Female early marriage in South Asia under the threat of global climate change

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Extended abstract

1. Background and Literature Review

Climate change induced natural disasters have significant and negative effects on human survival, especially for people living in vulnerable regions (Muttarak 2021). These effects go beyond just changing the local environment. They also impact demographic, economic, institutional, and socio-cultural aspects of human life, making the population more vulnerable and affecting poorer social groups (Jiang & Hardee 2011; Otto et al. 2017). The United Nations reports that the negative consequences of climate change disproportionately affect women, leading to higher death rates during natural disasters and increased household and care burdens. Extensive research shows that climate change and extreme weather events significantly influence human health, well-being, and major life events through various economic and social development channels, particularly for poor individuals and families. When looking at the demographic impacts of climate change, natural disasters like heatwaves, droughts, floods, and cyclones have been found to profoundly affect mortality patterns, especially child mortality (Dasgupta 2018; Bunyavanich et al. 2003), and malnutrition (Dimitrova & Muttarak 2020; Muttarak & Dimitrova 2019). Furthermore, climate change is also linked to increased illness and migration (Best et al. 2022; Carrico & Donato 2019; Kartiki 2011; Piguet et al. 2011; Mueller et al. 2014).

Another important consequence of climate change on human life is seen in how it changes the timing and outcomes of life course transitions, including the transition to marriage of young girls (Andriano and Behrman 2020), a phenomenon also known as female early marriage. According to UNICEF, early or child marriage refers to both formal and informal unions where a person under 18 is involved as a partner. Despite a decline in recent decades, early marriage is still common worldwide. South Asia currently has the highest proportion of girls and women who were married in childhood. This study aims to explore this link, extending a comparative perspective to India and Nepal. While the average age at marriage in South Asia is generally rising, this progress against early marriage can be set back by economic and environmental shocks, with more international observers pointing to climate change and extreme weather events as a key cause South Asia is exposed to many climate hazards including cyclones, tidal surges, floods, rising surface air temperatures, glacier melting, and droughts which cause damage to human lives and property every year, making it a disaster-prone region. It is consistently ranked among the ten most climate-affected regions globally (Shaw et al. 2022). Therefore, the region's specific characteristics, with its increasing susceptibility to climatic risks and the widespread practice of early marriage, make South Asia an important setting to study the relationship between climate change and the transition into marriage. Previous studies have highlighted the role of climatic variability in shaping marriage patterns and gendered demographic outcomes in some South Asian countries, (see Ortensi, Tosi, and Rettaroli, 2025 for recent evidence on

Bangladesh), also showing how such relationship varies according to the territorial context e.g., whether live in rural or urban setting

2. Data & Methodology

This paper extends previous research on Bangladesh (Ortensi et al. 2025) examining how weather variability affects the risk of marrying as a child (before 18 years of age) for girls and women in Pakistan, India, and Nepal. We use multilevel discrete-time survival modelling with integrated data from the Demographic and Health Surveys (DHS) and climate information at the district level from the Standardized Precipitation and Evapotranspiration Index (SPEI) (Vicente-Serrano et al. 2010). SPEI measures drought severity by considering both its intensity and duration, based on the cumulative difference between precipitation and potential evapotranspiration. This allows it to capture both dry and wet climate anomalies and reflect changes in surface water balance (Zhang et al. 2015). SPEI is commonly used in environmental and population science (e.g., Andriano & Behrman 2020; Muttarak & Dimitrova 2019) and enables comparisons of drought severity across different climates and timescales in this study we employ the SPEI-12 measuring weather anomalies over the 12 months prior to women's marriage. To study the effect of SPEI levels on marriage likelihood at each age, we control individual and district-level factors, both observed and unobserved, by including a set of covariates and a random intercept at the district of residence level.

Our study contributes to existing literature in several ways. First, by focusing on both wet and dry extreme weather, our approach aims to assess the impact of different weather conditions. Second, by using the fine geographical detail of available statistical information, we study the link between unusual weather conditions and the timing of marriage, explicitly considering how the frequency and intensity of these phenomena vary at the district (province) and division (region) levels. Finally, besides testing the impact of climate variability on child marriage, we also check its effect on the likelihood of accelerating marriage for women of any age. This latter approach is new in literature and has important implications for family formation dynamics and women's empowerment and rights under the threat of global climate change, so separate models were estimated for rural and urban populations to account for possible contextual differences in the determinants of early marriage.

3. Preliminary Results

Table 1 presents key demographic and socioeconomic statistics, while Table 2 reports the estimated effects of medium-term climatic variability (SPEI-12) on early marriage across Nepal, Pakistan, and India. Descriptive evidence shows that the average age at first marriage is around 18 years in all three countries, with higher early-marriage rates in Nepal and Pakistan, where rural residence and low education levels are most common. Model estimates presented in Table 2 indicate that wet climatic anomalies significantly increase the likelihood of early marriage, especially in urban Nepal and both urban and rural Pakistan, while moderately dry conditions seem to delay marriage, particularly in rural India.

Table 1: Descriptive Statistics of Key Demographic and Socioeconomic Variables for Nepal, Pakistan, and India

	Nepal		Pakistan		India	
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**
Age at first marriage	17.9	3.390	17.9	4.085	18.0	4.385
Early marriages (%)	51.1	0.500	51.6	0.500	46.9	0.499
Immobile women (%)	24.6	0.431	50.9	0.499	50.8	0.220
Rural (%)	41.4	0.492	78.5	0.411	70.7	0.455
Never went to school (%)	40.6	0.491	83.8	0.368	33.6	0.472

Source: NDHS (pooled 2001-2006-2016-2022), PDHS 1991, IDHS 2015 (weighted observations)

Table 2. Multilevel discrete-time survival model estimates of the risk of entering marriage before age 18 in India, Nepal, and Pakistan (SPEI12)

SPEI12 (5 categories)		**Urban**			**Rural**		
		Coef.	**Lower CI**	**Upper CI**	**Coef.**	**Lower CI**	**Upper CI**
India	Extremely wet	0.003	-0.002	0.007	0.008***	0.005	0.011
	Moderately wet	0.008**	0.002	0.013	0.002	-0.001	0.005
	Moderately dry	-0.005*	-0.008	-0.001	-0.004***	-0.006	-0.002
	Extremely dry	-0.005*	-0.010	-0.001	-0.001	-0.004	0.002
Nepal	Extremely wet	0.013*	0.003	0.024	0.004	-0.004	0.013
	Moderately wet	0.020***	0.009	0.032	-0.001	-0.010	0.010
	Moderately dry	0.001	-0.007	0.008	-0.002	-0.009	0.005
	Extremely dry	0.012**	0.003	0.021	-0.005	-0.013	0.003
Pakistan	Extremely wet	0.076***	0.032	0.120	0.073***	0.035	0.111
	Moderately wet	0.063	-0.048	0.174	0.044	-0.032	0.120
	Moderately dry	0.011	-0.056	0.077	0.038	-0.019	0.094
	Extremely dry	-0.024	-0.103	0.054	0.037	-0.058	0.132

Note: The reference category is “Near normal” the reference is Significance at *** 0,1%; ** 1%; * 5%; + 10%.
Source: Our elaborations on NDHS (pooled 2001-2006-2016-2022), PDHS 1991, IDHS 2015

Overall, our preliminary findings suggest that periods of extreme humidity and drought significantly affect the risk of entering marriage for girls under 18. This evidence helps improve our understanding of natural disasters as triggers of less-than-ideal adaptation strategies, emphasizing the importance of monitoring the long-term effects of environmental changes on human behavior.

4. Future Developments

Developments of the present research include further exploring within- and between-country heterogeneity, assessing how socioeconomic and regional contexts mediate climate impacts. In addition, the study will examine marriage-market outcomes following climate-driven acceleration in marriage, such as spousal age gaps, socioeconomic status, and gender-norm

indicators. These extensions will provide a deeper understanding of how persistent environmental stress interacts with social and demographic transitions in South Asia.

References

Andriano, L., & Behrman, J. (2020). The effects of growing-season drought on young women's life course transitions in a sub-Saharan context. *Population Studies*, *74*(3), 331–350.

Best, K., Carrico, A. R., Donato, K., & Mallick, B. (2022). A multicontextual analysis of place attachment, environmental perceptions, and mobility in southwestern Bangladesh. *Translational Issues in Psychological Science*, *8*(4), 461–472.

Bunyavanich, S., Landrigan, C. P., McMichael, A. J., & Epstein, P. R. (2003). The Impact of Climate Change on Child Health. *Ambulatory Pediatrics*, *3*(1), 44–52.

Carrico, A. R., & Donato, K. M. (2019). Extreme weather and migration: evidence from Bangladesh. *Population and Environment*, *41*, 1–31.

Dasgupta, S. (2018). Burden of climate change on malaria mortality. *International Journal of Hygiene and Environmental Health*, *221*(5), 782–791.

Dimitrova, A., & Muttarak, R. (2020). After the floods: Differential impacts of rainfall anomalies on child stunting in India. *Global Environmental Change*, *64*.

Jiang, L., & Hardee, K. (2011). How do Recent Population Trends Matter to Climate Change? *Population Research and Policy Review*, *30*(2), 287–312.

Kartiki, K. (2011). Climate change and migration: a case study from rural Bangladesh. *Gender & Development*, *19*(1), 23–38.

Muttarak, R. (2021). Demographic perspectives in research on global environmental change. *Population Studies*, *75*(sup1), 77–104.

Muttarak, R., & Dimitrova, A. (2019). Climate change and seasonal floods: potential long-term nutritional consequences for children in Kerala, India. *BMJ Global Health*, *4*(2), e001215.

Otto, I. M., Reckien, D., Reyer, C. P. O., Marcus, R., Le Masson, V., Jones, …, & Serdeczny, O. (2017). Social vulnerability to climate change: a review of concepts and evidence. *Regional Environmental Change*, *17*(6), 1651–1662.

Ortensi, L. E., Tosi, F., & Rettaroli, R. (2025). Estimating the relationship between prolonged weather variability and accelerated marriage in Bangladesh. *World Development*, 195, 106994.

Piguet, E., Pécoud, A., & De Guchteneire, P. (2011). Migration and climate change: An overview. *Refugee Survey Quarterly*, *30*(3), 1–23.

Shaw, R., Luo, Y., Cheong, T.S., Abdul Halim, S., Chaturvedi, S., Hashizume, M., …, & Zhang,

Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index. *Journal of climate*, *23*(7), 1696–1718.

Zhang, Q., Qi, T., Singh, V. P., Chen, Y. D., & Xiao, M. (2015). Regional frequency analysis of droughts in China: a multivariate perspective. *Water Resources Management*, 29, 1767–1787.