Chapter 2
Livelihood Vulnerability and Displacement in Coastal Bangladesh: Understanding the Nexus

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Abstract Although numerous researches came up with various estimates about climate migrants from coastal Bangladesh, yet the connections between vulnerability and forced displacement are poorly understood. This research is aimed first, to assess the linkages between people's livelihood vulnerability and their intention for outmigration from the coast; second, to identify the vulnerability reduction measures, implementation of which may significantly arrest the likely trend of forced migration. Empirical part of this research was conducted in three coastal villages in Bangladesh. A total of 285 respondents were randomly interviewed using a semi structured questionnaire. Given the scenario of sea level rise (SLR), respondents were first asked—what they or their descendent would probably do if their most parcels of farmland gradually go under half-knee deep (20–25 cm) sea water by the middle of this century. Then they were asked to identify the nature of livelihood vulnerability for which, they or their descendent may permanently leave their current place of residences. Finally, they were advised to identify various vulnerability reduction measures, implementation of which will reduce their vulnerability as well as will arrest the likely trend of forced migration. Findings suggest that one in every three families will be forced to migrate. Therefore, about five million people may turn out as climate migrants. There emerged a clear linkage between mass displacement and sources of livelihood vulnerability. Finally, Binomial logistic regression model has identified six vulnerability reduction measures from a total of 18 which will significantly arrest the likely trend of forced migration by

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minimizing people's exposure and sensitivity and enhancing adaptive capacity. The policy implication is to avoid the occurrence of any large scale forced migration from the vulnerable coast of Bangladesh measures must be initiated in line with the findings without further delay.

Introduction

The Intergovernmental Panel on Climate Change (IPCC) in its several assessment reports has made strong assertion about the occurrence of accelerated sea level rise (SLR) and more frequent extreme events such as coastal flooding, cyclones, storm surges and salinity intrusion. Low-lying deltaic and small island countries (SICs) are particularly vulnerable to the SLR and its associated extreme events (IPCC 2001a, 2007). Bangladesh with a vast low-lying deltaic coast is one of the countries very much susceptible to SLR and its associated disastrous events (IPCC 2001a; GOB 2009; UNDP 2009). Coastal morphology, hydrology, soil, agriculture, horticulture, forestry, fisheries, infrastructures, settlements all will be severely impacted by these disasters (Mirza 2002; CARE 2003). Numerous studies have warned that the situation may aggravate more as Bangladesh might experience 30, 50 and about 100 cm SLR by the year 2030, 2050 and 2100 respectively (World Bank 2000). For the projected SLR many of these impacts will be felt more severe than any time in the past.

Vulnerability of people of Bangladesh to SLR and its associated events is attributed to both physical and socio-economic factors. Physical factor, for instance, low elevation from the mean sea level makes the entire coast highly exposed to cyclonic storms, tidal incursion, coastal flooding and salinity intrusion. Particularly the southwest coast experiences recurrent exposure to these hazards as this area is located only about one meter above the mean sea level (World Bank 2000; Ali Khan et al 2000; Cannon 2002; GOB 2009; Thomalla et al 2006; UNDP 2009). Some socio-economic factors, such as high population growth, extreme poverty, poor resource base, low adaptive capacity and high dependency on natural resources also make the livelihood of coastal people highly sensitive to these SLR and its associated events (Mirza 2002; CARE 2003; Agrawala et al. 2003; Adger et al. 2003; Wisner et al. 2004).

As the livelihood of about 35 million natural resource-dependent coastal population would be severely affected by SLR and its associated events, a significant proportion of them might turn out as climate migrants by the middle of this century (GOB 2009, 2010). The issues of climate change induced displacement and climate migrants already have been appeared as serious concern for Bangladesh and its neighbouring countries as well. Drawing from the evidences of previous migration patterns in the Indian subcontinent, many scholars have warned that huge displacement from coastal Bangladesh may eventually drag Bangladesh in violent conflict with neighbouring India, Pakistan and Myanmar as many climate migrants may arrive in these neighbouring countries following some historical links (i.e. cultural, religious and ethnic). Such massive displacement from the vulnerable coast of Bangladesh could be reduced by reducing the vulnerability of the coastal population (Saroar and Routray 2010).

Theoretically, there are two important ways of reducing vulnerability and livelihood insecurity. First, it can be reduced by lowering the people's exposure and sensitivity to these [SLR induced] extreme events; second, by enhancing their adaptive capacity (Chambers and Conway 1992; Ellis 2000). To minimize exposure usually various hard (i.e. engineering) measures such as new safe (e.g. cyclone, flood) shelters, sea walls, sluice gates, dykes etc. are undertaken. Sensitivity can be minimized by taking various managerial measures such as providing early warning, quickly mobilizing rescue units and operating community food security program al local level. Similarly to enhance adaptive capacity various other programs that support the socio-economic development of the coastal population are initiated (Kelly and Adger 2000; Grothmann and Patt 2005; Adger 2006). Drawing on the findings of earlier researches (Kelly and Adger 2000; Grothmann and Patt 2005; Pelling and High 2005; Tol et al. 2008; Schmidt-Thome and Klein 2013), it is hypothesised that some of these vulnerability reduction measures will encourage the coastal people of Bangladesh to adopt anticipatory adaptation in situ rather than turn out as climate migrants. However, how each of these vulnerability reduction measures may affect the livelihood security of coastal population in Bangladesh is not empirically studied yet. Therefore, the connection among vulnerability reduction measures, people's livelihood security and intension for displacement from the coast is poorly understood. Acknowledging this lack in research that examines the casual links among vulnerability reduction measures, livelihood security and mass displacement, this evidence based research is aimed to fill this gaps in knowledge and practice by addressing two research questions. First, what are the impacts of SLR and its associated events that people count as the key threats to their livelihood security which may cause forced outmigration? Second, what potentials various vulnerability reduction measures have to arrest the likely trend of outmigration from the coast? The policy implication of the research finding is- it might help devising public interventions for vulnerability reduction and to avoid the occurrence of mass displacement from the fragile coast of Bangladesh and elsewhere.

Materials and Methods

Selection of Study Area, Respondents and Survey Procedures

Coastal Bangladesh covers an estimated area of 47 thousand sq km which is divided in three distinct zones, i.e. south-western, south-central and south-eastern zone. Although whole coastal area of Bangladesh is susceptible to multiplicity of disasters, historical evidences and scientific studies indicate that people of the south-west part are more vulnerable to various hydro-meteorological disasters including cyclones, storm surges, salinity intrusion, and tidal flooding (Castro-Ortiz 1994; Ali and Chowdhury 1997; Ali Khan et al. 2000; World Bank 2000; Khan 2008; GOB 2010). The vulnerability of the population of south-west coast may increase further in the changing context of climate; especially the accelerated SLR might amplify the devastating effects of many of these already occurring disasters. Patuakhali District of this south-west zone, which is worst affected by these disasters selected for empirical part of the research.

A multistage sampling technique was employed to collect data and information from the study area. In first stage, from the six Upazila (sub-district) of Patuakhali District, “Kalapara Upazila” (sub-district) was selected. In second stage, from nine Union Parishad (lowest tier of local government) in Kalapara, three UPs which are flanked by the bay of Bengal and located about 0–30 cm (1 ft contour) above mean sea level was selected for this study. Tidal water inundates a significant part of the study area during high tide as the sea water travels upward from the bay of Bengal through a network of rivers, natural cannels and creeks (Fig. 2.1). People have been living here are historically prone to various natural calamities. In the final stage, a total of 285 households selected randomly were interviewed during January–April 2009. Interviews of usually the head of households were done through administering semi-structured questionnaire. Among the respondents 175 are male and 110 are female. The Bengali version of questionnaire was used to facilitate the survey process. Several focus group discussion sessions both formal and informal were conducted to get deeper insight about issues of particular interest.

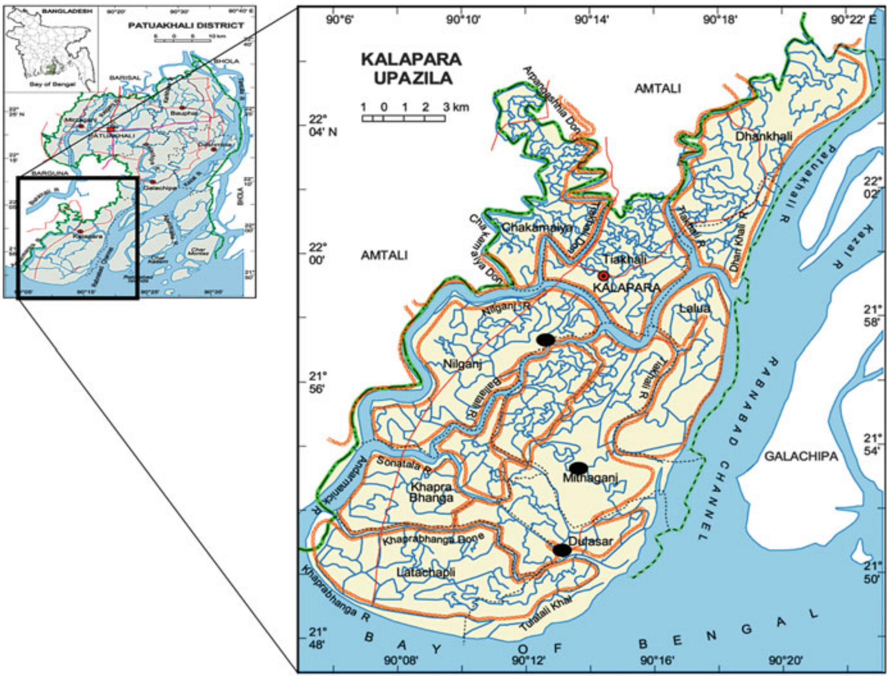

Fig. 2.1 Study sites (marked with *black circles*): in Dhulasar, Mithaganj and Nilganj “Union Parishad”. *Source*. Islam (2003)

Approaches to Study and the Research Instruments

To address the research questions stated in the introduction part, a semi-structured questionnaire was prepared and tested in the study area before conducting the actual field survey. The questionnaire included among others various socio-economic and demographic information of the family, their exposure to various disasters, the damage that they experience due to recurrent disasters, their perception about the changing nature of climate, extreme events and sea level rise, and the likely impacts of these events on their live and livelihood. The following steps were followed to carry out the survey and data processing.

- First, the likely scenarios of SLR for the year 2020–2030 and 2050–2075 were narrated in brief before taking interview of the respondents. The direct impacts that might result from such SLR were also shared with them before the start of the interview. Respondents were asked to rate the impacts in a simple 3-point scale according to the level of severity of the impacts. They were further asked, what they or their decedents would probably do if their livelihood become insecure due to the impacts of future SLR and its associated events. From numerous responses, ultimately the likely occurrence of forced migration from the coastal tract was counted. The whole process of this step is discussed in some detail in respective section.
- Second, the respondents were asked to rank a maximum of five key causes/ sources of livelihood insecurity that might force them or their decedents (e.g. children or grandchildren) to migrate out from the fragile coast.
- Third, the respondents were asked to identify appropriate measures to reduce their livelihood vulnerability. Accordingly they were provided with three separate lists of measures, for instances, measures for minimization of exposure and sensitivity, and maximization of adaptive capacity. These lists of measures were prepared based on review of both hazard and climate literature. Broadly, these measures include—technological, managerial, policy, and other supportive measures that have the potential to ameliorate the negative impacts of SLR and its associate events on the livelihood of coastal people.
- Fourth, they were asked if appropriate measures are implemented whether they will still migrate out or change their intension of outmigration. It is expected that their responses will give a strong indication about the effectiveness of vulnerability reduction measures to stop mass displacement from the fragile coast.

Finally, to assess the effectiveness of each of the three kinds of vulnerability reduction measures in arresting the likely trend of mass displacement, a binomial logistic regressions (BLR) model was developed. This is discussed in some detail in respective section.

Result and Discussion

Socio-demographic Profiles of the Respondents

Among the respondents about 61 % are male and 39 % are female. The average age of the family head is 49 years and average duration of stay in the same locality is 44.45 years which means respondent's spatial mobility in terms of permanent migration is very less common. Of course, this interpretation does not consider the nearly permanent move out of female respondents from their parental house to husbands' house after their marriage. Almost 60 % of the respondents are illiterate; 20 % have completed grade-5 and 5 % have completed grade-8. Only about 2 % of them are college/university graduate. About 17 % of the respondents belong to different social and/or economic groups/organization but remaining 83 % are not member of any such groups.

The most dominant occupation of the respondents are crop agriculture (30.5 %) followed by casual labor (18.6 %) and fishing (17.2 %). Other available occupations are petty trade, business, transport-work, formal job, and various other on farm and off farm economic activities. However, almost every family is somehow engaged in natural resource-based livelihood which increases their vulnerability to climatic disasters. The annual average income of a family is about 141,438 BDT (US $2,065; 1 $ = 68.5 BDT). However, most of the families earn annually about 65,000 BDT (marginally below US $1,000). Average farm size among the surveyed household is only 0.36 ha and one fourth (24.6 %) of the families do not have any farmland; farmland holding is highly skewed.

Impacts of Hydro-meteorological Disasters on Livelihood Security

As the study area is historically exposed to multiple-hazards, the respondents are in general familiar with the impacts of cyclone, tidal surge, coastal inundation, salinity intrusion. They have a common perception that extreme events are more pronounced in recent time than these had been earlier. Respondents were asked to identify the likely impacts of various hydro-meteorological events including SLR especially if their farmlands gradually go under half of knee-deep water (20–25 cm) forever. Similarly they were asked about the impacts they will encounter if height of storm surges increase more few meters than they have had in the past. The use of this kind of plausible scenarios of climate change for studying the perception of common people is a widely accepted method (cf. Ford et al. 2010). To facilitate their responses, a total of 25 plausible impacts were included in the questionnaire. This list of 25 impacts of climate change induced hydro-meteorological events was prepared from the review of literature of climate and disaster science that have both global (see Smith 1997; Middleton 1999; IPCC 2001b; van Aalst 2006; Bosello et al. 2007; Wilbanks et al. 2007; Bunce et al. 2010) and regional focus, e.g. Asia pacific region (see Twigg and Bhatt 1998; Luna 2001; Ahmed 2005; Choudhury et al. 2005; Allen 2006; GOB 2009; De Silva and Yamao 2007). They have rated each of these impacts on their natural resource based livelihood in a simplified 3-point scale [low to high] instead of a 5-point Likert scale. Although a 5-point Likert scale is widely used, to facilitate the responses of rural illiterate/less educated respondents a 3-point simplified scale was preferred.

The Table 2.1 reports that respondent's livelihood security is impacted largely by physical damage of settlements, stock of foods, biomass fuels, cattle's fodders, and harvest failure. More than 50 % of the respondents mentioned that their

Table 2.1 Types of livelihood insecurity attributed to hydro-meteorological events in coastal Bangladesh

Livelihood insecurity: type and nature[a]	High		Medium		Low	
	%	f	%	f	%	f
Loss of crop production	48.77	139	36.49	104	14.74	42
Complete harvest failure	***51.93***	148	38.60	110	9.47	27
Increase cost of agricultural production	44.56	127	9.82	28	45.61	130
Degradation of pastureland	35.44	101	16.49	47	48.07	137
Seasonal shortage of fodder	43.86	125	7.37	21	48.77	139
Difficulty in animal/poultry husbandry	38.95	111	30.88	88	30.18	86
Over bank flow of fishponds/fish farm	3.86	11	8.07	23	88.07	251
Higher risk in offshore fishing	20.00	57	14.39	41	65.61	187
Limited scope of festival and social gathering	35.79	102	34.74	99	29.47	84
Increase number of non-fishing day	29.12	83	5.96	17	64.91	185
Decrease in fish catch per go	31.93	91	3.16	9	64.91	185
Difficulty in preserving fish	21.75	62	18.95	54	59.30	169
Physical damage of settlement	***62.46***	178	12.28	35	25.26	72
Damage of stock of food, biomass fuel and fodder	***62.11***	177	10.53	30	27.37	78
Cost of maintenance and rebuilding of private infrastructure	44.56	127	24.21	69	31.23	89
Damage of road infrastructure	22.46	64	43.16	123	34.39	98
Damage of social physical infrastructure, e.g. market, school etc.	38.25	109	32.28	92	29.47	84
Difficulty in physical mobility	18.25	52	44.56	127	37.19	106
Difficulty in carrying goods and commodities	32.28	92	39.30	112	28.42	81
Decrease number of earning/productive day	***61.40***	175	32.28	92	6.32	18
Fluctuation/decline in wage rate	48.42	138	42.46	121	9.12	26
Limited supply and stock of foodstuff in the market	42.81	122	43.86	125	13.33	38
Spread of contaminated water	28.42	81	54.04	154	17.54	50
Lack of saline free fresh water for drinking	***60.70***	173	20.00	57	19.30	55
Prevalence of waterborne diseases	26.32	75	54.39	155	19.30	55

[a]Percentage should be read row-wise. Figures in Italic imply high impacts

livelihood security will be highly impacted in each of these dimensions. Severe threat to these dimensions of livelihood security is acknowledged by a large number of population because these are the common dimensions of livelihood security of most occupational groups in the study area. Similarly 40–50 % of the respondents mentioned that their livelihood will be highly impacted by loss of crop production, high cost in production, seasonal shortage of fodders, fluctuation/decline in wage rate, and limited supply of food staff in the markets. Livelihood insecurities of many other families are highly related to damage of fish ponds/enclosures, higher risk in offshore fishing, decrease in fish catch per go. Some other impacts, for instances, damage of road infrastructure, difficulty in physical mobility, difficulty in carrying commodity and goods, spread of contaminated water, and prevalence of waterborne diseases also will cause the livelihood of coastal people insecure in the changing context of climate.

Contrary to general expectation, more than 50 % respondents acknowledged that their livelihood security is rather less impacts in the dimensions of damage of fish ponds/farms, higher risk in offshore fishing, increase number of non-fishing day, decrease in fish catch per go, and difficulty in preserving fish. More than 50 % of the respondents assigned a low score for each of these dimensions of livelihood insecurity. It is probably because the livelihood challenges in these dimensions are related to only a particular occupational group [e.g. artisanal fisher/fishing community]. Although, probably fisher-group expressed higher concern in these dimensions of livelihood security, however, as a whole due to the presence of higher number of respondents from other occupational groups who do not expressed higher concern, higher percentage of low scores are observed in these dimensions. About 30–50 % of the respondents mentioned that they will experience medium level of impacts in their livelihood security due The respondents perceived relatively medium level of livelihood insecurity from other impacts such as loss of crop production, fluctuation/decline in wage rate, difficulty in animal/poultry husbandry, damage of road infrastructure, difficulty in physical mobility, difficulty in carrying goods and commodities, spread of contaminated water, and prevalence of waterborne diseases.

Causes of Livelihood Insecurity and Mass Displacement

Not all impacts cited earlier in the Table 2.1 will cause livelihood insecurity that may trigger mass displacement from the coast. The respondents have identified and ranked five major causes of livelihood insecurity that might force them or their descendants to migrate out from the fragile coast. Table 2.2 reports that almost half of the respondents, i.e. 48 % (137 out of total 285), do not think about permanent displacement from their current place of living. Other half (148 out of total 285) of them, however, identified one or more causes of livelihood insecurity which may force them or their descendent to leave the fragile coast forever. About 36 % respondents from the latter category reported that they or their descendants may

Table 2.2 Reasons of livelihood insecurity which may cause forced migration from the fragile coast

Reasons of livelihood insecurity which may cause forced migration from the coast (*N* = *148*[a], *total responses* = *208*[b]):	Count	Percent of cases	Rank
i. If current main sources of income are likely to encounter irrecoverable loss due to SLR associated events	53	35.8	1
ii. If current physical accesses to services - local health care, market place, schooling are likely to be severely affected due to SLR associated events	52	35.1	2
iii. If current free/low cost accesses to potable water are likely to be diminished due to SLR associated events	45	30.4	3
iv. If food securities (production/availability) are likely to be severely affected due to SLR associated events	39	26.4	4
v. If most relatives are likely to quit/evacuate due to perceived threat of SLR associated events	19	12.8	5

[a]Remaining 135 (285–148) respondents do not consider outmigration as an adaptation strategy
[b]Multiple responses (adopted from Saroar and Routray 2013)

eventually leave the coast if their livelihood is severely affected due to complete loss of income from current/known sources. About same number of the respondents (35 %) think that people may leave the coast if their access to various services including local health care, market places, schools etc. are permanently disrupted. Another 30 % respondents believe that people may leave the coast because of severe crisis of salt free water for drinking and similar uses. Only about 25 % respondents have identified food insecurity (production loss/harvest failure) as the main cause in this regard (Table 2.2). It is a bit strange however to note that more people are willing to leave the fragile coast for severe scarcity of freshwater than loss of crop production due to harvest failure. About 10 % may prefer outmigration just because their close relatives will be doing so. The latter cause is not so serious from the point that normally about 5 % out migration is common from this part of fragile coast.

Linking Livelihood Vulnerability and Forced Migration

The likely scenarios of climate change induced sea level rise (CC-SLR) for the year 2020–2030 and 2050–2075 were presented to the respondents; these scenarios were adopted from the National Adaptation Programme of Actions (NAPA) for Bangladesh (GOB 2005). In general respondents are not familiar with the phrase "sea level rise". However, they are very much familiar with periodic/occasional inundation of their farmlands by tidal or cyclonic surges that originate from the bay of Bengal located nearby. They experience such inundation due to their recurrent exposures to tidal floods, storm surges, breach of embankments, and high tides. Considering their low level of familiarity with CC-SLR, the essence of SLR was rather communicated with them using practical means. Accordingly the respondents were asked- what they or their descendants would probably do, if their farmlands gradually go under “ankle-deep (10–15 cm)” and “half of knee-deep (20–25 cm)” salt water by the year 2020–2030 and 2050–2075 respectively? When the essence of SLR and its associated events were communicated using this kind of iconic images, the respondents were able to identify the likely impacts on their livelihood security and they replied accordingly. To deals with the future livelihood insecurity, the respondents may choose from eight courses of actions/responses. Their future responses will be: raise homestead and continue the same occupation anyway; raise homestead and continue agriculture (hoping salt tolerant varieties will be available); raise homestead and adopt brackish water aquaculture; switch to non-farm occupations; evacuate and settle nearby safer localities and towns; evacuate and arrive at major metropolises, especially in Dhaka; and evacuate the locality without predefined destination.

As it was aimed at identifying the links among SLR induced impacts, livelihood insecurity and forced migration of people from the fragile coast, therefore, the above responses concerning the people’s spatial mobility and adaptive responses were grouped into two distinct and meaningful categories by collapsing closely related responses. The broad two categories of respondents are those who will not leave the coast (i.e. adaptation in situ) and those who will leave the coast (climate migrants/forced migrants) (Table 2.3). Finding suggests that no significant occurrence of forced migration will take place in the near future (by 2020–2030). However, almost 30 % respondents believe that they or their offspring may be forced to turn out as climate migrants in distant future (2050–2075) if appropriate measures are not taken beforehand.

Although about 35 million people inhabit in the entire coast of Bangladesh, half of them live in the low-lying parts alone. Based on the estimates of forced migrants (see last column: Table 2.3), one can expect that by the later part of this century (2050–2075) almost 5 million people will turn out as climate migrant (Table 2.3) from the low-lying part of the coast alone. However, if forced migration from the whole coastal tract is considered this number would be double, i.e. about 10 million population. Available estimates show that by 2050, 130 million more people will be

Table 2.3 Likely trend of forced migration for two plausible scenarios of SLR in coastal Bangladesh

Likely responses of respondent if farmlands permanently go below salt water	Below ankle-deep water (10–15 cm) by 2020–2030	Below half—knee deep water (20–25 cm) by 2050–2075
i. Adaptation in situ (no occurrence of forced migration)	100 % (285)	70.2 % (200)
ii. Permanent displacement (occurrence of forced migration)	00 % (0)[a]	29.8 % (85)
Total	100 % (285)	100 % (285)

[a]Figure in parenthesis indicates frequency/absolute response. Respondents do not considered 10–15 cm inundation as a problem and have rejected the idea of permanent evacuation

added in Bangladesh many of whom will be in this part of the fragile coast (GOB 2009). Therefore, it is reasonable to conclude that number of climate migrants will exceed 10 million from Bangladesh coast before the end of this century. These prospective climate migrants will evacuate their current localities and settle permanently elsewhere, mostly in the metropolises, and Dhaka—the capital city of Bangladesh. This kind of mass displacement would create numerous problems in the places of destination as well (Moser and Satterthwaite 2009). Offering healthy places of living in the cities for this huge number of forced migrants is really a critical concern (Table 2.3). Massive forced migration from the vulnerable coast in Bangladesh could only be avoided through careful anticipatory adaptation planning. For this there is a clear need of evidence based research which will examine the effectiveness of various anticipatory measures to arrest the likely trend of forced migration by reducing the people's livelihood insecurity (Stern 2006; Leal Filho 2009).

Preferred Measures to Reduce Livelihood Insecurity and the Occurrence of Forced Migration

Broadly three types of measures are suggested to address the livelihood security of natural resource-dependent coastal community against the threats of SLR and its associate events (Klein et al. 2001). These measures are initiatives to minimize people's exposure to and sensitivity against these SLR induced events; and also initiatives to enhance their adaptive capacity. Exposure is the nature and degree to which a system experiences environmental or socio-political stress (Klein et al. 2001). Sensitivity is the degree to which a system is modified or affected by perturbations of certain types (McCarthy et al. 2001; Adger 2006). On the other hand, adaptive capacity is the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (Brooks et al. 2005; Smit and Wandel 2006).

From a total of 18 measures, the respondents have identified their preferred measures that will minimize their exposure and sensitivity and also maximize their adaptive capacity. They believe that implementation of these measures will discourage forced migration by ensuring their livelihood security. For exposure minimization their first priority is construction of more multipurpose cyclone/flood shelters. Maintenance of existing embankments/levees has been appeared as an important measure to discourage forced migration. Almost 75 % of them preferred operation of more new sluice gates. Similarly, about 65 % preferred construction of new flood walls/embankments/levees believing that construction of these will reduce their exposure to SLR and its associate events. Although everyone understood the roles of naturally occurring mangrove forest to minimize their exposure but only 30 % preferred reforestation of mangrove in their localities (Table 2.4).

Table 2.4 Respondent's preferred measures to discourage forced migration from Bangladesh coast

Measures preferred by the respondent to discourage forced outmigration from the coast	Count	Percent of cases
Measures to minimize exposure (N = 285, total responses = 1,187[a]):		
i. Construction of new flood wall/embankment/levee	187	65.6
ii. Maintenance of existing embankment/levee	226	79.3
iii. Operation of more new sluice gate	214	75.1
iv. Re-excavation of illegally occupied canals	192	67.4
v. Protection of mangrove and reforestation	83	29.1
vii. Construction and maintenance of cyclone/flood shelter	285	100.0
Measures to minimize sensitivity (N = 270, total responses = 810[a]):		
i. Early dissemination of warning information	169	62.6
ii. Emergency rescue and recovery unit at community level	197	73.0
iii. Quicker and better access to cyclone/flood shelter	204	75.6
iv. Community food security program	138	51.1
v. Others- as part of integrated coastal management	102	37.8
Measures to enhance adaptive capacity (N = 285, total responses = 1,187[a]):		
i. Awareness rising program on CC and SLR	285	100.0
ii. Strengthening community cohesiveness and bonding	140	49.1
iii. Help upgrading indigenous coping and adaptation	128	44.9
iv. Low-cost innovation for saline free water	170	59.6
v. Cash incentive for post disaster rehabilitation	285	100.0
vi. Special social safety-net for coastal communities	185	64.9
vii. Support for coastal resources based adaptive livelihood	221	77.5

[a]Multiple responses (adopted from Saroar and Routray 2013)

To minimize sensitivity about 75 % respondents preferred initiatives for quicker and better access to cyclone/flood shelters. Almost similar number (73 %) of them preferred establishment of emergency rescue and recovery units at community level. About 63 % preferred measures to disseminate warning information earlier than what is done now. About half of them preferred community food security program at community level (Table 2.4). To enhance their adaptive capacity about 77.5 % respondents preferred new initiatives for coastal resources based livelihood. About 65 % preferred special social safety nets for coastal area. Providing cash incentive for post disaster rehabilitation has been appeared as very popular initiative for adaptive capacity enhancement (Table 2.4).

Effectiveness of Measures to Discourage Forced Migration

To assess the effectiveness of both exposure and sensitivity minimization measures and adaptive capacity enhancement measures in lowering the likely trend of forced migration from the coast a Binomial Logistic Regression (BLR) model is built. This

BLR model only predicts the probability of arresting the likely trend of forced migration of those people whose avenues of income will be severely threatened by SLR and its associate events. Among the 18 vulnerability reduction measures, if a specific measure is considered by the respondents as an appropriate one then their response is coded with 1; but if that measure is considered inappropriate, then the responses is coded with 0. All the 18 measures are grouped under three major categories, such as measures for 'minimization of exposure (6 variables)', 'minimization of sensitivity (5 variables)', and 'enhancement of adaptive capacity (7 variables)'. Each of these 18 measures is used as an independent variable in the BLR model. Respondent's intension to migrate or not (when a specific measure will be implemented) is the dependent variable. Despite implementation of preferred measures if the respondents still intend to migrate out, their response is coded with 0. But if they intend not to migrate out any more, their response is coded with 1 (Table 2.5).

To fit the independent variables in the BLR model, the constant variables (i.e. 100 % responses are either 'yes' or 'no' or variables that have high colinearity/multicolinearity problem (i.e. correlation coefficient in excess of 0.70) (Field 2005) are excluded from the model. Following Field (2005), three independent variables, such as 'construction and maintenance of cyclone/flood shelter', 'awareness rising program on CC-SLR', and 'cash incentive for post disaster rehabilitation' are excluded from the model because these are constant variables (i.e. 100 % responses are same: see Table 2.4). Similarly, independent variable- 'quicker and better access to cyclone/flood shelter' is excluded from the model because it has strong colinearity (i.e. correlation coefficient is >80) with another variable 'emergency rescue and recovery unit at community level' (Table 2.6). Finally 14 independent variables are used in the model.

Respondents were asked if their preferred vulnerability reduction measures are implemented whether still they intend to migrate or not. Based on their responses, how far each measure will be effective in stopping forced migration is predicted with this BLR model. Models output are presented in Table 2.7. The result shows that exposure minimization measures (LR chi-square = 46.80, Pseudo $R^2 = 0.24$, $p < .01$), and adaptive capacity enhancement measures (LR chi-square = 49.45, Pseudo R2 = 0.26, $p < .01$) will have statistically significant influence than the sensitivity minimization (LR chi-square = 8.53, Pseudo $R^2 = 0.05$, $p < .10$) measures on the future migration behaviour of the respondents. It means if vulnerability reduction measures are implemented, prospective climate migrants may rethink and eventually may not migrate out from the coast.

Table 2.7 further reports that implementation of adaptive capacity enhancement measures will have highest influence on migration behaviour of coastal people. By contrast o implementation of "sensitivity minimization measures" will have least influence in this regards. As regards exposure minimization measures is it seen that the odds of preference for "not to out migrate (i.e. adaptation in situ)" is 24.1 times higher among the respondents who considered "construction of new flood walls/ embankments/levees" as appropriate than who did not considered (B = 3.18, Exp (B) = 24.10, Wald = 9.32, $p < .01$). It means among the various measures of

Table 2.5 Variables used in BLR model and their coding

Variables	Coding
Independent variables:	
i. Exposure minimization measure:	
Construction of new flood wall/embankment/levee (dummy)	1, if think appropriate; 0, otherwise
Maintenance of existing embankment/levee (dummy)	1, if think appropriate; 0, otherwise
Operation of more new sluice gate (dummy)	1, if think appropriate; 0, otherwise
Re-excavation of illegally occupied canals (dummy)	1, if think appropriate; 0, otherwise
Protection of mangrove and reforestation (dummy)	1, if think appropriate; 0, otherwise
Construction and maintenance of cyclone/flood shelter (dummy)[a]	1, if think appropriate; 0, otherwise
ii. Sensitivity minimization measure:	
Early dissemination of warning information (dummy)	1, if think appropriate; 0, otherwise
Emergency rescue/ recovery unit at community level (dummy)	1, if think appropriate; 0, otherwise
Quicker and better access to cyclone/flood shelter (dummy)	1, if think appropriate; 0, otherwise
Community food security program (dummy)	1, if think appropriate; 0, otherwise
Others- as part of integrated coastal management (dummy)	1, if think appropriate; 0, otherwise
iii. Adaptive capacity enhancement measures:	
Awareness rising program on CC and SLR (dummy)[a]	1, if think appropriate; 0, otherwise
Strengthening community cohesiveness and bonding (dummy)	1, if think appropriate; 0, otherwise
Help upgrading indigenous coping and adaptation (dummy)	1, if think appropriate; 0, otherwise
Low-cost innovation for saline free potable water (dummy)	1, if think appropriate; 0, otherwise
Cash incentive for post disaster rehabilitation (dummy)[a]	1, if think appropriate; 0, otherwise
Special social safety-net for coastal communities (dummy)	1, if think appropriate; 0, otherwise
Support for coastal resources based livelihood (dummy)	1, if think appropriate; 0, otherwise
Dependent variables:	
If the preferred measured is implemented whether the respondent still intend to migrate out from the coast? (dummy)	1, no; 0, yes

[a]The responses are constant (i.e. 100 % respondents responded in the same way); cannot be used in final modelling

Table 2.6 Partial correlation matrix to identify colinearity among independent variables

		1	2	3	4	5	6	7
	Measures to minimize sensitivity[a]:							
1	Early dissemination of warning information	–						
2	Emergency rescue and recovery unit at community level	−0.16**	–					
3	***Quicker and better access to cyclone/ flood shelter[a]***	−0.17**	***0.83** [a]***	–				
4	Community food security program	0.10	0.24**	0.24**	–			
5	Others- as part of integrated coastal management	0.43	0.09	0.07	0.27**	–		
	Measures to minimize Exposure[a]:							
1	Construction of new flood wall/embankment/levee	–						
2	Maintenance of existing embankment/ levee	0.54**	–					
3	Operation of more new sluice gate	−0.04	−0.11*	–				
4	Re-excavation of illegally occupied canals	0.33**	0.31**	0.01	–			
5	Protection of mangrove and reforestation	0.25**	0.33**	−0.11	0.10	–		
6	Construction and maintenance of cyclone/flood shelter'	[c]	[c]	[c]	[c]	[c]	–	
		1	2	3	4	5	6	7
	Measures to maximize Adaptive capacity[a]:							
1	Awareness rising program on CC and SLR	–						
2	Strengthening community cohesiveness and bonding	[c]	–					
3	Help upgrading indigenous coping and adaptation	[c]	0.09	–				
4	Low-cost innovation for saline free potable water	[c]	0.04	0.11	–			
5	Cash incentive for post disaster rehabilitation	[c]	[c]	[c]	[c]	–		

(continued)

Table 2.6 (continued)

		1	2	3	4	5	6	7
6	Special social safety-net for coastal communities	[c]	0.05	0.15*	−0.10	[c]	–	
7	Support for coastal resources based adaptive livelihood	[c]	0.11	0.06	−0.07	[c]	0.13*	–

*$p < 0.05$; **$p < 0.01$

[a]If a measure is considered appropriate by the respondent it is coded with 1; otherwise coded with 0

[b]Bold and Italicized item shows colinearity (e.g. Correlation coefficient value: 0.83)

[c]Cannot be computed because at least one variable is constant (i.e. 100 % responses are either yes or no)

exposure minimization, initiatives for "construction of new flood walls/embankments/levees" will have significantly higher influence to stop forced migration and to encourage adaptation in situ. In case of sensitivity minimization measures, it is found that the odds of preference for "not to out migrate (i.e. adaptation in situ)" is 1.9 times higher among the respondents who considered "community food security program" as appropriate sensitivity minimization measure than who did not ($B = 0.64$, Exp $(B) = 1.90$, Wald $= 3.65$, $p < .10$). It means, among the various measures of sensitivity minimization, initiatives for "community food security program" will have significantly higher influence to stop forced migration and to encourage adaptation in situ. In case of adaptive capacity enhancement measures, it is seen that the odds of preference for "not to out migrate (i.e. adaptation in situ)" is 5.17, 4.0 and 3.34 times higher among the respondents who considered "special social safety-nets for coastal communities" ($B = 1.75$, Exp $(B) = 5.74$, Wald $= 12.01$, $p < .01$), "strengthening community cohesiveness and bonding" ($B = 1.38$, Exp $(B) = 4.0$, Wald $= 14.7$, $p < .01$) and "support for coastal resources based adaptive livelihood" ($B = 1.21$, Exp $(B) = 3.34$, Wald $= 4.52$, $p < .05$) respectively as the appropriate measures (Table 2.7). It means implementation of adaptive capacity enhancement measures such as "special social safety-nets for coastal communities" and "support for coastal resources based adaptive livelihood" will have significantly high influence to stop mass displacement from the fragile coast of Bangladesh.

Analysis, Policy Implications and the Limitations of the Research

Results show that about 30 % families believe that they or their descendants will probably turn out as forced migrants because of loss of livelihood avenues. Considering the current population of fragile coast one can assume that about five

Table 2.7 Binomial logistic regression model to predict the influences of various vulnerability reduction measures on peoples' forced migration behaviour that may result from livelihood insecurity

Vulnerability reduction measure preferred by the respondent (1 = yes; otherwise, 0)	Model 1 Exposure minimization		Model 2 Sensitivity minimization		Model 3 Adaptive capacity enhancement	
	B: Coefficient (Exp (B): odds ratio)	Wald chi-square	B: Coefficient (Exp (B): odds ratio)	Wald chi-square	B: Coefficient (Exp (B): odds ratio)	Wald chi-square
Construction of new flood wall/embankment/ levee	3.18*** (24.10)	9.32				
Maintenance of existing embankment/levee	1.47 (4.35)	1.86				
Operation of more new sluice gate	−0.39 (0.68)	1.19				
Re-excavation of illegally occupied canals	0.23 (0.33)	1.27				
Protection of mangrove and reforestation	−0.40 (0.67)	1.37				
Early dissemination of warning information			0.18 (1.2)	0.23		
Operate emergency rescue and recovery unit at community level			0.21 (1.23)	0.31		
Community food security program			0.64* (1.90)	3.65		
Others- as part of integrated coastal management			0.32 (1.37)	0.77		
Help upgrading indigenous coping and adaptation					0.41 (1.50)	1.43
Strengthening community cohesiveness and bonding					1.38 *** (4.0)	14.70
Low-cost innovation for saline free potable water					−0.49 (.62)	2.03
Special social safety-net for coastal communities					1.75*** (5.74)	12.01
Support for coastal resources based adaptive livelihood					1.21** (3.34)	4.52
Likelihood Ratio Chi-square	46.80***		8.53*		49.45***	

(continued)

Table 2.7 (continued)

	Model 1 Exposure minimization		Model 2 Sensitivity minimization		Model 3 Adaptive capacity enhancement	
Vulnerability reduction measure preferred by the respondent (1 = yes; otherwise, 0)	B: Coefficient (Exp (B): odds ratio)	Wald chi-square	B: Coefficient (Exp (B): odds ratio)	Wald chi-square	B: Coefficient (Exp (B): odds ratio)	Wald chi-square
Pseudo R^2 (Nagelkerke)	0.24		.05		0.26	
N	285		285		285	

Note: 1. 'Construction and maintenance of cyclone/flood shelter', 'Awareness rising program on CC and SLR', and 'Cash incentive for post-disaster rehabilitation' are excluded from the models as the responses are constant (100 % same)

2. 'Quicker and better access to cyclone/flood shelter' is also excluded because of its co-linearity with 'Emergency rescue and recovery centre at community level' ($r = 0.83$, $p < 0.01$: see Table 2.6)

3. Dependent variable: Whether the people still intend to migrate, if their preferred vulnerability reduction measures are implemented (no response is coded with 0; yes with 1)

*significant at 0.10; **significant at 0.05; ***significant at 0.01

million people will be forced to be climate migrant by the middle of this century (see Table 2.3). If the projected population are taken into consideration this number could be double by the end of this century. However, results further show that if various vulnerability reduction measures are initiated well before reaching the tipping point, a significant portion of the 'would be forced migrants' will adopt anticipatory adaptation instead of leaving the coast forever. In this respect implementation of exposure and sensitivity minimization measures and adaptive capacity enhancement measures will play very crucial role to hold back the prospective climate migrants. For instance construction of hard measures such as new sea walls and embankments will minimize exposure and introduction of community food security programs, special safety-net for coastal region, and coastal resources based adaptive livelihood will enhance people's adaptive capacity which eventually will slow down the likely trend of forced migration from the coastal tract. It is worth noting that the contributions/influences of exposure minimization measures have outweighed the total contribution of other measures in these respects. In fact, people put too much emphasis on these hard structural measures primarily because most peoples are engaged in agriculture and allied occupations; for them if production unit/place is safe from inundation of sea water they are comfortable with dealing with others anomalies.

Among various exposure minimization measures 'construction of new flood walls/embankments/levees' have been appeared as most effective to reduce the occurrence of forced migration. It is because for certain occupation groups who are willing to migrate because of fear of loss of income from higher exposure to disastrous events, they believe implementation of these hard measures will minimize their exposure and thus they will not require to leave the coast. For instances, agricultural farming communities, are more prone to saline water where as people engaged in aquaculture are more concerned about coastal inundation. For these both occupational groups minimization of their exposures to surges, salinity intrusion, and coastal inundation through construction of new sea walls or embankments having sufficient height will discourage them to leave the coast. Despite having huge potential to minimize people's exposure to disastrous events implementation of these hard measures such as construction of new sea wall, operation of new sluice gate and re-excavation of illegally occupied canals are really capital intensive as costs are substantial. If public funds are not allocated implementation of these exposure minimization measures from mere community or private initiative is hardly possible. Therefore there is need for planned public initiatives where other actors including community and individuals will participate proactively to avoid the occurrence of any large scale forced migration.

The Results further reveal that a significant portion of the respondents believe adaptive capacity enhancement measures will be effective to lower the likely trend of forced migration. Accordingly they have identified- 'special safety-net for coastal communities' and 'community food security program' as top priority initiatives in this regards. In fact, implementation of these two measures along with 'initiative for coastal resource based adaptive livelihood' will strengthen the very foundation of adaptive capacity of the prospective climate migrants. As the key sources of livelihood in the coastal area are agriculture and allied activities, and fishing it is not unusual that they have also prioritized introduction of coastal resources based adaptive livelihood as a long term strategy to avoid mass displacement. In the same vein they give heavy emphasis on measures of social insurances and cushion against temporary/seasonal loss of income as short-term or medium-term coping and adaptation strategy. This is possibly the case for people, for instance day labourer, off-farm workers, subsistence fishers who really lack year-round permanent sources of income.

Finally, it has also been appeared that some people think policy makers and planners should concentrate more on adaptive capacity enhancement of people as implementation of exposure minimization measures will require long time and allocation of huge public fund which the government of Bangladesh may not be able to afford. However, it should be noted that although implementation of adaptive capacity enhancement measures involve fewer technicalities, require less budgetary allocation and execution time, paradoxically in absence of exposure minimization measures such as construction of new sea walls/embankments people might rarely invest for anticipatory adaptation no matter how strong their adaptive capacity are. Thus there is a need for forward planning where a balance among exposure and sensitivity minimization and adaptive capacity enhancement measures will be maintained to arrest the likely trend of forced displacement from the fragile coast of Bangladesh. While this study has identified important avenues of intervention to bring down the likely trend of forced migration from coastal Bangladesh but the major limitation of this work is it has only considered those people who may migrate due to the loss of avenues of income. Earlier analysis shows that people might be forced to migrate for many other reasons associated with climatic disasters. This model does not consider those factors' induced mass displacement. Incorporation of those factors' induced forced migration in the model would have helped designing a more pragmatic plan to address the critical linkages among climate change induced vulnerability, livelihood insecurity and forced migration.

Conclusion

In the context of rural Bangladesh circular migration or seasonal displacement of people is not a new phenomenon especially in the poverty stricken and flood affected areas. However, permanent displacement is the last resort for the people who lose their farmlands and settlements due to natural calamities, for instance massive riverbank erosion. As the coast-lying areas are very fertile and resourceful, and riverbank erosion is not very severe, peoples rarely leave their place of living permanently only because of coastal hazards. However, given the context of future climate change induced vulnerability a significant number of people from the coastal tract might turn out as climate migrants. Because their perceived threat on livelihood security due

(continued)

to SLR and its associated disastrous events are very deep rooted in their mind-set. Unless they are assured with substantial visible initiatives for building a more resilient coastal community, it will be very hard to encourage anticipatory adaptation and to stop forced migration. Experience shows that anticipatory adaptation in situ rarely take place automatically when there is uncertainty. Therefore it is strongly suggested that a balanced and coordinated effort must be made to minimize exposure and sensitivity, and enhance adaptive capacity of people which will eventually bring down the likely trend of forced migration from the coastal tract of Bangladesh.

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