Extreme Weather and the Probability of Marriage among Women in Bangladesh

Amanda Carrico (University of Colorado at Boulder)
Katharine M. Donato (Georgetown University)
Jonathan Gilligan (Vanderbilt University)

Introduction & Rationale

Climate change is expected to interact with social, economic, and political forces in ways that shape demographic behavior. There has been a great deal of research in recent years into how climate-related shocks shape patterns of mortality and migration, but less attention given to other behavioral responses such as marriage and fertility. This paper focuses specifically on how extreme weather shapes patterns of marriage among women in the highly vulnerable region of southwest Bangladesh.

Marriage in Bangladesh involves patrilocal residence. When a woman marries, she typically relocates to her husband's household. In about one-third of marriages, a woman will leave the sub-district (*upazila*) in which her family lives to join her husband's family (unpublished data). Research suggests that marrying a daughter is one strategy that households use to cope with periods of abrupt economic hardship (Schuler, Bates, Islam, & Islam, 2006). Households that are economically insecure may seek out marriage partners for their daughters earlier than they might prefer to reduce economic demands on the household or to ensure better marriage prospects given their scarce resources (Schuler et al., 2006).

There is surprisingly little systematic research that examines the relationship between environmental shocks and the timing of marriages in Bangladesh. Qualitative research suggests that households impacted by drought or cyclones sometimes choose to marry their daughters at a very young age to ensure here economic security or to reduce the cost of her dowry (Islam & Rashid, 2011). The age and conditions under which women are married have dramatic impacts on their eventual health and well-being. It is for these reasons that more research is needed to understand how climate change may shape patterns of marriage in Bangladesh as well as in other parts of the world.

Data and methods

These data were collected as part of the Bangladesh Environment and Migration Survey (BEMS) (Donato, Carrico, Sisk, & Piya, 2016). In 2014 we interviewed 1695 randomly selected households in nine *mouzas* (small administrative units that typically contain one to three villages). We first enumerated all households in each mouza, and then randomly selected 200 from each for inclusion in the sample. Two mouzas had populations of less than 200; therefore, all households in these locations were included. Approximately 1 percent of households selected for the sample did not agree to participate. We replaced these households with a randomly selected alternate to achieve a final sample size of 1695.

The BEMS instrument was adapted from the Mexican Migration Project, and collected marriage and migration histories of the head and spouse. We also collected detailed data about the socioeconomic and environmental conditions of household and communities. Using these data, we generated a discrete-time person-year file that followed the female head of household from age 11 to her first marriage or the year of the survey (2014), whichever came first. The primary outcome was a binary variable that represented whether the woman's first marriage occurred in a given person year (x=1) or not (x=0). We also constructed a three-level dependent variable that represented whether the marriage was local (i.e., to a spouse who lived in the same subdistrict [*upazila*]), or to someone outside of the subdistrict.

We constructed two indicators of extreme weather using daily temperature and precipitation data from a regional meteorological station (Jessore Station; Bangladesh Agricultural Research Council, 2017). We then generated a measure of heat waves and dry spells using a methodology recommended by the Expert Team on Climate Change Detection Indices (ETCCDI) (Donat et al., 2013; Peterson & Manton, 2008). Heat waves are measured using the Warm Spell Duration Index (WSDI), which is the annual count of days during which 6 consecutive days exceeded the 90^{th} percentile of temperature. Dry spells are measured using the Consecutive Dry Days (CDD) index, which is the maximum number of consecutive days within a year with less than 1 millimeter of rainfall. We selected these two forms of extreme weather because of prior research suggesting that extreme heat and rainfall deficits (relative to cold spells, wet spells, and intense precipitation) have bigger impacts on human mobility (Call, Gray, Yunus, & Emch, 2017; Gray & Mueller, 2012) and agricultural livelihoods (Basak, Ali, & Islam, 2010; Karim, Hussain, & Ahmed, 1996; Sarker, Alam, & Gow, 2012; Shahid & Behrawan, 2008) in Bangladesh.

Although the person years in this file spanned from 1939 to 2014, we limit these analyses to 1972 to 2012. This window comprises the period after which Bangladesh obtained independence from Pakistan (December of 1971) to 2012, for which daily meteorological were available.

Results & Discussion

Between 1973 and 2012 WSDI ranged from 0 to 79 (*Mean [M]* = 20.98, *Standard Deviation [SD]* = 20.48), and CDD ranged from 32 to 135 (*M* = 71, *SD* = 24.21). The risk of a first marriage in any given person year was 13.61%, with 36.81% of those marriages involving a migration outside of the sub-district.

Table 1 presents the results of a series of discrete-time event history models to predict the probability of marriage. Model A includes only the control variables, which include the woman's age, religion, and education at the time of the survey, as well as fixed effects for community and year. Model B adds the standardized variables for WSDI and CDD. We also include estimates of WSDI and CDD lagged one year behind a given person year to examine whether heat spells and dry spells impacted marriages in the following year. Model B reveals a small but significant effect of CDD. Net of other variables, a one standard deviation increase in the number of consecutive dry days was associated with an 8% increase (Odds Ratio [*OR*] = 1.077 that a woman married within the following year. There were no effects of heat spells on marriage.

Model C in Table 1 includes a series of interaction terms to test whether joint shocks (simultaneous exposure to heat spells and dry spells) or sequential shocks (exposure to extreme weather in two sequential years) predicts the risk of marriage. We find that two consecutive years of intense dry spells significantly amplified the risk of marriage. The probably of a first marriage during a two-year period of average CDD was approximately 14% (0.139); however, when CDD was at two standard deviations above the mean for two consecutive years, the risk of marriage rose to nearly 22% (0.216).

Table 2 presents the results of a multinomial regression in which we model the competing risks of entering into a local vs. non-local marriage. Again we see that consecutive dry days in the prior year are associated with a small but significant increase in the risk of local marriages. CDD did not predict non-local marriages; however, the direction of the effect was also positive. Interaction terms were tested and none were significant.

Conclusions & Future Directions

Consistent with prior research, these data provide some evidence that climate-shocks in the form of dry spells are associated with an increased probability that a woman will marry within the subsequent year. We also find evidence that when drought conditions extend over a two year period, the risk of marriage is amplified. Although these analyses do not yet consider the age of a woman's marriage, we hypothesize that these effects may be driven a household's desire to "speed up" plans to marry their daughters as a coping strategy in response to the economic hardships that follow from extended dry spells.

We plan to elaborate on these analyses in several ways in the coming months. First, we have recently acquired updated daily meteorological from over thirty stations throughout the country. These data will be used to generate more precise estimates of WSDI and CDD for origin and destination communities throughout the country. This will generate a more robust model that leverages spatial heterogeneity in extreme weather conditions. Second, we plan to examine the age of first marriage using Cox-proportional hazard models.

Table 1. Logistic regression predicting first marriage of female heads females

	Model A		Model B		Model C	
	Coef	SE	Coef	SE	Coef	SE
Control Variables						
Age	0.008	0.006	0.006	0.006	0.005	0.007
Muslim	-0.041	0.059	-0.052	0.061	-0.056	0.061
Education (ref=none)						
Some primary	-0.002	0.073	-0.025	0.077	-0.024	0.077
Some secondary	-0.074	0.080	-0.117	0.083	-0.117	0.082
Some post-secondary	-0.549 **	0.095	-0.581 **	0.097	-0.581 **	0.097
Mouzas (ref = m7)						
m1	-0.045	0.095	-0.054	0.096	-0.055	0.096
m2	-0.112	0.096	-0.140	0.097	-0.142	0.096
m3	0.018	0.122	0.007	0.124	0.007	0.124
m4	0.062	0.133	0.057	0.139	0.055	0.138
m5	-0.155	0.113	-0.181	0.115	-0.182	0.114
m6	-0.031	0.110	-0.032	0.112	-0.036	0.112
m8	-0.178	0.110	-0.199	0.111	-0.199	0.111
m9	-0.114	0.104	-0.128	0.105	-0.130	0.105
Year (ref = 1973 - 1982)						
1983 - 1992	0.123	0.091	0.181	0.121	0.149	0.125
1993 - 2002	0.162	0.086	0.210	0.121	0.194	0.126
2003 - 2012	0.393 **	0.095	0.462 *	0.211	0.374	0.242
Extreme Weather						
WSDI			0.049	0.054	0.083	0.071
WSDI (1 yr lag)			-0.055	0.067	-0.021	0.083
CDD			-0.031	0.038	-0.022	0.043
CDD (1 yr lag)			0.074 *	0.036	0.046	0.039
Interaction Effects						
WSDI X CDD					-0.040	0.051
WSDI X CDD (1 yr lag)					-0.028	0.047
WSDI X WSDI-lag					0.057	0.093
CDD X CDD-lag					0.115 *	0.050
Constant	-1.976 ***	0.164	-1.951 ***	0.210	-1.890 ***	0.214
Chi-square	97.81***		111.57***		118.68***	
Pseudo R-squared	0.007		0.009		0.010	

**p* < 0.05, ***p* < 0.01; *n = 9,746* person-years

Table 2. Multinomial regression predicting the risk of local vs. non-local marriages of head females (base = no marriage)

	Local Marriage		Non-local Marriage	
	Coef	SE	Coef	SE
Extreme Weather				
WSDI	0.014	0.066	0.115	0.084
WSDI (1 yr lag)	-0.108	0.084	0.033	0.102
CDD	0.016	0.047	-0.108	0.060
CDD (1 yr lag)	0.093 *	0.044	0.042	0.054
Constant	-2.8548 **	0.272	-2.631 **	0.332
Chi-square	358.60***			
Pseudo R-squared	0.038			

p < 0.05, **p* < 0.01; *n = 9,746* person-years; Control variables are included in the model but not shown.

References

Bangladesh Agricultural Research Council. (2017). Climatic Information Management System. Retrieved from http://climate.barcapps.gov.bd/index.php

Basak, J. K., Ali, M. A., & Islam, N. (2010). Assessment of the effect of climate change on boro rice production in Bangladesh using DSSAT model. *Journal of Civil Engineering (IEB), 38*(2), 95–108.

Call, M. A., Gray, C., Yunus, M., & Emch, M. (2017). Disruption, not displacement: Environmental variability and temporary migration in Bangladesh. *Global Environmental Change*, *46*, 157–165.

Donat, M. G., Alexander, L. V., Yang, H., Durre, I., Vose, R., & Caesar, J. (2013). Global land-based datasets for monitoring climatic extremes. *Bulletin of the American Meteorological Society*, *94*(7), 997–1006.

Donato, K. M., Carrico, A. R., Sisk, B., & Piya, B. (2016). Different but the Same: How Legal Status Affects International Migration from Bangladesh. *The ANNALS of the American Academy of Political and Social Science*, *666*(1), 203–218.

Gray, C., & Mueller, V. (2012). Natural disasters and population mobility in Bangladesh. *Proceedings of the National Academy of Sciences*, 1–6.

Islam, M. D. F., & Rashid, A. N. M. B. (2011). Riverbank erosion displacees in Bangladesh: Need for institutional response and policy intervention. *Bangladesh Journal of Bioethics*, *2*(2), 4–19.

Karim, Z., Hussain, S. G., & Ahmed, M. (1996). Assessing the impact of climatic variations on foodgrain production in Bangladesh. In L. Erda, W. C. Bolhofer, S. Huq, S. Lenhart, S. K. Mukherjee, J. B. Smith, & J. Wisniewski (Eds.), *Climate Change Vulnerability and Adaptation in Asia and the Pacific* (pp. 53–62). Manila, Philippines. Retrieved from

Peterson, T. C., & Manton, M. J. (2008). Monitoring changes in climate extremes: A tale of international collaboration. *Bulletin of the American Meteorological Society*, *89*(9), 1266–1271.

Sarker, M. A. R., Alam, K., & Gow, J. (2012). Exploring the relationship between climate change and rice yield in Bangladesh: An analysis of time series data. *Agricultural Systems*, *112*, 11–16.

Schuler, S. R., Bates, L. M., Islam, F., & Islam, M. K. (2006). The timing of marriage and childbearing among rural families in Bangladesh: Choosing between competing risks. *Social Science and Medicine*, *62*(11), 2826–2837.

Shahid, S., & Behrawan, H. (2008). Drought risk assessment in the western part of Bangladesh. *Natural Hazards*, *46*(3), 391–413.