Journal of Rural and Community Development

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Authors: Gopal Datt Bhatta, Pramod Kumar Aggarwal, Santosh Poudel, & Debbie Anne Belgrave

Citation:
Bhatta, G. D., Aggarwal, P. K., Poudel, S., & Belgrave, D. A. (2015). Climate-induced migration in South Asia: Migration decisions and the gender dimensions of adverse climatic events. *The Journal of Rural and Community Development*, *10*(4), 1-23.

Publisher: Rural Development Institute, Brandon University.

Editor: Dr. Doug Ramsey

ISSN: 1712-8277 © Journal of Rural and Community Development
www.jrcd.ca

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Gopal Datt Bhatta
CGIAR Program on Climate Change, Agriculture and Food Security (CCAFS), South Asia
and
Research & Strategy, Community and Neighborhood Services
The City of Calgary, Alberta, Canada
bhattagopal@gmail.com

Pramod KumarAggarwal
CGIAR Program on Climate Change, Agriculture and Food Security,
International Water Management Institute
New Delhi, India
p.k.aggarwal@cgiar.org

Santosh Poudel
Department of Bioresource Policy, Business and Economics
University of Saskatchewan, Saskatchewan, Canada
sap91@mail.usask.ca

Debbie Anne Belgrave
Research & Strategy, Community and Neighborhood Services
The City of Calgary, Alberta, Canada
Debbie.Belgrave@calgary.ca

Abstract

There is significant interest in determining the role of climate-induced shocks as a prominent driver on migration decisions of different groups of farmers in South Asia. Using data from a survey of 2,660 farm-families and focused group discussions in Bihar (India), Terai (plains) (Nepal) and coastal Bangladesh, we employed logistic regression to investigate household response towards migration and gender dimensions of adverse climatic events. The results suggest that migration decisions depend on farmers' unique resource profiles: (a) households that use migration to improve their resilience, mostly resource rich households; (b) households that have no alternative but to migrate, mostly poor farmers; and (c) households who cannot migrate due to different socio-economic obligations, mostly farmers with intermediate level of income that also includes women, children and elderly of different income profiles. These profiles represent a spectrum with households within a profile being closer to one or the other of the profiles on either side. They are not mutually exclusive and serve as a point of departure for further research to refine key explanatory variables. Given that some members of the household pursue migration as a result of adverse climatic events, government strategies are required to mitigate risks at destinations and create opportunities for the trapped populations.

ISSN: 1712-8277 © Journal of Rural and Community Development
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Keywords: distress migration, climatic risks, extreme events, rainfall variability, gender dimensions, South Asia

1.0 Introduction

South Asia, one of the highly vulnerable regions to climate change, is the hardest hit by climate-induced events and climatic change (Bhattacharyya & Werz, 2012; Battisti & Naylor, 2009; Intergovernmental Panel on Climate Change, 2007; Mendelsohn, Dinar & Williams, 2006; Aggarwal, Joshi, Ingram & Gupta, 2004). This region experiences a high degree of exposure to environmental risks (World Bank, 2009). There is also heavy reliance on climate sensitive sectors such as agriculture and fisheries (Ahmed, Hassan, Etzold & Neelormi, 2012; Kumar & Viswanathan, 2012). Increasing temperatures, more adverse climatic events, rising sea levels, increasing cyclonic activity (Bhattacharyya & Werz, 2012; World Bank, 2009), higher inter-annual variability of precipitation (Giorgi & Bi, 2005; May, 2004; Lal, Meehl & Arblaster, 2000), as well as water-related hazards induced by climate variability are characteristics of the region (Ahmed, 2009). For instance, every 3-5 years, two-thirds of Bangladesh is inundated by floods, and approximately every 3 years a cyclone hits the country (World Bank, 2009). It has been widely recognized that global climate change will instigate greater climate variability which in turn will increase people's exposure to extreme events such as intense rainfall (Trapp et al., 2007; Diffenbaugh, Pal, Trapp & Giorgi, 2005), greater heat stress (Battisti & Naylor, 2009; Diffenbaugh et al., 2005), and more storm events (Emanuel, 2005).

Both sudden-onset events—such as flooding, cyclones, and storms—and slow-onset events—such as changes in precipitation, temperature, and sea level rise—will have detrimental impacts on key economic sectors. Over time these events will influence decisions to move to access greater economic opportunity (Bhatta & Aggarwal, 2015; Bhattacharyya & Werz, 2012). Over the next decade, a considerable number of people could be affected by climatic hazards in South Asia and the bulk of climate-induced migration will involve poor people— the most vulnerable segment to climate change (Asian Development Bank, 2009).

Literature highlights that poor people are the ones to bear the brunt of climate change and they are the ones to migrate under adverse events due to lower adaptive capacity (Kumar & Viswanathan, 2012). However, studies investigating the climate-induced migration pattern——short-term distress migration—across different income and resource profiles of farm households are very limited. The gender dimension of adverse weather events and male out-migration as an aftermath of these events is under-explored. With increasing climatic risks, it is a matter of significant interest to investigate which group of farmers—based on on-farm livelihood diversification, income, education, rainfall variability, asset profiles etc.—decide to migrate under adverse events and what the gender dimensions of adverse climatic events are. We, therefore, hypothesize that, (a) the middle class farmers—those with a moderate level of income—including women, children and elderly of different income profile are vulnerable to climatic shocks in the long-run as they are unable to migrate for a variety of socio-economic and cultural reasons; (b) farmers with more access to assets, income and/or education are more likely to migrate under adversity, and (c) poor farmers who live in more variable rainfall areas are more likely to migrate in the event of adversity. The current study also presents the gender dimensions of

adverse weather events, particularly the impact—of adverse climatic events and male out-migration—on women, children and elderly. We test our hypotheses through household surveys of 2,660 farm-families (19 sites covering 133 villages) and focused group discussions in different locations across climatic risk areas of India (Bihar state), Nepal (Terai), and Bangladesh (south-western coastal areas).

2.0 Literature Review

2.1 Climatic Risks and Migration

Climate change causes serious problems, including extreme weather events, the rise of sea levels and environmental degradation. Each of these events is expected to trigger short- or long-term migration. South Asia is burdened with a high level of exposure to risks from climatic events including the risk of migration. Every year, large numbers of people migrate (temporarily or permanently) to cope with extreme weather events such as floods, droughts, salinity and cyclones. Such events are predicted to become more common with climate change (Asian Development Bank, 2012). While many of those displaced return to their homes as conditions become conducive, others may struggle to survive in new environment after incurring substantial losses. The climate-induced migrants are those who leave their habitual homes, or choose to do so temporarily because their livelihoods have been negatively affected by adverse weather events (ADB, 2012; McLeman & Smit, 2006). Migration flows as a result of climatic events are often categorized as 'distress migrations'. The term 'distress migration' in this study hence refers to the household members who pursued migration as a short-term coping strategy in response to adverse weather events. This movement could be either a labour migration or migration to make a family living under climate-induced adverse events. The climate-induced distress migration from agriculture could largely manifest in the short-term (Kumar & Viswanathan, 2012). While climate will always interact with numerous push-pull factors to compel migration, a more nuanced understanding of the role of adverse events in migration decisions of different groups of farmers will help shape adaptation investments.

2.2 Migration as a Livelihood Strategy

Despite various climate- and non-climate-related stresses and shocks, smallholder farmers in South Asia have been coping with and adapting to the local circumstances over many years (Ojha et al., 2014). However, adaptive capacity of smallholder farmers in the face of increasing climatic risks is usually low due to their dependence on natural resources and poor human and physical capital (Gukurume, 2013; Salau, Onuk & Ibrahim, 2012; Ahmed et al., 2012; Shewmake, 2008; Kelkar & Bhadwal, 2007). The situation becomes worse if suddenly occurring hazards destroy the potential harvest and jeopardize livelihood. While relatively affluent households—or members of a household—generally choose permanent migration (Kumar & Viswanathan, 2012; Deshingkar & Akter, 2009), persons with lower income undertake short-term migration as a livelihood strategy (Kumar & Viswanathan, 2012). Short-term migration to cope with climatic shocks has the potential to ameliorate the food insecurity to some extent (Ahmed et al., 2012). Cyclic migration for a short duration in response to climatic adversity may perpetuate or even grow in the future as long as climatic variability increases (Deshingkar & Start, 2003).

Migration is often seen as a coping strategy against rapid onset events (Etzold, Ahmed, Hassan & Neelormi, 2014) and a mode of adaptation to climate change (Brockhaus, Djoudi & Locatelli, 2013; Kumar & Viswanathan, 2012; Ahmed et al., 2012; Warner, 2010; Brooks, Grist & Brown, 2009; McLeman & Smit, 2006). The decisions on migration are driven to maximize income as well as to minimize risks (Meza, 2015; Massey et al., 1993). Rademacher-Schulz et al. (2012) identified migration as a major coping strategy to address unfavourable economic and unexpected environmental conditions, including the local implications of rainfall variability. For instance, labour migration in response to climatic risks, food and livelihood insecurity is one of the most important strategies of farmers in Bangladesh (Etzold et al., 2014). Individuals with some resources, but not an adequate amount, undertake short-term migration to supplement their livelihoods (Kumar & Viswanathan, 2012). Economic inequality as a driver of migration also interacts with environmental change to impel movement from the origin to other areas (Geddes & Somerville, 2013). The principal motivation of the richer farmers to migrate is for educational reasons or to obtain better-paid jobs in the urban centres (Ahmed et al., 2012). Migration for this group contributes to a further diversification of income and attainment of a higher social status (Etzold et al., 2014).

2.3 Gender Dimension of Climatic Events

The effects of climate change are not gender neutral and impact the poor, marginalized and vulnerable population groups such as women (Hunter & David, 2009; Canadian International Development Agency, 2002). Unequal gender relations and access to resources may make women more vulnerable to climate change than men. Climatic events may not only directly impact women and vulnerable populations, but also make them more vulnerable because of their interaction with socio-cultural factors. Furthermore, adaptation, that is, the ability to adapt to and cope with changes due to climate change, is also gendered. Adaptive capacities of individuals greatly depend on income, education, health and access to natural resources. Given that women tend to be poorer, less educated, have a lower health status and have limited direct access to or ownership of natural resources, they are disproportionately affected by climatic risks (Demetriades & Esplen, 2010). Women in Bangladesh were found to be more vulnerable during cyclones because cultural norms prevented them from leaving their homes in time and learning to swim (Nelson, Kate, Terry & John, 2002). Water stress due to climate change is expected to cause further difficulties for women in West Africa (Denton, 2002). In many cases displaced women are forced into labour-intensive and low-paying jobs due to low levels of education. Women from the fishing community in the Philippines facing climate disasters were forced to work as domestic helps due to lack of skills (United Nations Population Fund, 2009). Although migration, short or long term and different factors promoting it, bridges the income gaps to some extent, it also has social costs such as inequality within the community and a substantial increase in workload of women (Meza, 2010).

Climate-induced women migrants are at a greater risk of sexual and gender-based violence (Brown, 2008). Many women state lack of safe shelters upon being forced to migrate as one of their primary concerns after climatic events (Mitchell, Tanner & Lussier, 2007). There are also other issues of safety and security arising from women's health status and disintegration of social networks. Mitchell et al. (2007) observe that women suffer from psychosocial impacts of natural disasters to a greater degree as compared to men. The extra burden of looking after their family

members under distress situation results in many women suffering from anxiety and post-traumatic stress.

Further, the breaking of social ties and separation of families also has a severe impact on women. In addition, often women are not allowed direct access to relief aid because they are not the 'head of the household' (Spring, 2008). Such exclusion is likely to make them more vulnerable. Similarly, in Nepal, as more and more males migrate from vulnerable areas to the cities, women are becoming heads of households. These women are highly vulnerable to adverse climatic events as they have to survive in already fragile landscapes (UNFPA, 2009). If the migrant is the father or household head, the family is seasonally separated and the woman becomes the *de facto* head of household. Although this increases women's autonomy and decision making power (Brown, 2008), it places additional burden to care for the household, the children, elderly, and themselves. In particularly hard times, girls drop out of school to help their mothers and the probability for domestic violence increases (Bernabe & Penunia, 2009).

3.0 Research Methods

3.1 Study Areas and Sampling Process

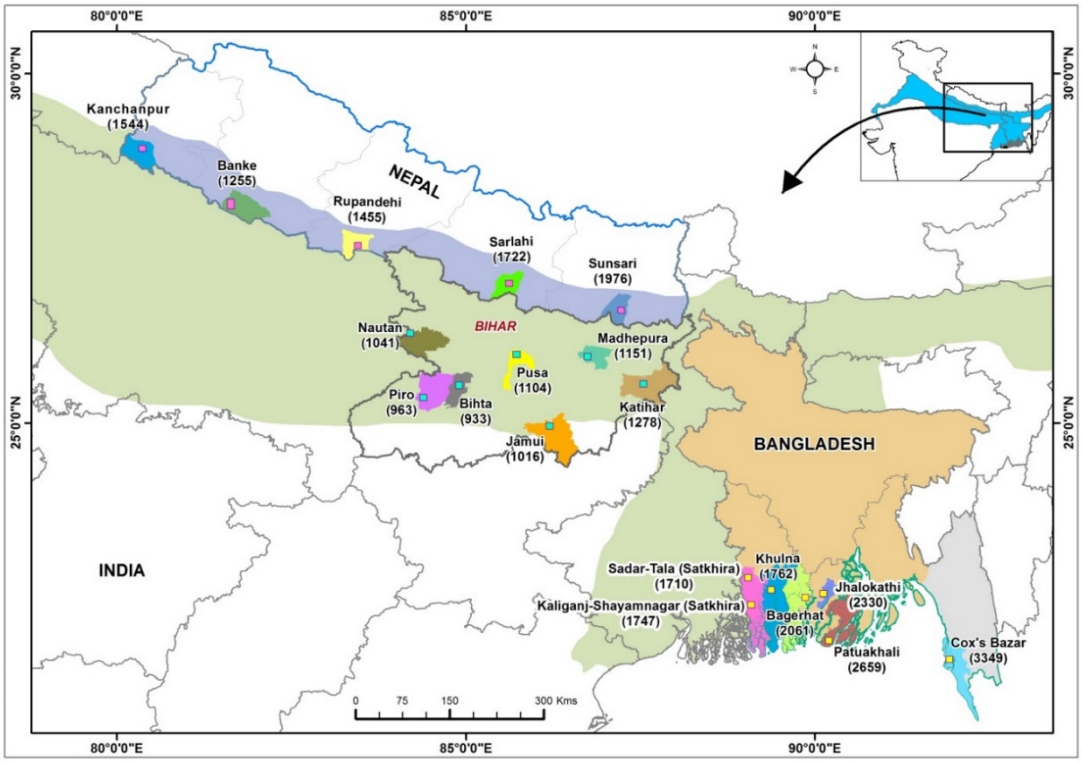
A household survey was done in three contrasting sites of South Asia: India (Bihar State), Nepal (Terai) and Bangladesh (south western coastal area) in 2011-2012. The selected sites (Figure 1) represent climatic 'hotspots' in South Asia (Bhatta & Aggarwal, 2015; Bhatta, Aggarwal, Shrivastava & Sproule, 2015) and a high degree of socio-economic vulnerability to climate change (Wood, Jina, Jain, Kristjanson & DeFries, 2014). The key characteristics of the regions surveyed are depicted in Table 1.

Table 1. *Description of the Regions*

Regions	**Description**
Bihar, India	Hot and humid climate, subsistence farming, very small land size per household, dominance of rice-wheat pattern, subsistence farming, a frequent occurrence of drought and floods and erratic rainfall pattern, average temperature increasing, rainfall decreasing, depth of water table increasing and soil fertility decreasing.
Terai, Nepal	Tropical climate and highly fertile flood plain, the major supplier of food in the country, rice-wheat cropping pattern dominant, a distinct rainfall gradient from east to west, frequent floods and droughts, feminization in agriculture, westerly wind during wheat grain filling period, cold spells increasing, overall rainfall almost the same but winter droughts common in many parts of the Terai.
Coastal Bangladesh	High amount of annual rainfall, predominance of aquaculture and rice-rice based livelihoods, mostly low-income agricultural workers, highly vulnerable to climate change and highly susceptible to climate-induced hazards, high level of salinity in many areas restricting normal production of agricultural crops, salinity intrusion increasing due to sea-level rise, frequent occurrence of floods, cyclones and droughts.

The sampling process was done in three stages: (a) areas with contrasting climatic risks were selected (Bihar, Terai and the coastal area); (b) key districts were chosen based largely on rainfall and salinity gradients. A sampling frame, consisting of a 10 km x 10 km area, was then overlaid in the chosen district purposively (Bhatta et al., 2015). All villages within the chosen frames were enumerated and seven villages were selected randomly. A complete list of households within each selected village was generated with the help of village authorities; (c) using simple random sampling, 20 households within each village were chosen. From 19 sites in the region, we selected 133 villages and 2,660 farm households. The selected households have engaged in farming either in their own farms (land owned farmers) and/or contributed their labour in others' farms (landless households). Whether or not the households own land, they all qualify as being considered as farmers because farming is their dominant profession.

Figure 1: Surveyed sites in South Asia (values in parentheses indicate average annual rainfall in mm).



Source: Authors.

3.2 Survey Instruments

A structured questionnaire was designed, tested and implemented across all the sites. Trained enumerators were deployed to ensure a consistent level of precision on sampling and data collection. The survey questionnaire was first translated into the local languages of the respective areas and then back translated into English to ensure consistency in interpretation of each question. The interviews of one or more individuals primarily the head of the household and/or spouse within the household was carried out. Questions related to impact of adverse events on women, children

and elderly were administered in a focused group discussion (FGD) with women and local government officials. There were two FGDs in each site, one for women and one for local government officials. A standard checklist was used to facilitate FGDs. The key components of checklist were: who migrates in the households and why; aftermath of adverse climatic events on women, children and elderly, food, nutritional and general security issues. The same checklist was used in a FGD with local officials to capture their different perspectives. The participants were selected purposively based on their willingness to participate in the discussions. Local government officials were approached in their office (mainly in the district agriculture development office) in each site and FGD was conducted.

The structured questionnaire for household surveys has several components: socio-demographic information; sources of livelihoods; changes made to farm practices including livestock over the last 10 years; food security; household asset profile; community groups; coping strategies under adverse weather events; distress short-term migration in the adverse year during the last 10 years; and, factors preventing households from migrating even under adverse events. The questionnaire also has questions like household income before and after distress migration, length of migration, number of family members who migrated and the nature of work post migration.

3.3 Data Analysis

A simple descriptive analysis was done across the three broader areas (Bihar, coastal Bangladesh and Terai) to see cross-site variations in terms of socio-demographic variables. The Kruskal-Wallis test was performed to test the significance of the variables. This test is performed for the dataset that violates assumption of normality (Field, 2005). Rainfall data from 1961 to 2010 was extracted from the Climate Research Unit (CRU) gridded database (0.5 degree resolution) and annual rainfall variability (%) was calculated for 50 years. The annual rainfall variability in the surveyed sites ranges from 13 to 26%. Variability less than 19% was considered moderate (n= 1,120) and more than 19% was considered a highly variable rainfall area (n= 840). Since rainfall variability is considered one of the most important factors to agriculture livelihood in South Asia, we included this variable in logistic regression to observe how it categorizes the migration decisions of the farmers under adversity.

Migration is considered to be a very important coping strategy during adverse events in some regions in South Asia. How do different groups of farmers behave in terms of making decisions to migrate under adversity? Are families from a relatively more deprived household (marginal farmers, farmers with low income, fewer assets, etc.) more likely to migrate compared to those from a relatively less deprived household? In order to test the hypothesis that individuals under adverse weather events migrate due to their resource constraints, we used a logistic model. A set of qualitative and quantitative variables were used to explain migration which is dichotomous (1= migration as a coping strategy under adverse event and 0, otherwise). Logit and probit are the two most commonly used techniques for estimation of models with dichotomous dependent variables. Estimation of ordinary least square may give the correct sign; however, it doesn't fit considering the nature of the data and dependent variables we had. We found that the distribution of residuals is logistic and hence logistic regression was employed. The probit and logit models produce qualitatively similar results. The choice between these two is largely one of the

statistical conventions since the substantive results are generally indistinguishable (Long, 1997).

A logistic model was run using data from Bihar and coastal Bangladesh only as none of the respondents in Nepal considered migration as a coping strategy. Bhatta & Aggarwal (2015) also reported formal and informal credit markets as the most important coping strategy of farmers under adversity in Terai while migration in Bihar and coastal Bangladesh. The reason could be that most of the family farms in Terai are run by women due to out-migration of men. The Maoist conflict that occurred from 1996 to 2006, a key driver of out-migration of male members of the household and subsequent exodus of men from villages, put an additional burden on women to take the sole responsibility of agricultural production (Gartaula, Niehof & Visser, 2010; Women Organizing for Change in Agriculture and NRM, 2010). Since most of the family farms have already been managed by women and their counterparts are temporarily away from home, out-migration and further women's involvement in agriculture during adversity cannot be considered a feasible coping strategy in Terai (Bhatta & Aggarwal, 2015).

A set of categorical variables was created to group farmers based on their socio-demographic and resource characteristics. Following Bhatta, Singh & Kristjanson (2013) and Kristjanson, Garlick, Ochieng, Förch & Thornton (2011), farm households with less than four on-farm sources of livelihood (on-farm diversification) were considered poorly diversified (n= 692), 5-8 as intermediate diversification (n= 880), more than 8 as highly diversified farming (n= 388). Households with diverse livelihood sources are considered to be better adapted to climatic risks than those who rely on one of few sources (Cunguara, Langyintuo & Darnhofer, 2011). The number of farm practices changed, including livestock and fisheries, over the last 10 years is considered as a proxy of adaptation (or innovativeness) under changing circumstances including climate change. Accordingly, farm households with less than 5 changes in farming practices were categorized as poorly adapted (n= 504), those with 5-10 as intermediate adaptation (n= 417) and with more than 10 as high adaptation (highly innovative) (n= 1,039). Participants were also asked the highest level of education of the household head. Based on the responses, respondents were grouped in to four classes: household with no formal education (n= 154), primary level (up to 5^{th} grade) (n= 600), secondary level (up to 10^{th} grade) (n= 691) and post-secondary level (more than 10^{th} grade) (n= 515).

Different types of household assets such as information, transportation, energy, production and luxury assets were summed up and households with less than 3 assets were considered to have basic asset profiles (n= 568), those with 3-5 assets as intermediate asset profiles (n= 764) and more than 5 as higher asset profiles (n= 628). The household's annual income was used to form three categorical variables: poor, lower middle class and upper middle class. The World Bank's criterion of poverty analysis, which states 1.25 US Dollar ($) a day as poor, was used to define the poor class in our analysis. Our calculation shows that a farm household with less than $1,500 in a year falls in the poor class (n= 1,379) followed by lower middle class with $1,500-3,000 income (n= 410) and upper middle with more than $3,000 annual income (n= 171). However, it should be noted that the current classification simply serves as a basis of comparing migration decisions of households with different income profiles.

A multivariate-correlation analysis was done to determine the co-linearity effect of the independent variables. Any independent variables with a high degree of

correlation (r >0.5) with each other and a low degree of correlation with the dependent variable were excluded from the model. The logistic regression coefficients and marginal effects (dy/dx) were calculated to see which variable affects the most on migration under stressful events. In logistic regression, a positive coefficient indicates that each unit increase in the independent variable is associated with an increase in the dependent variable by a given coefficient.

4.0 Results and Discussion

4.1 Farm-family Resources

This section presents the description of the farm household's socio-economic characteristics including resource endowment. On average, all farm households surveyed in the region are smallholders; farmers in Terai possess relatively bigger land size (1.37 ha) compared to Bihar (0.86 ha) and coastal Bangladesh (0.63 ha) (Table 2). This means that a large proportion of the sampled households in coastal Bangladesh are landless and marginal. Despite higher on-farm diversification compared to Bihar, farmers in the coastal Bangladesh face hunger months for a quarter of the year while most of the farmers in Bihar and Terai face around a month of food deficit in a year.

Farmers in Bihar seem to be somewhat more innovative as reflected by a greater number of changes made in farming during the last 10 years. Our data reflects a number of changes made during specified period of time (2001-2010) which conferred some benefit to the farmers who made such changes. Therefore, number of changes is a proxy measure of potential adaptation (Wood et al., 2014). Farmers in Terai have more household assets compared to those in Bihar and coastal Bangladesh. Average income of the farm household in coastal Bangladesh is significantly higher (US $1542) compared to Bihar (US $1462). Although rainfall variability is higher in Bihar and Terai compared to coastal Bangladesh, because of its physical location, coastal Bangladesh is more vulnerable to climatic hazards. Despite frequent adverse events such as floods and cyclones, the numbers of coping strategies farmers follow in coastal Bangladesh are less than that in Terai.

4.2 Distress Migration in the Past

Households were asked whether they had engaged in distress migration (short term) in the past because of extreme climatic events. The results reveal that distress migration occurred more often in coastal Bangladesh (35%) as compared to Bihar (23%). Because of the frequent occurrence of climatic events in Bangladesh, climate-induced migration is quite common (Gray & Mueller, 2012; IPCC, 2007). The average number of household members who migrated during adverse events is also higher in coastal Bangladesh compared to Bihar (see Table 3). In Bihar, almost all households reporting distress migration involved male migration while in coastal Bangladesh both male (97%) and female (3%) migration have occurred. In general, male migration is predominant during agricultural distress in South Asia. Prevalent social norms, lack of education and skills, fear of harassment and social exclusion are the prime reasons for no or low rates of female migration (Ahmed et al., 2012).

Table 2. *Average of Different Quantitative Variables in the Study Areas*

Key variables	**Bihar, India**	**Terai, Nepal**	**Coastal Bangladesh**
Household size	7.80[a] (0.153)	7.40[b] (0.145)	5.00[c] (0.066)
Land size (ha)	0.86[b] (0.053)	1.37[a] (0.070)	0.63[c] (0.028)
Food available months in a year	11.09[a] (0.074)	10.82[b] (0.089)	9.47[c] (0.102)
On-farm sources of livelihoods	4.69[c] (0.087)	7.86[a] (0.082)	6.61[b] (0.091)
Off-farm sources of cash	1.56[b] (0.035)	1.44[c] (0.040)	1.64[a] (0.032)
Number of changes made in farming	10.81[a] (0.200)	8.90[c] (0.143)	9.88[b] (0.206)
Household assets	5.00[b] (0.110)	8.18[a] (0.119)	4.01[c] (0.087)
Annual income per household (US $)	1462[b] (61.26)	-	1542[a] (51.47)
Annual rainfall variability (%)	19.69	19.83	15.91
Number of Coping strategies under adversity	3.58[c] (0.043)	4.18[a] (0.071)	3.65[b] (0.040)

Note: Values in parentheses indicate standard error of mean. Letters in the superscript show significant difference between the areas at 5% level of significance according to Kruskal-Wallis test.

Climate-induced migrants both in Bihar and coastal Bangladesh after migrating engaged in unskilled work as reported by 66% of the respondents. More than 50% of the distress migrants reported that they had higher incomes after migration. This infers that while short-term migration is considered a survival strategy under adversity, it also enhances the income profile of the migrants and possibly enhances their livelihood. The migrants, whatever the duration of migration may be, generally put their efforts into a gradual improvement of their families' livelihoods (Etzold et al., 2014). It has also demonstrated that the very poor move to "low-return" destinations, or to other high-risk marginal places nearby. In Bangladesh, for instance, people living on chars often need to move regularly to another char, though these are places of extreme environmental vulnerability (ADB, 2012). However, detailed investigation on the changes in post migration economy and livelihood resilience of the migrant families is beyond the scope of this study.

Table 3. *Descriptive Information Related to Distress Migration*

Variables	**Bihar, India**	**Coastal Bangladesh**
Number of households with distress migration	221 (23)	345 (35)
Average number of household members migrated	1.48	2.19
Who migrated		
Male	221 (100)	336 (97)
Female	0	9 (3)
Nature of work after distress migration		
Skilled	30 (14)	41 (12)
Semi-skilled	42 (19)	76 (22)
Unskilled	149 (67)	228 (66)
Income after distress migration		
Same as before	84 (38)	79 (23)
Less than before	11 (5)	72 (21)
More than before	126 (57)	194 (56)

Note: Values in the parentheses indicate percentage.

4.3 Determinants of Migration Under Adverse Weather Events

Table 4 depicts the estimated coefficients and marginal effects of different variables based on logistic regression analysis for migration as a coping strategy under adverse weather events. The result shows that the probability of migration increases with an increase in the number of dependents and number of adults in the household. Availability of surplus labor within the household enables members of the family to move out for a short period to supplement the family's income (Kumar & Viswanathan, 2012). Agriculture becomes a risky endeavor with rainfall variability, and households with less land but with surplus labor have a tendency to seek off-farm income (Gebru & Beyene, 2012). The likelihood of migration decreases if the household has taken credit in the recent past. This provides interesting insight that an easy to avail credit mechanism could provide the short-term means of survival in the event of weather adversity. Bhatta & Aggarwal (2015) also noted that farmers in Bihar, coastal Bangladesh and Terai avail credit facility (through formal or informal sources) under adverse weather events.

There is less likelihood of households with irrigation facilities to migrate under adverse events. Households with no irrigation facility tend to be reluctant to adopt new agricultural technologies even when expected net returns are high (Yesuf & Bluffstone, 2008). Families dependent on rain-fed smallholdings are additionally vulnerable during seasons of adverse weather. Availability of irrigation increases the options for diversification (Singh, Kumar & Woodhead, 2002). Subsistence farmers often lack irrigation facilities. Weather events such as droughts hit subsistence farmers the hardest. Such farm households pursue short or mid-term labor mobility to secure households' access to food (Findlay & Geddes, 2011). Compared to the households with no formal education, households with primary and secondary levels

of education are less likely to migrate while those with post-secondary education are more likely to migrate. Kumar & Viswanathan (2012) reported that the probability of short-term migration is higher among the non-literate category and people with more education are more likely to be long-term migrants.

The likelihood of migration under adverse weather events is significantly higher with poor and upper middle class families when compared to the reference category (lower middle class). Therefore, in the short run, poor farm families seem to be much more affected by the adverse event which increases their (or at least some members of the household) probability of migration from the areas of difficult situation to the new environment. Similarly, the higher income farm families can also afford migration. However, because of several socio-economic, cultural and emotional obligations to the community, a large proportion of farmers with a middle level of income have a tendency to stay in the difficult situation. Cultural constraints and social networks are also very important determinants of migration decisions (Sherbinin et al., 2008). Social stigma and security of assets such as livestock, household items, and land, as well as emotional attachment with the land resources (Bhatta & Aggarwal, 2015) preclude middle income farmers from migrating even under adverse weather events. Even if middle income farmers lose a significant portion of their farm produce due to the environmental crisis, they have hope to recover (Gray & Mueller, 2012). While people at the middle end of the socio-economic spectrum may be strongly tied up with their household capital or are emotionally attached to their land resources which precludes them from resorting to migration under distress situations (Ahmed et al., 2012), the people at the lower end of the spectrum (poor, landless, and low asset owners) may easily be displaced by climate hardships (Ahmed et al., 2012; Kumar & Viswanathan, 2012). The well-off farmers, on the other hand, temporarily migrate from areas with adversity to safer places because they can easily afford it. If this is the case, novel adaptations and risk management strategies are called for, should we expect such middle income farmers to adapt to the growing risks.

Individuals with a lower adaptability index have a lower probability of migration while the opposite seems true for the higher adaptability category. Similarly, households with poor asset profiles are less likely to migrate while the opposite is true with the high asset class as compared to the intermediate asset profile. The households with higher number of assets may be better able to reduce economic vulnerability with off-farm changes (migration, for instance). Importantly, rainfall variability—captured through the average over a fifty year period—has significant influence on distress migration. The marginal effect of rainfall variability is very high (around 12%). In South Asia, inter- and intra-annual rainfall variability is a key determinant of agricultural productivity. The increase in climate variability means that the range of weather conditions experienced annually will be higher, exposing the region to a less predictable and more variable rainfall season. Such changes will bring about impacts on weather-related events and adverse environmental conditions (Arendse & Crane, 2011). Greater weather variability in the area of residence will increase the probability of an individual to undertake migration for alternative livelihoods (Kumar & Viswanathan, 2012). An associated issue is the potential link between the weather variability and agricultural production, which in turn would influence the migration decision of the farmers who predominantly depend on rain-fed farming (Warner & Afifi, 2014; Rademacher-Schulz et al., 2012). The current analysis does not aim to capture this three-way linkage.

Table 4. Determinants of migration under adverse weather events: A logit estimates

Variables	**Migration as a coping strategy**		
	β	**SE**	**dy/dx**
Number of dependents in the household	0.072*	0.039	0.016*
Total land (ha)	-0.066	0.055	-0.015
Group membership (n=354) (yes=1)	-0.054	0.143	-0.013
Credit taken (n=381) (yes=1)	-0.507**	0.149	-0.111**
Farm types (n=470) (Irrigated=1)	-0.260*	0.141	-0.061*
Food availability (months)	-0.029	0.020	-0.006
Household type (n=1898) (male headed =1)	0.484*	0.307	0.111*
Number of adults in the household	0.058**	0.019	0.013**
Number of off-farm sources of income	0.059	0.040	0.014
Number of farm items sold	-0.185**	0.040	-0.042**
Number of coping strategies	0.633**	0.045	0.145**
Education- no formal education (n= 154) (reference)			
Primary (n=600)	-0.350*	0.205	-0.079*
Secondary (n=691)	-0.196	0.213	-0.045
Post-secondary (n=515)	0.463*	0.235	0.102*
Household annual income (lower middle class- reference)			
Poor	0.419**	0.144	0.094**
Upper middle class	0.207*	0.227	0.048
On-farm diversification (5-8 sources of on-farm sources of livelihoods- intermediate-reference)			
Low (<5)	0.175	0.144	0.040
High (>8)	0.112	0.174	0.025
Adaptability index (5-10 number of farm practices changed- intermediate-reference)			
Low (<5)	-0.422**	0.168	-0.094**
High (>10)	0.027	0.139	0.006
Household asset profile (3-5 household assets- intermediate-reference)			
Poor (<3)	-0.294*	0.136	-0.066
Rich (>5)	0.092	0.140	0.021
Annual rainfall variability (high=1)	0.549**	0.130	0.122**
Intercept	-3.39**	0.519	
Log likelihood	-1098		
LR $chi^2(23)$	410**		
Pseudo R^2	0.157		

The results provide for three distinct household profiles using migration as a short-term coping strategy under adversity. These profiles represent a spectrum with households within a profile being closer to one or the other of the profiles on either side. They are thus not mutually exclusive and serve as a point of departure for further research to refine key explanatory variables.

- Households that use migration to improve their resilience: The households use migration in ways which improve their resilience, such as earning more to invest in climate-resilient livelihood opportunities. These households use migration as one of a variety of adaptation strategies under adversity, moving seasonally or temporarily, often to non-agricultural jobs. This strategy is not only common among relatively richer households but also households with more adults, those with diverse assets and those which have access to a variety of adaptation, or risk management options (Warner & Afifi, 2014), and, hence they use migration in ways that enhance resilience to changing circumstances including climate-induced adverse events.
- Households that use migration as a survival strategy: This group is risk averse and has meagre adaptation options or resources. This group may often move during the adversity to other areas in their region in search of alternative income sources. Households in this class are mainly poor, have subsistence-oriented farming and no or very marginal land with more food deficit months in a year. These households are highly vulnerable to climatic events and they use migration as a risk management strategy in response to climatic variability and livelihood insecurity (Warner & Afifi, 2014).
- Households that cannot migrate: The third group includes trapped populations that struggle to survive under adversity and cannot easily use migration to adapt to the negative impacts of climatic events. They may have strong social ties and are emotionally attached to their resources which restrain them from moving even under adverse events. These households have an intermediate level of income and land resources, and also include women headed households, women, children and elderly.

4.4 The Gender Dimensions of Extreme Events

We present results based mainly on focussed group discussions with women and local officials. Women are affected in two ways due to adverse events: (a) by the direct impact of adverse events which jeopardize the livelihood security of women, children and the elderly and (b) by forced migration of the male counterpart which increases the workload for the women and put them at additional risk. Women are generally less likely to move, due both to cultural and economic reasons, as are children and the elderly (Ahmed et al., 2012; Tacoli, 2009). Around 20, 65 and 85% of the household in Terai, Bihar and coastal Bangladesh respectively reported that the past adverse events have significant impact on women. Terai of Nepal exhibits a slightly different picture as compared to Bihar and coastal Bangladesh since only 20% of the households reported impact on women. Since agriculture in many parts of Nepal is mostly feminized, women are accustomed to farming activities (Bhatta & Aggarwal, 2015). Another reason could be that even though the male counterpart is at home, women in Nepal contribute significantly in agriculture irrespective of climate-induced events. Close to 20, 50 and 70% of the households respectively in Terai, Bihar and coastal Bangladesh reported that past extreme events have an impact on children, 10, 20 and 40% reported an impact on pregnant and lactating

women (see Figure 2). Women's insecurity associated with male out-migration due to extreme events is a big issue in coastal Bangladesh as reported by around 60% of the households.

Since women bear the biggest burden from climate change impacts (Mnimbo, Mbwambo, Kahimba & Tumbo, 2015), we asked women members of the household about the consequences of male migration on women, children and elderly. The socio-economic, cultural and religious values in the region have resulted in its women and children being more vulnerable to adverse situations in comparison to men. These dynamics form the vicious cycles where women and their children get trapped. In general, workload of women both in the household and on the farm, health risks and security issues increase due to adverse events and climate-induced migration of male members while nutritional status, educational attainment and food consumption decrease (see Table 5).

Figure 2: Effect of Adverse Weather Events on Women and Children.

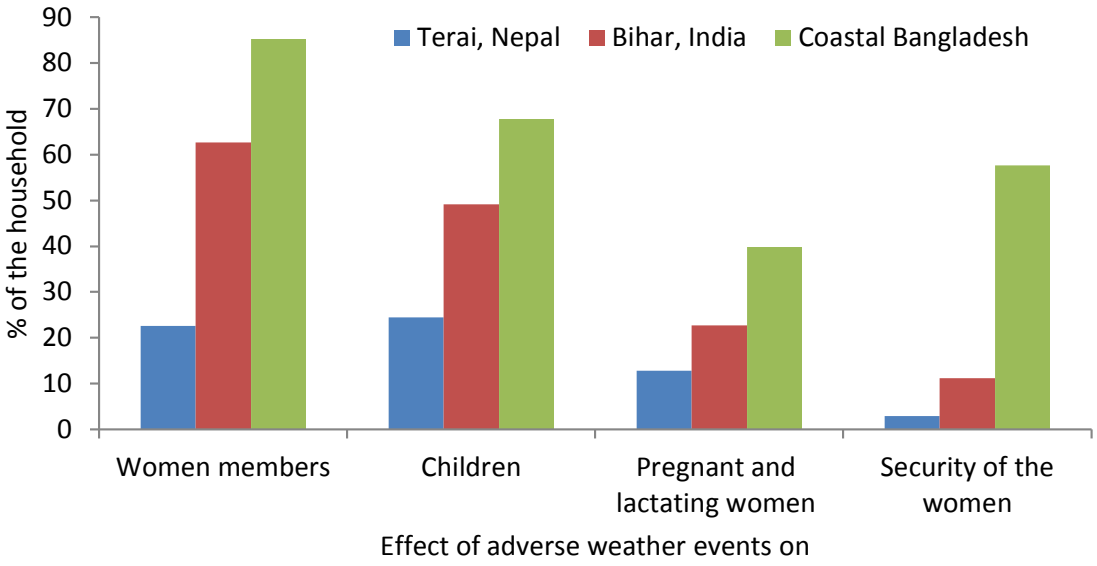


Table 5. *Impact of Extreme Weather Events and Male Out-migration on Vulnerable Population*

Group	Workload	Nutritional status	Education	Health risks	Security issues	Food consumption
Women						
Children						
Elderly						
Overall effect	↑	↓	↓	↑	↑	↓

Severe increase/decrease | Moderate increase/decrease | Increase/decrease slightly | Minor/no effect

Once male members out-migrate, women have to do all the farm work which many women are not accustomed to. In this circumstance, women become the *de facto* heads of the household, and this increases their workload, as they have to manage the farm in addition to conducting the usual household chores (Shah & Shah, 2005; Rogaly et al., 2002). Moreover, when women have to spend more time on productive and reproductive tasks, it limits their time that could be spent on alternative livelihood development activities. It reinforces already skewed customary gendered divisions of labour. In Nepal for instance, the out-migration of men from the rural areas has feminized the agriculture system in which women are extensively involved in agricultural activities compared to their male counterpart (WOCAN, 2010). It is estimated that women's average contribution to the agricultural sector in Nepal is at 55-66% of the total labor (Gurung, Karki, Bista & Oh, 2012). It is found that women not only have to work harder to meet their family's food requirements; they also have to work to pay off the debts that the household incurred. Some women reported that remittance sent by their husbands relieve some of the debts, however, women have to listen to the moneylenders which creates mental tension. Increasing workloads may also result in families withdrawing daughters from schools to help at home reducing their future opportunities.

Women suffer much from food and nutritional insecurity when there are extreme events such as floods and/or droughts leading to a shortfall in production. They cope with the decreased food availability at home by consumption smoothing in order to feed their children. Prolonged malnutrition and increasing workloads during adverse events affect women's physical and mental health, especially of pregnant and lactating mothers. Infants and young children also suffer adversely as a result (Bhandari et al., 2007). In addition, women often face the most negative economic implications of crop failure as they usually have fewer economic resources to fall back on in times of crisis. This also has implications for the health of many women and girls, as malnourishment increases so too does the risk of contracting infections. Furthermore, women and girls' lower socioeconomic status make it more difficult for them to access and pay for treatment.

The most visible impact on children is the increased dropout rate from school. Children, who drop out because of the workload, and who have no opportunity to attend schools, support their parents by taking charge of household and farm activities. Extreme events increase the time it takes to collect water in rural areas, a task mainly done by women and girls in the region. This provides women with less time to take part in other developmental activities. Furthermore, women and children are exposed to a health risk from inadequate water supplies during drought and also predicted changes in vector-borne diseases. Children are also at the risk of malnutrition which has a long-term implication for overall development. Children may be at a risk of early entry into work and exploitation in order to cover lost income from agriculture. Ali, Begum, Shahabuddin & Khan (2006) noted that women and children in Bangladesh are especially vulnerable to the health effects of flooding.

Some women reported harassment and even sexual abuse in the absence of their male counterpart. Ahmed et al. (2012) also reported sexual harassment of women and girls. A young unmarried girl who has been sexually harassed is subject to social stigma, for which the parents have to pay a large penalty, often in the form of dowry at marriage (Ahmed et al., 2012). Thus, the head of household's migration under adverse events causes further costs and threatens the security of

the female members. Furthermore women face social and mental health stress due to disasters and displacement.

The above-mentioned gender dimension of adverse climatic events demonstrate the vicious cycle in which the structures in society keep women low in terms of education, employment opportunities and mobility. The major gap here is that the socially constructed dependency of women on male family members turns against women in the absence of male. These gender nuances in climate-related vulnerabilities vary notably based on caste, class, ethnicity, age and the level of development of the society. The social barriers occur not as a result of their femininity, but rather through the institutional and cultural environment that governs acceptable behaviour and entitlements towards women (Jones & Boyd, 2011). There remain significant caste inequalities in access and entitlement to key social safety nets and resources in many countries of South Asia. This inequality may have considerable implications for lower caste people to adapt amid climate change (Jones & Boyd, 2011). Addressing the root causes and social conditions of vulnerability needs to be dealt with at two levels; at the fundamental level, and at a practical level. At the fundamental level the issues of entitlements, access to basic needs, and the requirements of the resource poor to develop their full potential are key issues. To address these fundamental issues, the will and commitment at all levels is required. At a practical level, the initiatives which create space for men and women to enhance their capacities and to enhance their survival strategies need to be implemented. There is also a need to identify and create risk and vulnerability reduction possibilities within the existing livelihoods. This study makes the case that any policy intervention aimed at addressing climate-induced migration should care not only for those who leave but also for those who stay, as they are often the most vulnerable.

5.0 Conclusions

Study of general migration abounds in the literature, and there is growing interest on climate-induced migration of farm households (Rademacher-Schulz et al., 2012; McLeman & Smit, 2006) and the impact of adverse climatic events on vulnerable populations. In the areas surveyed, around 28% of the households used migration as a coping strategy in response to climate-induced events in the past. The probability of migration is higher for individuals residing in areas experiencing greater rainfall volatility. More deprived households (economically poor, landless and marginal farmers, those with less number of months of food availability in a year) have a higher probability to migrate under adversity. At the same time, the likelihood of migration is higher with higher income.

The results provide for three distinct household profiles using migration as a short-term coping strategy under adversity: (a) households that use migration to improve their resilience; (b) households that have migration as a survival strategy; and (c) households that cannot migrate (trapped population). These profiles represent a spectrum with households within a profile being closer to one or the other of the profiles on either side. They are thus not mutually exclusive and serve as a point of departure for further research to refine key explanatory variables.

The results signal that relatively wealthier households are better adapted to a changing climate because they can employ multiple measures including migration to cope with extreme events. The poor, on the other hand, can find migration the only alternative to evade suffering in the event of adversity. The trapped group has

intermediate income including women who are generally less likely to move, due to socio-cultural and economic reasons, as are children and the elderly, and therefore local adaptation efforts should target these groups specifically. Given that men's migration could contribute to the further deprivation and risk that women face, the trapped population needs to be provided with greater social protection and opportunities for livelihood security. Accordingly, investments that improve options for the trapped group, such as improved agricultural technology, financial instruments and off-farm income opportunities, will likely be critical for adapting to a changing climate.

The current study is expected to improve the understanding of climate-induced migration, and stimulates policy debate on how to tackle the anticipated movement of people due to changing weather patterns in the coming years. It also opens an avenue for further research deeply covering several socio-demographic and biophysical factors as potent drivers of migration under distress situations.

Acknowledgements

The authors would like to thank all members of site survey team and all interviewees in the local communities (Bihar state of India, Coastal Bangladesh and Terai of Nepal). We appreciate the support from CCAFS's numerous investors and CGIAR centre colleagues and partners. CCAFS data collection work was carried out with funding by the European Union (EU) and with technical support from the International Fund for Agricultural Development (IFAD). We also extend our thanks to Amit Shrivastava for preparing a nice map of surveyed sites. The anonymous reviewers deserve special appreciation for providing their valuable comments on our manuscript. Last but not the least Robert Rivers gets special thanks for providing his generous support in going through the manuscript and editing the language.

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