Natural disasters and population mobility in Bangladesh

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The consequences of environmental change for human migration have gained increasing attention in the context of climate change and recent large-scale natural disasters, but as yet relatively few large-scale and quantitative studies have addressed this issue. We investigate the consequences of climate-related natural disasters for long-term population mobility in rural Bangladesh, a region particularly vulnerable to environmental change, using longitudinal survey data from 1,700 households spanning a 15-y period. Multivariate event history models are used to estimate the effects of flooding and crop failures on local population mobility and long-distance migration while controlling for a large set of potential confounders at various scales. The results indicate that flooding has modest effects on mobility that are most visible at moderate intensities and for women and the poor. However, crop failures unrelated to flooding have strong effects on mobility in which households that are not directly affected but live in severely affected areas are the most likely to move. These results point toward an alternate paradigm of disaster-induced mobility that recognizes the significant barriers to migration for vulnerable households as well their substantial local adaptive capacity.

environmental migrant | natural hazards | internally displaced persons

Among the social and economic impacts of climate change, the potential displacement of large numbers of involuntary migrants has drawn particular attention (1–8), with some authors predicting tens of millions of such "climate refugees" over the next century (2, 7). These predictions have focused on vulnerable populations in the rural developing world and on the impact of extreme events such as large-scale natural disasters (1–3). Numerous studies have shown that population mobility can in fact serve as an important coping strategy following these events (5, 9), but this finding is often extrapolated to predict that extreme events routinely give rise to human displacements that are large-scale, international, and permanent and that disproportionately affect the poor and vulnerable (2, 4). This view, which we refer to as the conventional narrative, could be described as Neo-Malthusian in that it assumes that very little local adaptive capacity to environmental shocks (10).

As this view has spread to become a common element of discussions about climate change impacts (7, 8), it has increasingly diverged from scientific understandings of both migration and adaptive capacity. A large body of research on the determinants of human migration in the developing world has revealed the existence of substantial social and economic barriers to migration, particularly for international and permanent migration streams (11). Migrants often face significant moving and start-up costs, the need to access social networks in the destination, the short-term (and potentially long-term) loss of access to origin-area resources such as land, as well as considerable uncertainty regarding the economic success of their move (12). Even local moves, often associated with marriage and new household formation, can be quite costly (13). The result is that migration often selects for individuals with above-average access to human, social, and financial capital (14), which is not consistent with the view that the poor and vulnerable are most likely to be displaced by climate change and that they will often make international moves.

A largely separate body of research on adaption to climate change and extreme events has highlighted the numerous and often successful strategies of rural households in coping with environmental change (9, 15). These include local strategies such as livelihood diversification and participation in risk-sharing networks as well as temporary and permanent migration (16). Despite the adoption of these strategies, this research also indicates that environmental shocks regularly have substantial negative impacts on household welfare in the developing world (17). Relative to household-specific or idiosyncratic shocks, this is particularly true for shared or covariate shocks such as natural disasters that undermine risk-sharing networks (18).

The conventional narrative on disaster-induced migration is also not fully consistent with a small body of research that has directly investigated the quantitative effects of natural disasters on human migration in the developing world. Multiple studies have focused on the effects of drought, revealing that drought most commonly increases migration (19–23) but can also reduce migration for particular migration streams and subpopulations, including for international migrants in Burkina Faso (20) and female internal migrants in Ethiopia (23). Another study found that an earthquake in El Salvador induced the return of migrants rather than their displacement (24). Multiple other studies of environmental influences on migration have also found mixed effects that are most visible for internal rather than international moves (25–27). These results are consistent with the view that migration serves as an important coping strategy, but they also suggest that natural disasters can potentially reduce migration by removing access to the necessary resources or by increasing labor demands in the origin area.

To further test the predictions of the conventional narrative, we use a unique longitudinal dataset to investigate the consequences of floods and non-flood-related crop failure for both short-distance and long-distance population movements in rural Bangladesh. Bangladesh is a low-lying deltaic country that is universally recognized to be highly vulnerable to climate-related disasters, particularly riverine and coastal flooding (28). During the study period, Bangladesh experienced two severe floods (in 1998 and 2004) and a series of other large-scale natural disasters (29). Flooding is known to create significant hardships for affected households (30–34) and to result in short-term population displacements (33–34), but its consequences for long-term population relocation are controversial (35–38) and have not been investigated by large-scale quantitative studies. The consequences

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of non-flood-related crop failure, which is primarily due to drought, are also severe but have received substantially less attention from both aid agencies and researchers (39, 40).

In this context, we test three hypotheses derived from the conventional narrative about disaster-induced displacement and two hypotheses derived from other sources. The conventional narrative predicts that natural disasters consistently increase long-term population mobility (hypothesis 1), that these effects are most visible for long-distance moves (hypothesis 2), and that poor and vulnerable individuals are most affected (hypothesis 3). Drawing on the richness of our data, we are also able to test for the robustness of these effects across two spatial scales, the household and subdistrict, and across two types of natural disasters, flooding and crop failure, comparisons that have not been included in previous quantitative studies. Regarding spatial scale, we test the prediction of the risk-coping literature that area-level covariate shocks have more important effects than household-level idiosyncratic shocks (hypothesis 4). Given that discussions of disaster-induced displacement in Bangladesh focus on flooding, we also test whether these events are in fact more important than crop failure (hypothesis 5).

To test these hypotheses, we use data from the Chronic Poverty and Long Term Impact Study in Bangladesh, collected by the International Food Policy Research Institute (41). This unique longitudinal dataset spans the 1994–2010 period and includes 1,680 households in 102 rural communities from 14 districts across Bangladesh (*Methods*). The study districts include some that were severely affected by natural disasters during the period and others that were less affected (*SI Appendix*, S1). The study households are, overall, highly dependent on rice-centered agriculture and quite poor, with 37% reporting in 2006 that their food consumption was insufficient over the past month, suggesting that they are vulnerable to climate-related disasters. Data on migration were collected using migrant rosters, giving us access to detailed information on the timing and destination of moves that has not been accessible to most previous studies. We use these data sources to construct a longitudinal dataset on 4,646 individuals at risk for mobility (*Methods*). The unit of analysis is the person-year, and the dataset contains baseline and time-varying variables at individual, household, and subdistrict scales. Consistent with previous studies of population and the environment (17, 23, 26), our primary measures of out-migration and exposure to natural disasters are derived from the reports of remaining household members. We also replicate the main results using measures of disasters derived from satellite data on rainfall.

To analyze these data, we use a multivariate approach that links the timing of residential moves by individuals with their level and timing of exposure to flooding and crop failure at household and subdistrict scales while controlling for a large number of potential confounders. Specifically, we estimate discrete-time event history models of local population mobility and long-distance migration in which measures of exposure to natural disasters are included as independent variables. Other social and economic factors are included as controls, and fixed effects account for differences between subdistricts and the changing national context. This approach is consistent with our view that the migration of an individual and a household decision is strongly affected by contextual factors and reflects individual life cycles and household livelihood strategies.

Definition of Key Variables. The dependent variable is population mobility, defined at the individual level as "a change of permanent residence away from the origin household and from any new local households formed by the original household members after the baseline survey* (i.e., split-off households)." This dichotomous measure of mobility is additionally decomposed into (*i*) residential moves within the district of origin ("local mobility") and (*ii*) moves outside the district of origin ("long-distance mobility"). Long-distance moves, which are consistent with traditional definitions of migration, were often to urban areas (81% of moves) and rarely to international destinations (13% of moves). Annual rates of mobility for at-risk individuals (*Methods*) were 6.4% for overall mobility, 3.8% for local mobility, and 2.5% for long-distance mobility (*SI Appendix*, S2).

The key independent variables are exposure to flooding and non-flooding-related crop failure at household and subdistrict scales. Household exposure to flooding was defined as experiencing any flood-related damage to property or income in either year t or year $t-1$, encompassing the 1–2 y period before migration. Crop failure was defined as any non-flood-related damage to crops during the same period and was driven primarily by rainfall deficits (*SI Appendix*, S3). In the mean person-year, 5.6% of potential migrants were exposed to flooding and 4.7% were exposed to crop failure. These measures were derived from household retrospective reports of the timing and severity of exposure to negative events during the study period, which were combined across baseline and split-off households. To additionally capture larger-scale exposure to these events, we derived the annual proportion of sample households exposed in each subdistrict. Subdistricts (i.e., *upazilas* or *thanas*) are territorial units nested within districts that are roughly equivalent to US counties. These subdistrict-level measures are similar to those used by previous studies, which have largely focused on larger-scale effects (19–24).

Descriptive analysis of these data reveal that, among negative events reported by households, flooding and non-flooding-related crop failure were the most frequent and damaging climate-related events and among the most damaging events overall (42). Household-level economic damages per event averaged 20% of household expenditure for flooding [18,584 Taka (currency of Bangladesh)] and 12% for crop failure (11,489 Taka). However, other results points toward an unexpectedly severe effect of crop failure relative to flooding. Only 8% of households that experienced crop failure indicated that they had fully recovered from the event at the time of interview versus 27% that experienced flooding. Additionally, supplementary regression analyses reveal that both types of shocks had negative effects on household income in 2006 but that the effects of crop failure were larger and more significant (*SI Appendix*, S4).

Statistical Models. To estimate the effects of natural disasters on population mobility, we estimate discrete-time event history models, which are appropriate for the person-year data structure and naturally accommodate data censoring due to mobility and the survey design (43). For each of several model specifications described below, we first estimate a logit model of mobility with the following equation:

$$\log\left(\frac{\pi_{it}}{1-\pi_{it}}\right) = \alpha_t + \alpha_a + \beta X_{it},$$

where π_{it} is the odds of population mobility for individual i in year t, α_t is the baseline hazard of mobility in year t, α_a is the baseline hazard of mobility in subdistrict a, X_{it} is a vector of independent variables for individual i in year t, and β is a vector of parameters for the effects of the independent variables. The independent variables include measures of exposure to natural disasters and control variables as described below.

We subsequently extend this into a multinomial model of both local and long-distance mobility:

*Due to data limitations, we consider only long-term moves and do not investigate temporary moves in which the migrant moved and returned between survey rounds.

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$$\log\left(\frac{\pi_{rit}}{\pi_{sit}}\right) = \alpha_{rt} + \alpha_{ra} + \beta_r X_{it},$$

where π_{rit} is the odds of mobility of type r for individual i in year t, π_{sit} is the odds of no mobility, and the other terms are made specific to the type of mobility.

We estimate these models using five primary and three supplementary specifications of exposure to natural disasters. Consistent with previous studies that have focused on larger scales, specification A includes only subdistrict-level measures of exposure to flooding and crop failure. Specification B retains the subdistrict-level measures of exposure and adds household-level measures. This approach allows larger-scale effects of disasters, such as damaged infrastructure, increased prices, and disrupted labor markets (44, 45), to affect potential migrants differently from damage to their household, which most frequently included loss of assets and income. To test whether these effects are robust to an alternative measure of disaster impact, specification C replaces the exposure measures described above with the household-specific and subdistrict-mean level of economic damages from the event.

Specification D then extends specification B by permitting a nonlinear effect of subdistrict-level exposure and retaining the household-level measures. We distinguish between subdistrict-years in which greater than 20% of households were exposed ("severe"), years in which 5–20% were exposed ("moderate"), and years in which less than 5% were exposed ("low"), with the latter serving as the reference category. This specification asks whether individuals respond differently to moderate and severe levels of disaster-related disruption at the subdistrict level. Moderate flooding occurred in 11% of subdistrict-years, severe flooding in 9% of subdistrict-years, moderate crop failure in 20% of subdistrict-years, and severe crop failure in 6% of subdistrict-years. To examine the vulnerability of different subpopulations to these effects, we also re-estimate the specification D logit model for (*i*) men and women separately and (*ii*) for individuals in the poorest, intermediate, and richest terciles of household per-capita expenditure.[†]

Specification E extends specification D by allowing the effects of household and subdistrict-level measures to interact. Specifically, the effects of household-level flooding and crop failure are allowed to differ between years with low, moderate, and severe events at the subdistrict level, creating six categories of exposure for both flooding and crop failure. Finally, to test the robustness of these results, we estimate the model with three supplementary specifications. Specification F allows the effects of disaster exposure to differ between year t and year $t - 1$; specification G includes a separate model for each baseline survey (*Methods*); and specification H integrates satellite data on rainfall through an instrumental variables approach.

To account for the array of nonenvironmental factors that have been shown to influence population mobility (11, 12, 14), the models also include a large number of control variables as well as fixed effects for the subdistrict and year. The 21 control variables include various demographic characteristics of the individual and household, baseline measures of household wealth and village infrastructure, and time-varying measures of migrant networks (*SI Appendix*, S5). Exposure to livestock deaths and health shocks are also included as control variables, and the specification is allowed to vary per flooding and crop failure as described above. The inclusion of fixed effects for the subdistrict and year additionally accounts for any baseline differences between subdistricts as well as changes in the national context over time. Subdistricts were selected as the unit to measure aggregate exposure and to include fixed effects as a scale that is highly relevant to the daily lives of the respondents and at which we have sufficient data to estimate these terms. Finally, to account for the original sampling design (*Methods*), we also adjust all SEs for clustering (46) at the level of the village, a spatial unit nested within subdistricts.

Results

Table 1 presents the results of the logit and multinomial models for specifications A–D. Model coefficients (β) have been exponentiated to create an odds ratios (e^{β}), which can be interpreted as the multiplicative effect of a one-unit increase in the independent variable on the odds of that form of mobility and are accompanied by the results of cluster-adjusted significance tests. Coefficients for the control variables and fixed effects are included in the model but not displayed (*SI Appendix*, S6 and S7).

Specification A, including only the subdistrict-level measures, reveals that, contrary to expectations, the effects of flooding on overall, local, and long-distance mobility are nonsignificant and near zero. In contrast, the effects of crop failure are positive and highly significant. A 1% increase in the proportion of households experiencing crop failure leads to a 3.5% increase in the odds of overall population mobility ($P < 0.001$), a 3.8% increase in the odds of local mobility ($P < 0.001$), and a 2.9% increase in the odds of long-distance mobility ($P = 0.007$).

Specification B adds household-level shocks and reveals that the effects of flooding remain largely nonsignificant. Household exposure to flooding had a positive and marginally significant effect on long-distance mobility ($P = 0.085$), but the joint effects of both flood measures on long-distance mobility remain nonsignificant ($P = 0.165$). Exposure to crop failure at the household level, however, had large *negative* effects on mobility. Relative to households that were not exposed, household-level exposure to crop failure reduced the odds of overall population mobility by 38% ($P < 0.001$), of local mobility by 33% ($P = 0.018$), and of long-distance mobility by 47% ($P < 0.001$). Subdistrict-level exposure to crop failure continued to have significant positive effects per specification A. Specification C replaces these measures of exposure with the household-specific and subdistrict-mean values of economic damages from flooding and crop failure, better capturing the severity of these events. The direction and significance of effects are highly consistent with specification B, suggesting that the differential effects of flooding and crop failure are not due to differences in event severity.

Specification D expands on specification B by permitting a nonlinear effect of subdistrict-level exposure and reveals important nonlinear effects on mobility that are largely consistent with our descriptive results (*SI Appendix*, S2). Compared with years with low flooding, moderate flooding increased the odds of local mobility by 57% ($P = 0.001$) and marginally decreased the odds of long-distance mobility by 28% ($P = 0.066$), indicating a shift from long-distance to local mobility following moderate floods. The effects of crop failure are consistent with the linear specification, with large positive effects on mobility from severe crop failure and mixed effects from moderate crop failure. Thus, under severe crop failure, the odds of overall mobility are 138% higher ($P < 0.001$), the odds of local mobility are 197% higher ($P < 0.001$), and the odds of long-distance mobility are 82% higher ($P = 0.006$). Additionally, under moderate crop failure, the odds of local mobility are 45% higher ($P = 0.004$).

Re-estimating specification D for various subpopulations reveals important differences in the effects of both flooding and crop failure at the subdistrict level but not at the household level (Table 2). Subdistrict-level flooding has a nonlinear effect on the overall mobility of women and the poor that is consistent with the effects on local mobility in Table 1. Relative to nonflood years, the odds of overall mobility in moderate flood years are 59% higher for the poor ($P = 0.020$) and 36% higher for women ($P = 0.021$) but not significantly different for men and higher-expenditure households. The subdistrict-level effects of severe crop failure are also stronger

[†]Household expenditure was measured at baseline and inflated to 2005 prices.

Table 1. Odds ratios and significance tests from the event history analysis of population mobility

Exposure to natural disasters	Logit, all mobility	Multinomial: In district	Multinomial: Out of district
Specification A: Subdistrict exposure			
Flooding: % exposed in subdistrict	1.00	1.00	0.99
Crop failure: % exposed in subdistrict	1.04***	1.04***	1.03**
Specification B: Household and subdistrict exposure			
Flooding: household exposed (0/1)	1.08	0.93	1.31+
Flooding: % exposed in subdistrict	1.00	1.00	0.99
Crop failure: household exposed (0/1)	0.62***	0.67*	0.53***
Crop failure: % exposed in subdistrict	1.04***	1.04***	1.04***
Specification C: Cost-based measures of exposure†			
Flooding: household losses	1.04	0.99	1.09+
Flooding: Subdistrict mean losses	1.01	1.12+	0.94
Crop failure: household losses	0.84**	0.90	0.73***
Crop failure: Subdistrict mean losses	1.49**	1.67***	1.39
Specification D: Household and nonlinear subdistrict exposure‡			
Flooding: household exposed (0/1)	1.08	0.93	1.29
Flooding: 5–20% exposed in subdistrict (0/1)	1.08	1.57***	0.72+
Flooding: >20% exposed in subdistrict (0/1)	0.93	1.12	0.73
Crop failure: household exposed (0/1)	0.64***	0.69*	0.54***
Crop failure: 5–20% exposed in subdistrict (0/1)	1.19+	1.45**	0.96
Crop failure: >20% exposed in subdistrict (0/1)	2.38***	2.97***	1.82**
$N_{\text{person-years}}$	32,229	32,056	

Models also include control variables and indicators for the subdistrict and year. $^+P < 0.10$, $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

†Losses measured in '000 Taka and transformed by $\ln(x + 1)$.

‡The reference category for subdistrict-level nonlinear shocks is <5% exposed.

for women relative to men, with the odds of women's overall mobility increasing 178% ($P < 0.001$) versus only 91% for men ($P = 0.001$). No clear pattern is evident, however, in the effects of crop failure across terciles of household expenditure.

Specification E additionally allows interactions between the household and subdistrict-level measures, creating six categories of flooding and crop failure. To highlight the effects of crop failure, we derived predicted probabilities of the three forms of mobility across the six categories of crop failure using mean values of the other predictors (Table 3). (The effects of flooding are shown in *SI Appendix*, S8.) Consistent with the results of specification D, this analysis reveals that households that *did not* experience crop failure in subdistricts that experienced *severe* crop failure were the most likely to send household members. Ten percent of at-risk individuals moved under these circumstances, relative to 4.5% in the no-crop-failure condition. Similarly, 2.8 times as many individuals made local moves under these circumstances, and 1.7 times as many individuals made long-distance moves.

Finally, the supplementary specifications reveal that our core results are robust to (*i*) allowing the effects of disaster exposure to differ between year t and year $t - 1$, (*ii*) accounting for differences in the timing and location of the baseline surveys, and (*iii*) accounting for the potential endogeneity of household-level exposure to disasters (*SI Appendix*, S8). We also show that our survey-based measures of disaster exposure have strong but nonlinear relationships with external measures of rainfall (*SI Appendix*, S9).

Discussion

The results reveal that natural disasters have important effects on long-term population mobility in rural Bangladesh, as expected, but provide only limited support for hypotheses derived from the conventional narrative of disaster-induced displacement. Contrary to hypothesis 1, exposure to disasters did not have consistently positive effects on overall mobility. Effects were positive and significant only for crop failure at the subdistrict level, were largely nonsignificant for flooding, and were negative for household-level crop failure. This result indicates that although mobility can serve as a postdisaster coping strategy, it does not do so universally, and disasters in fact can *reduce* mobility by increasing labor needs at the origin or by removing the resources necessary to migrate. The prediction of hypothesis 2 that long-distance moves would be

Table 2. Odds ratios and significance tests from logit models of population mobility stratified by subpopulation

Exposure to natural disasters	Gender: Men	Gender: Women	Expenditures per capita: Low	Expenditures per capita: Medium	Expenditures per capita: High
Flooding: household exposed (0/1)	0.99	1.11	0.86	0.97	1.30
Flooding: 5–20% exposed in subdistrict (0/1)	0.89	1.36*	1.59*	0.94	1.04
Flooding: >20% exposed in subdistrict (0/1)	0.91	0.99	0.90	0.91	1.04
Crop failure: household exposed (0/1)	0.63**	0.68*	0.55*	0.79	0.52**
Crop failure: 5–20% exposed in subdistrict (0/1)	1.13	1.31*	1.32+	1.25	1.04
Crop failure: >20% exposed in subdistrict (0/1)	1.91***	2.78***	2.42**	2.36**	2.53***
$N_{\text{person-years}}$	20,748	11,481	9,449	11,232	11,548

Models also include control variables and indicators for the subdistrict and year. The reference category for subdistrict-level shocks is <5% exposed. $^+P < 0.10$, $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

Table 3. Predicted probabilities of population mobility under various conditions of crop failure

Exposure to crop failure: Subdistrict level	Household level	All moves (%)	Within-district moves (%)	Out-of-district moves (%)	Person-years exposed
<5% crop failure	No crop failure	4.5 (ref)	1.8 (ref)	1.8 (ref)	23,817
	Crop failure	3.2^{+}	1.3	1.0	290
5–20% crop failure	No crop failure	5.3^{+}	2.6**	1.7	6,027
	Crop failure	3.4	1.7	1.0^{+}	889
>20% crop failure	No crop failure	10.0***	5.0***	3.2**	864
	Crop failure	6.6	3.7*	1.7	343

Results are derived from specification E of the event history model (see text). Asterisks indicate the significance of contrasts with the no-crop-failure condition: $^{+}P < 0.10$, $*P < 0.05$, $**P < 0.01$, $***P < 0.001$.

disproportionately affected by disasters is also not supported: In the most detailed specification (specification D), most effects were larger and more significant for local moves rather than long-distance moves. This result is consistent with the higher costs and uncertainty associated with long-distance moves and the spatial scale of these disasters, in which the most severe effects typically occur at scales smaller than a subdistrict.

The conventional narrative also predicts that poor and vulnerable individuals are more likely to be displaced by disasters (hypothesis 3). We find mixed support for this hypothesis: The effects of crop failure and flooding are stronger for women, who have less secure access to land in this context (13), but no clear differences are evident between rich and poor households. This result underscores the significant barriers to migration identified by previous studies. These barriers likely undermine the extent to which mobility can be disproportionately used as a coping strategy by the poor despite their vulnerability to environmental change (9, 15). We also tested the prediction that area-level covariate shocks would have greater effects than household-level idiosyncratic shocks (hypothesis 4). Contrary to expectations, both household and subdistrict crop losses had important effects but in opposite directions. Household-level shocks likely undermine the resources necessary to move, whereas subdistrict-level shocks leave household resources intact but likely undermine risk-sharing networks and opportunities for off-farm employment, increasing the motivation to move.

Discussions of disaster-induced migration in Bangladesh have focused on the effects of flooding and have largely ignored drought and crop failures, assuming that the former are likely to be more important (hypothesis 5). Contrary to this focus, we find that flooding has only modest effects on long-term mobility whereas the effects of crop failure are large and significant, and this finding is not due to differences in the severity of events. This finding is consistent with our supplementary finding that crop failure has larger and more significant negative effects on household income (*SI Appendix*, S4). Both of these findings likely reflect the relative success of local adaptation strategies and disaster assistance programs following floods and the relative lack of these following crop failures (30, 31, 39, 40). Flooding undoubtedly causes substantial short-term population displacement (33, 34), but it appears that this translates into few long-term moves. Future research should investigate the use of other coping strategies, such as loans, following floods and crop failure to provide additional insight into why the latter are more disruptive. Despite this need for additional studies, it is clear from these results and those of other studies (39, 40) that, relative to flooding, crop loss in rural Bangladesh has been neglected by the research and disaster aid communities and deserves additional attention and resources.

Taken together, our results suggest that the conventional view of disaster-induced migration is in need of considerable revision. Future studies of large-scale natural disasters in other settings will be needed to confirm these patterns, but the need for an alternative paradigm is clear. An emerging alternative view, derived from this study and the small number of previous quantitative studies (19–27), is that disaster-induced population displacements are often temporary, of short-distance, and of smaller magnitude than expected and that the poor are not necessarily disproportionately affected. More broadly, future discussions should acknowledge the significant adaptability of rural households, as well as the significant economic, social, and legal barriers that often lie in the way of migration. Policymakers interested in assisting climate-induced migrants should be aware that migration is almost always multicausal and that typically only a small proportion of displaced individuals will have the means or motivation to cross a national boundary. Rather than attempting to identify "climate refugees," a more promising route is to improve the targeting of aid to disaster-affected areas through the increasing use of satellite imagery and rapid population surveys (47).

Methods

Our baseline data were collected by the International Food Policy Research Institute from three separate household samples using overlapping questionnaires (41). The first baseline survey was conducted in 1994 with 350 households in 7 rural communities, the second in 1996 with 957 households in 47 rural communities, and the third in 2003 with 473 households in 48 rural communities. The household and village samples were not selected to be strictly representative of rural Bangladesh, but the sample is large and encompasses diverse areas that span much of the country (*SI Appendix*, S1). In 2006, as part of the Chronic Poverty and Long Term Impact Study, the samples were linked through a joint follow-up survey that targeted all baseline households as well as local split-off households containing one or more original household members. Information on departed household members was collected through a migrant roster, which measured the timing of moves with a scale of 1 y and the destination of moves at the scale of the district (an administrative division that includes multiple subdistricts). An additional follow-up of the second and third baseline surveys was conducted in 2010 using the same approach. Including entire households that departed, only 6.5% of baseline individuals at risk for mobility were lost to follow-up between rounds, representing an annual rate of attrition of less than 1%, and this process does not appear to have been affected by flooding or crop failure (*SI Appendix*, S10).

These data sources were used to create a longitudinal dataset containing baseline and time-varying variables at individual, household, village, and subdistrict scales. The unit of analysis is the person-year, with a total sample size of 32,229 person-years. Data on the destination of moves is missing for 35 of 4,646 individuals, leaving 32,056 person-years for analyses of this outcome. Consistent with observed rates of mobility and with previous studies (20, 23, 25–27), individuals aged 15–39 in year t who were not heads of household or spouses of the head of household at baseline were considered to be at risk for mobility and were included in the analysis. Individuals enter the dataset at baseline or when they turn 15 y old and leave the dataset when they move, turn 40 y old, or are censored at the final data collection. Due to differences in the timing of baseline and follow-up surveys, not all individuals were observed for the same set of years. This feature is naturally accounted for through the use of the event history model described above. The robustness of the core results to additional differences between the baseline surveys is established in *SI Appendix*, S8.

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