job and residential location (Choice 6: Job1_Res1).

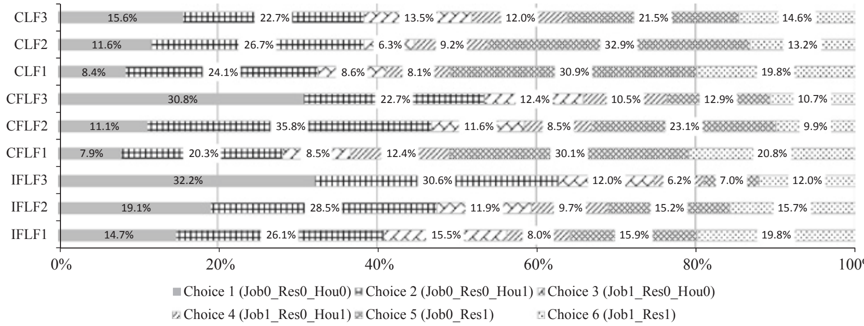
The SP attributes are the same as those in the previously mentioned SP survey of intercity travel behavior, that is, 16 SP scenarios divided into four groups. Each respondent answered questions for only one group, which includes four scenarios. As a result, a total of 788 valid respondents (3152 responses) were surveyed for this part of the analysis: 487 respondents (1948 SP responses) from the coastal area and 301 respondents (1204 SP responses) from the inland area.

12.5.2.1 Reported Features of Life Adaptation Behavior

The descriptive analysis results show that more people would choose to relocate their residence rather than change their job location in response to flooding and cyclone impacts, which underlines the seriousness of impacts on people's houses. In the proposed flooding scenarios, more people (almost 50 % of the respondents) from the inland region chose no response or would just reinforce their houses. However, more coastal people would choose to change residence location in response to flooding impacts. This indicates that coastal people suffer more from flooding impacts, and changing residence location may be their best choice when adapting to coastal flooding. People's choices in response to hypothetical flood and cyclone frequency and intensity are shown in Fig. 12.23. Figure 12.23(a) shows people's responses to different flood and cyclone frequencies. With a decrease in frequency, the percentage of people choosing no response (Choice 1) increases, and this increase under conditions of flood is greater than that of cyclones. The number of people who would change residence location (Choices 5 and 6) decreases when there is a decrease in flood or cyclone frequency. The number of people who choose job location change and house reinforcement (Choices 2, 3, and 4) increases with a decrease in frequency; however, this change is not as obvious as that for Choices 1, 5, and 6. Similar results can be observed for people's choices for different levels of flood and cyclone intensity, as shown in Fig. 12.23(b). The number of people who choose to change residence location (Choices 5 and 6) increases with flood or cyclone intensity, and the percentages of people who indicate no response or house reinforcement alone decrease with an increase in intensity. As illustrated in Fig. 12.23, more people would choose residence relocation when flood or cyclone frequency and intensity increase, and almost 50 % of the respondents would select Choices 5 and 6 under the highest level of frequency and intensity. More than half of the respondents would choose no response or just house reinforcement (Choices 1 and 2) given the lowest flood and cyclone frequency, but this percentage is a little lower (around



(a) Flooding and cyclone frequency.



(b) Flooding and cyclone intensity.

Fig. 12.23 People's location change choices under different **a** flooding and cyclone frequency, and **b** flooding and cyclone intensity

40 %) for Choices 1 and 2 with the lowest flood and cyclone intensity; the percentages of people who select job relocation choices (Choices 3 and 4) are the lowest among all the six choices; more people would choose residence relocation change given cyclone frequency changes than those who would do so for changes in flood frequency.

12.5.2.2 Reported Life Adaptation Associated with Disaster Attributes

Analyses in this section are based on the results shown in Figs. 12.24, 12.25 and 12.26.

Disaster Frequency

In the three cases (floods and cyclones in the coastal area, and floods in the inland area), the alternative "(a) change neither job nor residential location, and do not reinforce the house" (i.e., the status quo) is sensitive to flood frequency in a similar way: the proportions of respondents making this choice range from a frequency of about 10 % (a flood every year) to about 30 % (once every three years). These

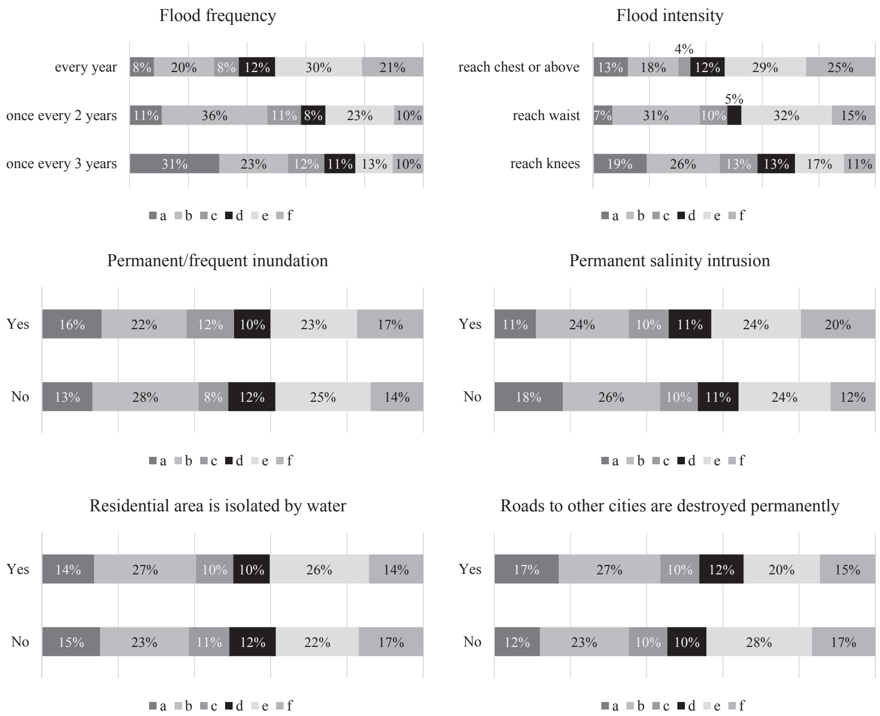


Fig. 12.24 Life adaptation behavior in the coastal area under the influence of flood

proportions are higher in the inland area than in the coastal area. The alternative "(f) change both job and residential location" (the most drastic change) shows the opposite response pattern, which is also similar across the three cases: the proportion of respondents ranges from about 10 % (once every three years) to about 20 % (every year). As for residential relocation (i.e., "(e) do not change job, but change residential location" and "(f) change both job and residential location"), consistent with our expectation, cyclones would result in more people changing their residential location than would flooding, while in the two flood cases, a coastal flood would lead to more relocation of households than would an inland flood. Concerning job change (i.e., the alternatives "c", "d" and "f"), variations in respondent proportions are smaller across the three disaster cases, ranging from about 30 % (once every two years) to 40 % (twice a year).

Disaster Intensity

Floods and cyclones are measured differently: by water level for floods and by damage to housing for cyclones. A comparison of floods in the two areas shows that floods in the coastal area have less influence on people's lives than on those in the inland area, because the choice shares for alternative (a) range from 7 to 19 % in the coastal area, and those in the inland area from 14 to 20 %. As for the most

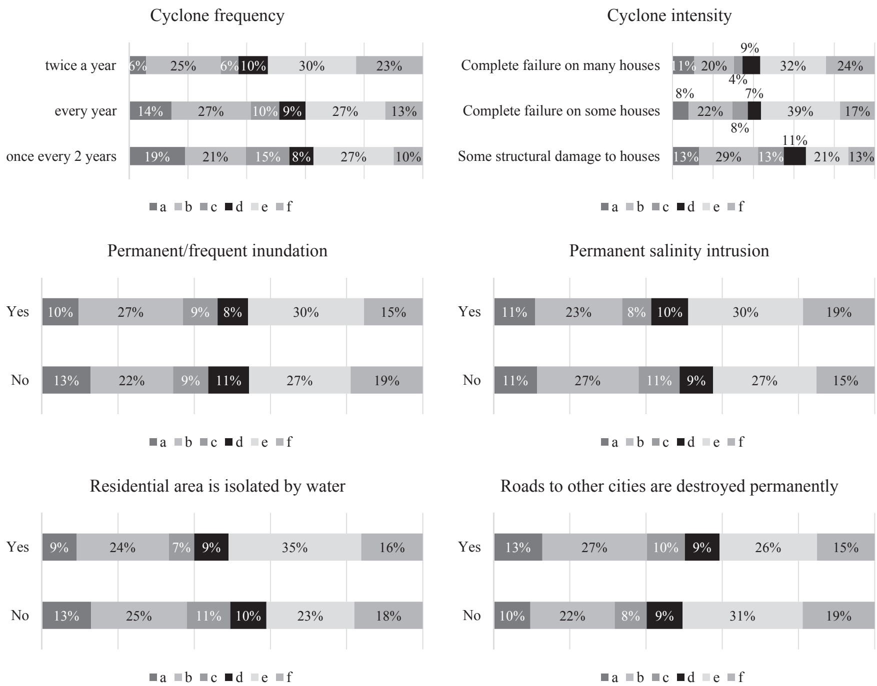


Fig. 12.25 Life adaptation behavior in the coastal area under the influence of cyclone

serious impact (i.e., alternative (f): change both job and household location), the variations of response proportions across the three cases are small, approximately between 10 and 25 %. Cyclones would force more people to change their residential locations than would floods, while the impacts of inland floods are smallest among the three scenarios in terms of residential relocation choices [i.e., alternatives (e) and (f)]. What are the impacts on job change? From a comparison of total choice proportions of alternatives (c), (d), and (f), it is found that half of the respondents in the inland area would have to change jobs when the water level reached chest level or above. In the case of coastal disasters (floods and cyclones), about 40 % of respondents would have to change their jobs if a cyclone caused the complete collapse of many houses in the area and floodwater levels reached chest level or above.

Permanent/Frequent Inundation of Houses

Impacts of permanent/frequent inundation of houses would result in the largest number of households (30 %) changing residential locations, but not changing jobs [i.e., alternative (e)] in the case of a coastal cyclone. A similar proportion of responses would be observed in the case of an inland flood with respect to alternative (b): “change neither job nor residential location, and reinforce the house” (28 % of responses). Note that similar proportions of responses have different

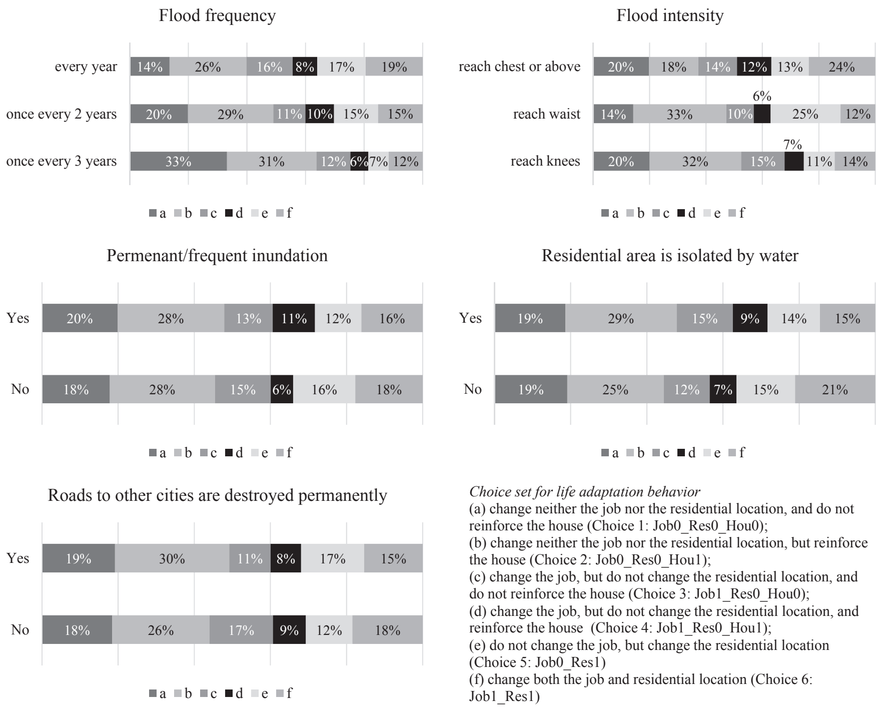


Fig. 12.26 Life adaptation behavior in the inland area under the influence of flood

meanings for disaster impacts. It would be fair to state that the impact of a cyclone is greater than that of an inland flood, because more people have to change residential location, which is costlier than reinforcing their houses. The most serious impact would be the job change. From this viewpoint, it is found that floods in both coastal and inland areas would result in about 40 % of respondents changing their jobs, while this proportion would be just 10 points lower in the case of a cyclone. This may be because of the fact that inundation caused by a flood lasts longer than that of a cyclone.

Permanent Salinity Intrusion

The impacts of salinity intrusion seem similar for floods and cyclones (only in the coastal area), where the only differences are the choices of "(c) change job, do not change residential location, and do not reinforce the house" and "(e) do not change job, but change residential location". Cyclones would lead to 30 % of respondents changing jobs, but they would see no need to change their residential location or reinforce their houses. In comparison, this proportion would drop to 24 % in a flood.

Isolation of Residential Area by Water

Isolation of residential areas by water from cyclones seems to have the largest impact on people's lives, because more people have to adapt to some extent, and because the proportion of respondents choosing "(a) change neither job nor residential location, and do not reinforce the house" is the lowest (just 9 %) among the two cases: 14 % in a coastal flood and 19 % in an inland flood. As for job change, an inland flood would result in 39 % of respondents changing jobs, while 32 % would do so in a cyclone, and 34 % in a coastal flood. Concerning residential relocation, a cyclone would force more than 50 % of households to relocate; in contrast, about 30 % would do so in the two flood cases.

Permanent Destruction of Roads to Other Cities
It is expected that road damage would markedly reduce the accessibility of households to various places, consequently forcing more people to change jobs. From the survey results, the total proportion of those who would change jobs with respect to alternatives (c), (d), and (f) is 37 % for a coastal flood, 34 % for a cyclone, and 34 % for an inland flood. In fact, the impacts on residential relocation measured by the proportion of respondents who chose alternatives (e) and (f) are similar to those for job change.

12.5.2.3 Choice Model Analysis

In the modeling analysis, the following variables are used:

- flood and cyclone attributes: all SP attributes including disaster frequency (once a year, once every two years, once every three years), disaster intensity (flood reaches knees, reaches waist, reaches chest or above on an adult of average size; cyclone: some structural damage to houses, complete collapse of some houses, complete collapse of many houses), permanent salinity intrusion (yes or no: only for life adaptation behavior in the coastal area), permanent or frequent inundation (yes or no), whether residential area is isolated by water (yes or no), whether roads to other cities are destroyed permanently (yes or no).
- self-help variables: financial ability (1. very capable, 2. capable, 3. somewhat capable, 4. not capable at all), physical strength (1. very capable, 2. capable, 3. somewhat capable, 4. not capable at all), capability of family structure (1. very capable, 2. capable, 3. somewhat capable, 4. not capable at all), help available from neighbors (1. very available, 2. available, 3. somewhat available, 4. not at all available), knowledge about countermeasures against disaster (1. much knowledge, 2. moderate knowledge, 3. a little knowledge, 4. no knowledge), available time (1. much time, 2. some time, 3. little time, 4. no time).
- mutual help and public help variables: help from the government during the recovery period, help from the community during the recovery period, help from the neighborhood during the recovery period—1. house repair, 2. food, 3. clothes, 4. clean water, 5. medicine, 6. money, 7. tents and quilts, 8. groceries, 9. shelter, 10. no help received, 11. other help.
- recovery variables: recovery time, recovery cost (to return to normal life following the impacts of a disaster).

The model estimation results (Tables 12.4, 12.5 and 12.6) with respect to the three cases revealed larger influences of disaster-related factors on people's lives in the coastal areas than those of the inland areas, while larger influences are also observed in terms of household capabilities, social capital, and recovery time and cost, in the inland area. To be specific, the most influential factors on life adaptation behavior in cases of coastal floods are flood frequency, flood intensity, and salinity intrusion, while in cyclones, inundation is the most influential factor.

(1) ***Life adaptation behaviors under the impacts of coastal flooding***

The strongest influence on "(a) change neither job nor residential location, and do not reinforce the house", is flood frequency, because the variance ratio is largest with a value of 46.1 %, followed by flood intensity (VR = 27.7 %) and salinity intrusion (VR = 14.9 %). These are also the major factors in "(b) change neither job nor residential location, and reinforce the house". Concerning "(c) change job, do not change residential location, and do not reinforce the house" and "(d) change job but not residential location, and reinforce the house", flood frequency and intensity share the top two factors. Unexpectedly, isolation of residential areas by water does not affect any life adaptation behavior. Even though the influences are smaller in magnitude, permanent road destruction results in more people choosing the status quo, i.e., the alternative "(a) change neither job nor residential location, and do not reinforce the house", and it further reduces the probability that people will not change their jobs, but will change their residential location.

Capability-related factors have much smaller influences on adaptation to cyclones. Higher capability related to family structure leads to a lower probability that people will choose the status quo (no change) and change their jobs, but will not change their residential locations and jobs. In contrast, help available from the neighborhood is associated with the probability that people will choose the status quo. As for social capital, i.e., external help, help from the community during the recovery period, has no influence at all on any choices. Help from the government during the recovery period affects alternatives (a), (b), and (e), and help from the neighborhood during the recovery period only influences (a). The parameter of help from the neighborhood in alternative (a) is negative, which indicates that with the help of their neighborhood, households attempt to change their behavior to mitigate the impacts of a cyclone. Similarly, help from the government also reduces the probability of people choosing the status quo. In contrast, with the help of the government, respondents tend to reinforce their houses [alternative (b)] and change their residential locations, but not to change their jobs.

The time-consuming nature of recovery results in fewer people reinforcing their houses (but not changing jobs or residential locations) or changing their jobs (but not their residential locations or reinforcing their houses) in the sense that the relevant parameters are negative and statistically significant. On the other hand, the financial demands of recovery lead to more people changing jobs, but not changing their residential location and reinforcing their houses, because the parameter of recovery cost is positive for alternative (d).

Table 12.4 Estimation results of household life adaptation behavior model: flood at the coastal area

Reference alternative in estimation: (f) will change both the job and residential location	(a) will change neither the job nor the residential location, and will not reinforce the house				(b) will change neither the job nor the residential location, but will reinforce the house				(c) will change the job, but will not change the residential location, and will not reinforce the house			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR	Param-	t-score		VR (%)
Constant term	6.494	7.145	**		4.545	5.963	**		4.289	4.498	**	
Disaster frequency	−3.317	−10.761	**	46.1	−1.865	−7.440	**	35.3	−1.901	−5.999	**	29.7
Disaster intensity	−0.896	−7.795	**	27.7	−0.614	−7.043	**	27.4	−1.010	−8.339	**	43.8
Inundation	−0.282	−1.585		1.0	−0.449	−3.084	**	6.2	0.313	1.718	+	2.2
Salinity intrusion	−1.124	−6.306	**	14.9	−0.699	−4.801	**	15.1	−0.464	−2.551	*	5.0
Isolated by water	0.037	0.200		0.0	−0.045	−0.300		0.1	−0.203	−1.075		1.0
Road destroyed	0.472	2.828	**	2.7	0.213	1.483		1.4	0.056	0.318		0.1
Financial ability	−0.022	−0.156		0.01	−0.129	−1.050		1.0	−0.108	−0.725		0.5
Physical strength	0.080	0.639		0.2	0.008	0.071		0.00	0.075	0.557		0.4
Capability of family structure	−0.232	−1.713	+	1.4	−0.113	−0.964		0.7	−0.481	−3.278	**	9.6
Available help from neighborhood	−0.219	−1.655	+	1.1	0.075	0.653		0.3	−0.052	−0.373		0.1
Knowledge about disaster	−0.158	−1.222		0.6	−0.119	−1.082		0.9	−0.145	−1.044		1.1
Available time to tackle disaster	0.072	0.635		0.1	0.184	1.868	+	2.8	0.122	0.994		0.8
Help from government during recovery	−0.430	−1.760	+	1.7	−0.419	−1.993	*	4.3	0.050	0.185		0.03
Help from community during recovery	0.181	0.891		0.4	0.139	0.798		0.5	−0.070	−0.323		0.1
Help from neighborhood during recovery	−0.419	−1.750	+	1.0	−0.016	−0.080		0.00	0.211	0.881		0.7
Recovery time	−0.004	−1.260		0.6	−0.006	−2.173	*	2.8	−0.007	−2.001	*	3.3
Recovery cost	−0.085	−1.207		0.5	−0.070	−1.162		1.2	0.099	1.212		1.6

(continued)

Table 12.4 (continued)

Reference alternative in estimation: (f) will change both the job and residential location	(d) will change the job, but will not change the residential location, and will reinforce the house				(e) will not change the job, but will change the residential location			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	−0.129	−0.133			3.010	4.025	**	
Disaster frequency	−0.683	−2.285	*	10.4	−0.072	−0.278		0.1
Disaster intensity	−0.453	−4.469	**	40.3	−0.114	−1.355		2.3
Inundation	−0.266	−1.536		4.4	−0.264	−1.808	*	4.6
Salinity intrusion	−0.360	−2.081	*	8.1	−0.547	−3.753	**	19.9
Isolated by water	−0.248	−1.385		3.8	0.156	1.017		1.6
Road destroyed	0.267	1.549		4.4	−0.383	−2.670	**	9.5
Financial ability	−0.033	−0.211		0.1	−0.413	−3.435	**	27.2
Physical strength	0.220	1.645		5.9	0.082	0.768		1.2
Capability of family structure	0.063	0.437		0.4	−0.159	−1.376		3.8
Available help from neighborhood	−0.005	−0.036		0.0	0.091	0.804		0.8
Knowledge about disaster	−0.150	−1.109		2.5	−0.165	−1.537		3.7
Available time to tackle disaster	−0.084	−0.697		0.9	0.177	1.827	+	4.9
Help from government during recovery	0.369	1.296		3.3	−0.481	−2.312	*	12.2
Help from community during recovery	−0.100	−0.484		0.5	0.240	1.413		3.5
Help from neighborhood during recovery	0.357	1.561		4.9	−0.291	−1.463		3.0
Recovery time	0.000	−0.050		0.01	−0.003	−1.163		1.6
Recovery cost	0.201	2.275	*	10.0	−0.015	−0.242		0.1

Initial log-likelihood: −4271.555; Final log-likelihood: −3798.506; McFadden's Rho-squared: 0.1107; Adjusted McFadden's Rho-squared: 0.1040; Sample size: 2384 SP responses

Note + Significant at the 10 % level; *Significant at the 5 % level; **Significant at the 1 % level; *VR* variance ratio in the total variance

Table 12.5 Estimation results of household life adaptation behavior model: cyclone at the coastal area

Reference alternative in estimation: (f) will change both the job and residential location	(a) will change neither the job nor the residential location, and will not reinforce the house				(b) will change neither the job nor the residential location, but will reinforce the house				(c) will change the job, but will not change the residential location, and will not reinforce the house			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	3.762	4.276	**		2.453	3.465	**		3.543	3.633	**	
Disaster frequency	−1.414	−10.187	**	67.3	−0.464	−4.151	**	14.1	−1.085	−7.457	**	42.3
Disaster intensity	−0.333	−3.074	**	7.6	−0.539	−6.534	**	31.6	−0.779	−6.383	**	26.3
Inundation	−0.033	−0.183		0.02	0.548	3.889	**	12.0	0.210	1.122		0.9
Salinity intrusion	−0.460	−2.554	*	4.9	−0.511	−3.638	**	10.7	−0.691	−3.686	**	10.0
Isolated by water	−0.594	−3.138	**	7.8	−0.223	−1.551		2.0	−0.520	−2.664	**	5.3
Road destroyed	0.391	2.306	*	3.5	0.301	2.167	*	3.7	0.274	1.521		1.6
Financial ability	0.001	0.004		0.00	−0.134	−1.129		1.5	−0.079	−0.515		0.2
Physical strength	−0.218	−1.649	+	2.6	−0.348	−3.252	**	12.8	−0.209	−1.492		2.5
Capability of family structure	−0.033	−0.235		0.0	0.167	1.472		2.3	0.181	1.217		1.4
Available help from neighborhood	0.129	0.942		0.6	0.186	1.686	+	2.0	0.032	0.220		0.0
Knowledge about disaster	0.013	0.099		0.01	0.116	1.112		1.2	−0.272	−1.926	+	3.0
Available time to tackle disaster	−0.178	−1.531		1.6	0.088	0.926		0.8	−0.174	−1.386		1.5
Help from government during recovery	−0.313	−1.250		1.7	−0.115	−0.557		0.4	−0.339	−1.238		1.5
Help from community during recovery	−0.152	−0.725		0.5	−0.179	−1.059		1.2	0.221	0.955		0.8
Help from neighborhood during recovery	−0.367	−1.553		1.6	−0.304	−1.640		2.1	0.063	0.263		0.1
Recovery time	−0.001	−0.392		0.1	0.000	0.008		0.00	−0.003	−1.080		1.0

(continued)

Table 12.5 (continued)

Reference alternative in estimation: (f) will change both the job and residential location	(a) will change neither the job nor the residential location, and will not reinforce the house				(b) will change neither the job nor the residential location, but will reinforce the house				(c) will change the job, but will not change the residential location, and will not reinforce the house			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)	Param	t-score		VR (%)
Recovery cost	−0.034	−0.462		0.2	−0.074	−1.250		1.6	0.122	1.376		1.5

Reference alternative in estimation: (f) will change both the job and residential location	(d) will change the job, but will not change the residential location, and will reinforce the house				(e) will not change the job, but will change the residential location			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	1.068	1.149			3.312	**		
Disaster frequency	−0.413	−2.945	**	20.1	−4.100	**		22.8
Disaster intensity	−0.417	−3.986	**	36.6	−0.737			0.6
Inundation	0.050	0.278		0.2	3.082	**		11.6
Salinity intrusion	−0.145	−0.815		1.5	−1.786	+		3.9
Isolated by water	−0.129	−0.703		1.2	1.972	*		5.1
Road destroyed	0.122	0.692		1.1	−1.025			1.3
Financial ability	0.043	0.275		0.2	−2.242	*		10.3
Physical strength	−0.103	−0.748		2.0	−3.016	**		17.1
Capability of family structure	0.193	1.312		5.2	1.592			4.0
Available help from neighborhood	0.010	0.067		0.01	1.305			2.0
Knowledge about disaster	−0.080	−0.581		0.8	1.323			2.3
Available time to tackle disaster	−0.338	−2.775	**	18.5	−0.319			0.1
Help from government during recovery	−0.091	−0.339		0.3	−2.004			8.3
Help from community during recovery	−0.273	−1.276		4.7	0.775			0.9
Help from neighborhood during recovery	0.148	0.648		1.0	−2.739	**		8.5
Recovery time	0.002	0.574		1.0	−0.083			0.01
Recovery cost	0.116	1.371		5.6	−0.857			1.3

Initial log-likelihood: −4271.555; Final log-likelihood: −3798.506; McFadden's Rho-squared: 0.1107; Adjusted McFadden's Rho-squared: 0.1040; Sample size: 2384 SP responses
Note + Signicant at the 10 % level; *Signicant at the 5 % level; **Signicant at the 1 % level; *VR* variance ratio in the total variance

Table 12.6 Estimation results of household life adaptation behavior model: flood at the inland area

Reference alternative in estimation: (f) will change both the job and residential location	(a) will change neither the job nor the residential location, and will not reinforce the house				(b) will change neither the job nor the residential location, but will reinforce the house				(c) will change the job, but will not change the residential location, and will not reinforce the house			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)	Param	t-score		VR (%)
Constant term	4.065	4.663	**		2.949	3.615	**		1.356	1.465		
Disaster frequency	−2.139	−5.659	**	23.5	−1.106	−3.232	**	13.3	−0.099	−0.252		0.2
Disaster intensity	−0.354	−3.140	**	5.9	−0.570	−5.596	**	26.5	−0.317	−2.733	**	20.8
Inundation	0.214	1.023		0.7	0.140	0.755		0.6	−0.042	−0.197		0.1
Isolated by water	0.113	0.550		0.2	0.310	1.706	+	2.7	0.498	2.370	*	13.8
Road destroyed	0.203	1.019		0.6	0.295	1.651	+	2.8	−0.306	−1.465		5.7
Financial ability	0.170	1.163		1.6	0.215	1.602		4.1	0.256	1.655	+	8.5
Physical strength	0.046	0.314		0.1	0.067	0.499		0.3	0.112	0.722		2.5
Capability of family structure	−0.224	−1.580		2.1	−0.233	−1.778	+	4.2	−0.186	−1.239		6.0
Available help from neighborhood	−0.414	−2.795	**	5.8	−0.190	−1.376		2.6	−0.174	−1.097		3.5
Knowledge about disaster	0.116	0.773		0.5	−0.282	−2.098	*	6.1	−0.250	−1.628		9.7
Available time to tackle disaster	0.162	1.322		1.2	0.238	2.102	*	6.7	0.185	1.431		8.2
Help from government during recovery	−1.436	−4.952	**	29.0	−0.511	−1.847	+	5.9	−0.124	−0.383		0.6
Help from community during recovery	−0.078	−0.332		0.1	−0.315	−1.491		3.2	−0.333	−1.355		7.0

(continued)

Table 12.6 (continued)

Reference alternative in estimation: (f) will change both the job and residential location	(a) will change neither the job nor the residential location, and will not reinforce the house				(b) will change neither the job nor the residential location, but will reinforce the house				(c) will change the job, but will not change the residential location, and will not reinforce the house			
Explanatory variable	Param	t-score		VR (%)	Param	t-score		VR (%)	Param	t-score		VR (%)
Help from neighborhood during recovery	−0.456	−1.536		1.2	−0.043	−0.170		0.0	−0.369	−1.225		4.0
Recovery time	0.025	3.609	**	25.8	0.019	2.739	**	20.9	0.004	0.421		0.4
Recovery cost	−0.112	−1.768	+	1.8	−0.008	−0.133		0.02	−0.104	−1.599		9.1

Reference alternative in estimation: (f) will change both the job and residential location	(d) will change the job, but will not change the residential location, and will reinforce the house				(e) will not change the job, but will change the residential location				
Explanatory variable	Param	t-score		VR (%)	Param	t-score			VR (%)
Constant term	0.205	0.186			1.445	1.548			
Disaster frequency	−0.959	−2.088	*	8.0	0.245	0.618			1.6
Disaster intensity	−0.003	−0.024		0.00	−0.088	−0.771			2.0
Inundation	0.995	3.876	**	25.9	−0.178	−0.833			2.9
Isolated by water	0.457	1.817	+	5.0	0.198	0.975			3.6
Road destroyed	0.252	1.033		1.8	0.337	1.652	+		10.6
Financial ability	0.056	0.307		0.2	0.229	1.493			10.8
Physical strength	0.093	0.514		0.7	−0.116	−0.754			3.4
Capability of family structure	−0.563	−3.169	**	21.2	−0.199	−1.362			8.8
Available help from neighborhood	0.144	0.733		0.9	−0.455	−3.006	**		42.2
Knowledge about disaster	−0.250	−1.335		4.1	0.045	0.296			0.4
Available time to tackle disaster	0.312	1.990	*	10.8	0.028	0.214			0.2
Help from government during recovery	0.035	0.090		0.02	−0.259	−0.802			3.8
Help from community during recovery	0.169	0.583		0.7	−0.017	−0.069			0.03

Table 12.6 (continued)

Reference alternative in estimation: (f) will change both the job and residential location	(d) will change the job, but will not change the residential location, and will reinforce the house				(e) will not change the job, but will change the residential location				
Explanatory variable	Param	t-score		VR (%)	Param	t-score			VR (%)
Help from neighbor-hood during recovery	−0.635	−1.654	+	4.8	−0.154	−0.529			1.2
Recovery time	0.011	1.124		2.2	0.009	1.074			6.4
Recovery cost	−0.178	−2.345	*	13.6	−0.046	−0.692			2.1

Initial log-likelihood: −2486.962; Final log-likelihood: −2224.902; McFadden's Rho-squared: 0.1054; Adjusted McFadden's Rho-squared: 0.0943; Sample size: 1388 SP responses
Note + Significant at the 10 % level; *Significant at the 5 % level; **Significant at the 1 % level; *VR* variance ratio in the total variance

(2) ***Life adaptation to the impacts of cyclones in the coastal area***

The impacts of a cyclone are observed with respect to the choices of "(b) change neither job nor residential location, and reinforce the house" and "(c) change job, do not change residential location, and do not reinforce the house", where cyclone frequency, intensity, inundation, and salinity intrusion are identified as the most influential factors in terms of statistical significance and the explained variance ratios. Specifically, cyclone frequency is decisive in the choice of alternative (a), because its variance ratio is 67.3 %, which is much larger than that of any other factor. Cyclone intensity mostly affects alternatives (b), (c), and (d), with variance ratios being 31.6, 26.3, and 36.6 %, respectively. The influences of salinity intrusion on (b) and (c) are also relatively large, with variance ratios being about 10 %. Isolation of residential areas by water is influential on (a), (c), and (e), but the variance ratios are just 7.8, 5.3, and 5.1 %, respectively, which is much smaller than those for other cyclone attributes, except for road damage. Road damage influences (a) and (b), although its influence is even smaller.

The third largest influence on (b) is physical strength, and that on (d) is time available to respond to disasters. Other capability-related factors are estimated to affect life adaptation behavior to a statistically significant extent, such as time available to respond to disasters influencing (b), and knowledge about disasters affecting (c); however, these influences are quite small. As for help-related factors, receiving help from the neighborhood during the recovery period reduces the probability that households will choose "(e) will not change jobs, but will change residential location". Finally, recovery time and cost do not affect any adaptation behavior.

(3) ***Life adaptation behaviors under the impacts of inland flooding***

All flood attributes affect some life adaptation behaviors in the inland area, but their influences are limited in terms of variance ratios. As for "(a) change neither job nor residential location, and do not reinforce the house", the most influential factor is help from the government during the recovery period (VR = 29.0 %), followed by recovery time (VR = 25.8 %) and flood frequency (VR = 23.5 %). In contrast, "(b) change neither job nor residential location, and reinforce the house", "(c) change job, do not change residential location, and do not reinforce the house", and "(d) change job but not residential location, and reinforce the house" are mostly affected by flood attributes: (b) and (c) by flood intensity (26.5 and 20.8 %, respectively), and (d) by inundation (VR = 25.9 %). In the case of "(e) do not change jobs, but change residential location", available help from the neighborhood is most influential (VR = 42.2 %), followed by financial ability (VR = 10.8 %) and road damage (VR = 10.6 %).

Other major influential factors are isolation of residential area by water (VR = 13.8 %) on alternative (c), capability of family structure on (d) (VR = 21.2 %), recovery time on (b) (VR = 20.9 %), and recovery cost (VR = 13.6 %) and available time to tackle disasters (10.8 %) on (d). Knowledge about disasters is also found to influence alternative (b), even though its influence is limited (VR = 6.1 %).

12.6 Tourists' Stated Adaptation in Response to Floods and Cyclones

12.6.1 Data

12.6.1.1 Questionnaire Design

For the purpose of this study, a questionnaire consisting of four main parts was designed. The first part includes questions regarding tourists' travel schedule for their current trips in Bangladesh (such as destination choice, travel date, travel mode, size of travel party, duration of stay, and expenditure) and their subjective evaluation of destinations visited.

The second part investigates tourists' SP responses regarding visitor behavior in Bangladesh in different flood and cyclone scenarios (i.e., their reported behavior in the hypothetical scenarios). The factors and levels describing these scenarios were developed in consultation with local experts involved either professionally or academically with disaster management.

The flood scenarios are defined by:

- frequency (three levels: every year, once every two years, or once every three years).
- intensity (three levels: reaches knees, reaches waist, or reaches chest or above).
- permanent/frequent inundation (two levels: yes or no).
- permanent salinity intrusion (two levels: yes or no).

- visited area is isolated by water (two levels: yes or no).
- roads to other cities are destroyed permanently (two levels: yes or no).

The cyclone scenarios are defined by:

- frequency (three levels: twice a year, once a year, or once every two years).
- intensity (three levels: some structural damage to houses, complete structural collapse in a small number of houses, or complete collapse in many houses).
- frequent inundation (two levels: yes or no).
- permanent salinity intrusion (two levels: yes or no).
- area visited is isolated by water (two levels: yes or no).
- roads to other cities are destroyed permanently (two levels: yes or no).

The choice set included five alternatives: (1) still travel as planned, (2) cancel the trip, (3) change to other destinations, (4) change travel modes/routes, (5) change the stay duration and/or timing. A fractional factorial experimental design was used in the generation of the choice situations. As a result, 16 SP profiles were generated for flood and cyclone scenarios. To reduce the burden on each respondent, each questionnaire included only four SP profiles for either flood or cyclone.

The third part investigates respondents' adaptation behavior to previous climate disasters. Respondents were asked to provide information about two recent trips that were influenced by climate disasters, including the disaster type, their information source, the timing of the disaster (i.e., before or during their trip), their travel schedule (destination country, travel date, travel purpose, companion, travel mode, duration of stay, expenditure, etc.), and their response to the disaster.

The fourth part collects information on individual and household characteristics, including gender, age, education level, occupation, household annual income, and travel experiences during the previous year (i.e., the number of tourism trips taken in the previous year, including both domestic and international travels).

12.6.1.2 Survey Implementation

The survey was conducted between the middle of January and the first week of February, 2013, which was the peak season for both domestic and international tourism. The survey focused on two main tourism regions of Bangladesh: one in the southeastern part, which has the world's longest natural sea beach, and the other in the southern part, which has the largest mangrove forest in the world.

The survey was carried out in nine zones of the above two regions by two survey teams. Each survey team consisted of one supervisor and several interviewers. The questionnaire was designed in English. For international tourists, the questionnaire was filled out by the tourists themselves. For domestic tourists, the survey was conducted through face-to-face interviews, and the questionnaire was filled out by the interviewers.

12.6.1.3 Data Description

As a result, 1000 valid questionnaires were obtained (537 domestic tourists and 463 international tourists). The data characteristics are summarized in Table 12.7. It is observed that 64.3 % of the respondents are male, three-quarters of whom were under 40 years of age, and about two-thirds of whom traveled with family or friends. In comparison with domestic tourists, international tourists have a more equal gender distribution, and are wealthier, older, and have more travel experience.

12.6.2 Aggregation Analysis

Figure 12.27 shows the cross aggregation analysis of several individual characteristics and tourists' adaptation behavior in response to floods and cyclones. The findings are summarized below:

(a) Gender: Male tourists are less likely to cancel their travel plans in response to climate disasters.
(b) Age: The probability of canceling or changing travel plans increases with age.
(c) Type of tourist: International tourists are more likely than domestic tourists to cancel or change their travel plans.
(d) Travel experience: Tourists with more travel experience are less likely to cancel their plans or change their travel timing.
(e) Traveling companions: Tourists who travel alone are more likely to cancel their plans.
(f) Travel mode: Tourists who travel by private car are more likely to cancel their plans in response to climate disasters.

12.6.3 Modeling Analysis

In this section, tourists' reported adaptation behavior in response to climate disasters is analyzed using an MNL model, which includes five alternatives: (1) still travel as planned, (2) cancel the trip, (3) change to other destinations, (4) change travel modes/routes, and (5) change the stay duration and/or timing of travel.

Because the cross aggregation revealed that gender, age, travel experience, type of tourist, companions, and travel mode have significant influences on responses to climate disasters, these variables are included as explanatory variables to represent reported behavior. Additionally, it is expected that tourist satisfaction with their travel may influence their future behavior as well. In the survey, respondents were asked to report their travel schedule for their current trip to Bangladesh

Table 12.7 Summary of survey data characteristics

Selected items	Domestic (537) (%)	International (463) (%)	Total (1000) (%)
Gender			
Male	71.1	56.4 %	64.3 %
Female	28.9	43.6	35.7
Age			
<30 years old	50.8	25.1	38.9
30 ~ 39 years old	33.7	38.9	36.1
40 ~ 49 years old	9.9	27.0	17.8
> = 50 years old	5.6	9.0	7.2
Annual household income			
<10,000 USD	67.4	17.3	44.2
10,000–50,000 USD	28.3	44.9	36.0
50,000–100,000 USD	3.5	18.8	10.6
>100,000 USD	0.8	19.0	9.2
Education level			
University or above	62.4	56.6	59.7
Others	37.6	43.4	40.3
Travel experience (*Including both domestic and international travel*)			
None	77.5	18.1	50.0
Once	16.4	33.1	24.1
More than once	6.1	48.8	25.9
Travel companion			
Alone	5.9	11.2	8.4
With family	37.6	34.1	36.0
With friends	37.8	28.9	33.7
With colleagues	7.6	9.3	8.4
Group travel	9.7	11.2	10.4
Others	1.4	5.3	2.9

and their subjective evaluation of destinations visited. The respondents were also asked to evaluate the tourism destination on a five-point scale, anchored by “1” indicating least satisfied and “5” indicating most satisfied. Twelve individual components and overall satisfaction were included in the questionnaire to obtain the tourists’ subjective evaluations. Given that the satisfaction levels of different components would be correlated, only overall satisfaction level is used as the explanatory variable in the analysis. Furthermore, tourists’ previous behavior is included as an explanatory variable to examine whether there is habit persistence in tourists’ adaptation behavior in response to disasters.

As mentioned above, the survey covers two types of disasters (i.e., floods and cyclones). Tourists’ responses to these two disasters are analyzed separately. Six attributes that describe the disaster scenarios are included in the model to examine the impact of disaster severity on tourist behavior. Table 12.8 lists the explanatory variables in the analysis of tourists’ stated adaptation behavior.

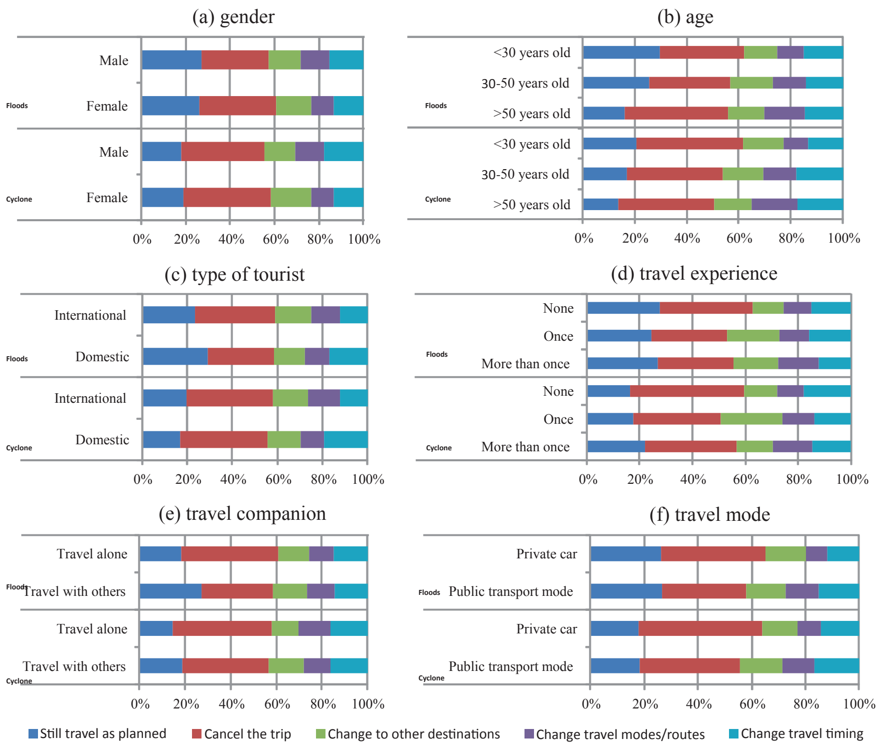


Fig. 12.27 Cross aggregation between individual characteristics and tourist's adaptation behavior

Tables 12.9 and 12.10 display model estimation results for tourist behavior in response to flood and cyclone disasters, respectively. For both flood and cyclone, most of the explanatory variables are statistically significant at the 95 or 90 % levels. The estimated parameters for individual characteristics and trip-related variables, including gender, age, travel experience, type of tourist, companion, and travel mode, show similar results to the cross aggregation. It is worth noting that satisfaction level has a significant influence on tourist behavior under climate disasters. This suggests that tourists with higher satisfaction levels are less likely to cancel their trips or change to other destinations when they experience climate disasters. Tourists' previous adaptation behavior has a significant influence on the alternative of "cancel the trip". The positive parameter indicates that tourists who canceled their trips in response to climate disasters previously are more likely to behave similarly when confronted by climate disasters in the future.

In terms of attributes related to the severity of floods, almost all the parameters show positive influences. It can be concluded that tourists are more likely to cancel or change their travel plans if floods become more severe. It is interesting that while the frequency of floods significantly increases tourists' probability

Table 12.8 List of explanatory variables

Explanatory variables	Description
Individual and trip related variables	
Gender	1: Male; 0: Female
Age	Actual age
Travel experience	Numbers of tourism trips last year
Type of tourist	1: International trip; 0: Domestic trip
Travel companion	1: Alone; 0: Otherwise
Travel mode	1: Private car; 0: Public transport mode
Satisfaction	Overall satisfaction level on a scale from 1 to 5
Previous adaptive behavior	1: Chose this adaptation alternative in the past; 0: Otherwise
Disaster scenarios	
Frequency	Frequency every year
Intensity (flood)	1: Reach waist or above; 0: Otherwise
Intensity (cyclone)	1: Complete house structure collapse; 0: Otherwise
Frequent inundation	1: Yes; 0: No
Permanent salinity intrusion	1: Yes; 0: No
Isolated by water	1: Yes; 0: No
Transportation is destroyed	1: Yes; 0: No

Table 12.9 Model estimation result for tourist behavior under flood disaster

Explanatory variable	Cancel		Change to other destinations		Change travel modes/routes		Change travel timing	
	Parameter		Parameter		Parameter		Parameter	
Individual and trip related variables								
Gender	−0.15	*	−0.09		0.19		0.01	
Age	0.31	**	0.27	**	0.37	**	0.22	**
Travel experience	−0.05	**	−0.01		−0.03		−0.08	**
Type of tourist	0.16	*	0.23	*	0.31	**	−0.10	
Travel companion	0.50	**	0.12		0.07		0.41	**
Travel mode	0.29	**	0.01		−0.38		−0.06	
Satisfaction	−0.62	**	−0.27	**	−0.01		−0.01	
Previous adaptation behavior	0.17	*	−0.02		0.14		0.08	
Disaster scenarios								
Frequency	1.73	**	1.32	**	1.52	**	1.62	**
Intensity	0.05		-0.29		−0.13		0.25	*
Frequent inundation	0.43	**	0.35	**	0.28	**	0.38	**

Table 12.9 (continued)

Explanatory variable	Cancel		Change to other destinations		Change travel modes/routes		Change travel timing	
	Parameter		Parameter		Parameter		Parameter	
Permanent salinity intrusion	0.35	**	0.19	*	0.26	**	0.06	
Isolated by water	0.56	**	0.26	*	0.01		0.07	
Transportation is destroyed	0.56	**	0.41	**	0.23	**	0.31	**
Initial log-likelihood	−6418.43							
Converged log-likelihood	−4783.42							
McFadden's Rho-squared	0.25							

*significant at the 90 % level, **significant at the 95 % level

of canceling or changing their travel plans, the intensity of floods only influences the alternative of "change travel timing". This indicates that when flood intensity increases, tourists are more likely to change their travel timing rather than to cancel their trip.

The results for cyclones are similar to those for floods, except that intensity significantly affects tourists' decisions to cancel their trip in response to cyclone disasters. This suggests that while the increased intensity of floods would increase the probability of tourists changing their travel timing, they would be more likely to cancel their trip if the intensity of cyclones increased.

12.6.4 Summary

This study investigated tourist adaptation behavior in response to climate disasters in Bangladesh. The findings can be summarized as: (1) there are more factors influencing the cancelation of trips than other types of adaptation behavior. This indicates that trip cancelation behavior would easily be influenced by various individual and trip attributes. Therefore, the question of how to reduce trip cancelations should receive close attention in tourism policy decisions in Bangladesh. (2) Most variables related to disaster severity (e.g., frequency, inundation, and damage to transportation networks) have statistically significant influences on adaptation behavior. (3) If climate disasters were to become more serious, one could expect more cancelations and changes of destination, especially for international

Table 12.10 Model estimation result for tourist behavior under cyclone disaster

Explanatory variable	Cancel		Change to other destinations		Change travel modes/routes		Change travel timing	
	Parameter		Parameter		Parameter		Parameter	
Individual and trip related variables								
Gender	−0.03		−0.23	**	0.24	*	0.18	
Age	0.28	**	0.21	**	0.34	**	0.39	**
Travel experience	−0.04	*	−0.05	*	−0.07	**	−0.05	
Type of tourist	0.42	**	0.15		0.13		0.72	**
Travel companion	0.26		−0.10		0.25		0.25	
Travel mode	0.41	**	−0.02		−0.19		0.09	
Satisfaction	−0.47	**	−0.21	**	−0.07		−0.01	
Previous adaptation behavior	0.21	*	0.10		−0.15		0.11	
Disaster scenarios								
Frequency	0.78	**	0.66	**	0.91	**	0.77	**
Intensity	0.15	*	0.02		0.12		0.03	
Frequent inundation	0.60	**	0.57	**	0.58	**	0.59	
Permanent salinity intrusion	0.07		0.05		0.01		0.17	
Isolated by water	0.27	**	0.11		0.32	**	0.22	*
Transportation is destroyed	0.41	**	0.08		0.21	**	0.14	
Initial log-likelihood	6436.14							
Converged log-likelihood	4757.64							
McFadden's Rho-squared	0.26							

*significant at the 90 % level, **significant at the 95 % level

tourists. This indicates that the national government should pay more attention to preparation for future disasters in tourism policy decisions. To improve resilience in overseas markets, it is recommended that regional planning be coordinated to promote alternate destinations within the country as a means of attracting international tourists who, as this research suggests, are more likely to switch destinations in the face of climate disasters. Satisfaction with travel is influential in decisions on both trip cancelation and change of destination. This suggests the importance of enhancing tourism service quality in Bangladesh.

12.7 Conclusions

Climate-related disasters have caused various kinds of damage to human lifelines, such as houses, roads, schools, agricultural land, factories, electric power stations, water supply facilities, and other public facilities. Without these lifelines, people could not survive, and damage to these lifelines would seriously affect people's lives. For example, as Kotzee and Reyers (2016) noted in a review, "studies on the impacts of severe flood events in the last decade report on unpredictable, usually rapid onset events that lead to substantial financial losses, destruction of infrastructure, displacement, and death." (p. 45). Such impacts are especially serious in low-income countries where various types of infrastructure are underdeveloped, even for current needs (Conway and Schipper 2011; Thakur et al. 2011; Arndt et al. 2012; Schweikert et al. 2014). Various studies have examined the impacts of climate change on human life, economic activity, physical assets, and the environment, and demonstrate the need to address these impacts proactively to minimize the damage to current and future development (Schweikert et al. 2014). Some researchers have pointed out that the literature on climate change impacts and adaptation in the infrastructure sector is primarily qualitative (e.g., Arndt et al. 2012). Various studies have shown quite a high probability that climate-related disasters will occur in the future (IPCC 2007). However, it is still uncertain where the disasters will occur nearby personal daily activity areas, and how great the impacts on human life will be. Under such uncertain situations, households must make difficult decisions on whether to continue their current lives as usual or to adapt themselves to uncertain future disasters at the expense of various monetary and mental costs. In particular, because jobs and residences currently meet people's most fundamental needs in life, changing these in response to climate-related disasters implies that people must simultaneously change other life behaviors, such as children's education, members' social networks, and/or various daily activities, accordingly. On the other hand, participating in international tourism activities has become an essential part of many people's lives in developed countries. This phenomenon will continue, and provide many developing countries with special economic development opportunities via the promotion of international tourism. Considering the negative impacts of climate-related disasters observed in various literature studies, it is obvious that providing disaster-resilient tourism is crucial for developing countries vulnerable to disasters, such as Bangladesh.

Climate change is a reality to which societies need to respond with appropriate and sustainable adaptive actions. However, little is known about how households, especially those in developing countries vulnerable to climate-related disasters, adapt themselves to survive with the future impacts of the disasters. In this study in the context of Bangladesh, we made an initial attempt to examine quantitatively adaptation behaviors and measures in a country at an ever-increasing risk of climate disasters at the household and individual levels by focusing on intercity travel adaptation, life adaptation, and tourism adaptation behaviors. A utility-based discrete-choice model was adopted to estimate how households and tourists would change their behavior in response to future impacts of floods and cyclones using a stated preference survey. The findings are useful to help identify the barriers to the adoption of adaptation measures, the roles of different stakeholders in implementing adaptation measures, and the directions of adaptation measures in the future, even though further studies are required to derive more robust conclusions based on advanced modeling techniques with more realistic decision-making mechanisms.

In the face of disasters, people have to make various decisions and take various actions to return to normal life. However, the question is whether their lives return to normal with these efforts. These efforts may or may not be made depending on their capabilities, the availability of social support, future concerns, or other considerations. People in countries such as Bangladesh have often experienced climate-related disasters. Whether people are capable of adapting to them depends not only on personal efforts, but also on external support. Even if people are capable of adapting to the disasters, they may still face difficult decisions, depending on how they perceive the uncertainty of future disasters at the level of their daily action space. Disaster-adaptive behavior is closely related to social exclusion issues, i.e., unequal treatment and situations of different population groups in society (e.g., Jones and Boyd 2011; Ruiz Meza 2014; Ensor et al. 2015). In this regard, adaptive capacity becomes a key concern. This is defined as the ability of social actors to make deliberate changes that influence the resilience of their complex social–ecological systems (Walker et al. 2004; Ruiz Meza 2014). Feasible adaptation measures should be proposed, considering people's acceptance of various interventions and examined by integrating insights from both interdisciplinary and cross-sectoral studies. On the other hand, climate-related disasters sometimes bring benefits. For example, land may become more fertile after a flood. Such positive impacts should also be identified and fully exploited in adaptation measures. Because climate-related disasters damage various sectors simultaneously, joint efforts from these sectors are required. It is necessary to clarify the kinds of cross-sectoral approaches that are more effective at various time scales: long term, medium term, and short term.

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