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Environmental Factors That Affect Child Marriage in Bangladesh: Harnessing Evidence from the 2017–18 Bangladesh Demographic and Health Survey

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ABSTRACT

Millions of teenage girls are affected by the global issue of child marriage, which is a violation of human rights. Compared to their unmarried peers, girls who marry young face disadvantages such as social exclusion, poverty, and inadequate education.

In Bangladesh, the effects of climate change are prevalent. The low-lying coastal towns near the Bay of Bengal are vulnerable to rising sea levels. The result of this is flooding, river erosion, evidence of waterlogging, and rising soil and water salinity in some areas of Bangladesh.

Poverty and economic instability are commonly understood to be the main drivers of child marriage. However, despite growing interest in the link between climate vulnerability and child marriage, little research is available on this topic. This paper examines how recent environmental changes may have affected the prevalence of child marriage in Bangladesh.

The study found that, among women age 20–49, the prevalence of child marriage was lower in Sylhet Division than in the other seven divisions in Bangladesh. Clusters from the coastal areas of Khulna, Barishal, and Chattogram and clusters from the northeast regions and from Sylhet had higher scores on the climate vulnerability index (CVI) than other clusters. We also found a correlation between the CVI developed in this study and the prevalence of child marriage, although the magnitude of this association varied by division. CVI was most strongly correlated with child marriage in Barishal and Rangpur, which are disaster prone in the context of coastal and drought conditions. Nationally, the correlation coefficient for the relationship between CVI and child marriage was almost 18% and highly significant ($p < .001$).

Key words: climate change, child marriage, geospatial covariates

ACRONYMS AND ABBREVIATIONS

BDHS	Bangladesh Demographic and Health Survey
CVI	climate vulnerability index
DHS	Demographic and Health Surveys

1 BACKGROUND

> *"Our family was severely affected during both cyclone Sidr [in 2007] and cyclone Nargis [in 2008]. My parents then migrated to Dhaka and I was sent to my maternal uncle's house, from where I continued my study. When I was in grade 8, my father asked me to come to Dhaka to attend a wedding function of a female cousin. During that visit, my father married me off without my consent and I couldn't oppose my parents' decision."*
>
> *(An adolescent girl from Purbachila, married at age 16, high-risk zone, Barguna)*

Fifty-nine percent of women in Bangladesh are married before their 18th birthday.

The above statement is from a Bangladeshi girl living in the coastal area who was married quite young and did not have the opportunity to complete at least a secondary level of education.[1] Millions of teenage girls worldwide are affected by the global issue of child marriage, which is a violation of human rights. Child marriage is defined as a legal marriage or an unofficial union in which at least one party is under age 18. Although boys sometimes participate in child marriage, girls are disproportionately affected by the consequences.[2] Child marriage effectively ends schooling and prevents girls from achieving their full economic potential. Compared to their unmarried peers, girls who marry young face disadvantages such as social exclusion, poverty, and inadequate education. The knowledge and abilities girls require to negotiate adult roles are limited. Empirical evidence shows that women who had married as girls have less decision-making power and less ability to determine their fertility-related behaviors than women who had married as adults. Bangladesh has the seventh highest prevalence of child marriage globally.[3] The data suggest that nearly six of every 10 women in Bangladesh are married before their 18th birthday.[4] Despite extensive efforts by the government and civil society in several sectors, the prevalence of child marriage in Bangladesh remain stubbornly high even with the country's progress in other areas of social development.

Several research studies have been conducted globally and in Bangladesh to assess the causes and consequences of child marriage. In most cases, the primary determinants of child marriage were lack of social security, economic hardship, and post-disaster distress. The latter two determinants are linked with climate change.

Climate change is a global phenomenon. Several signs of susceptibility to climate change are evident in Bangladesh, including the country's vulnerability to rising sea levels in the low-lying coastal towns near the Bay of Bengal. As a result of coastal flooding and rising sea levels, evidence of increased waterlogging, river erosion, floods, and rising soil and water salinity can be seen in some areas. Bangladesh has recently faced several extremely destructive cyclones. These passed across large sections of the country, with varying effects on communities and households. Given the variation in plant coverage and elevation, the vulnerability of communities to these storms differed.

Bangladesh is one of the most disaster-prone areas in Southeast Asia. According to the Global Climate Risk Index 2020, the threat of climate-related disasters continues in Bangladesh. Bangladesh is the seventh most vulnerable country to extreme weather conditions and the country most affected by natural disasters.

However, little research is available on the link between climate vulnerability and child marriage in Bangladesh's disaster-prone coastal locations.

1.1 Rationale

Previous research has explored the linkage between environmental vulnerability and child marriage, globally and in Bangladesh. A 2021 study found that environmental crises worsen the known drivers of child marriage.[5] Also in 2021, Asadullah et al. suggested that coastal households in Bangladesh turned to child marriage as a coping mechanism for their heightened susceptibility to natural disasters.[1] In 2020, Tsaneva had discovered that a higher proportion of dry months in a particular year greatly raised the likelihood of being married young in Bangladesh.[6] Relationships among dowry, climate change, and child or forced marriage in Bangladesh were described by Alston et al. in 2014.[7] Arsenic exposure and child marriage have been found to be minorly but significantly linked with preterm birth, as they were associated with reduced weight increase during pregnancy according to a mediation analysis in Bangladesh.[8] Bhowmik et al. in 2021 assessed the prevalence of child marriage and adolescent pregnancy among women in Bangladesh, as well as the impact of education and religious affiliation.[9]

Despite this previous research, to our knowledge no attempt has been made to use granular-level data to analyze the relationship between child marriage and environmental vulnerabilities in Bangladesh.

1.2 Research Question

In this study, we used granular (cluster-level) data from a national-level survey and available geospatial covariates to understand the relationships between child marriage and environmental vulnerabilities. The clusters in this study were enumeration areas, or the primary sampling units, made up of about 120 households each.

2 METHODOLOGY

This study utilized the individual women, household, and community datasets from the 2017–18 Bangladesh Demographic and Health Survey (BDHS) as well as available geospatial covariates, which are all publicly available from The Demographic and Health Surveys (DHS) Program. The BDHS used a two-stage stratified cluster sampling method based on the 2011 Population and Housing Census's sampling frame, and The DHS Program generated estimates on several geospatial covariates for all 672 clusters. The detailed methodology of the survey can be found on The DHS Program website, or in the final report for the 2017–18 BDHS.[4]

This study was a cross-sectional study of secondary data. The primary outcome variable was age at first marriage. The variable was continuous in nature as found in the BDHS survey data for individual women. Marriage before age 18 was regarded as a child marriage. This age cutoff has been used to define child marriage in the literature,[10] although the new *Child Marriage Restraint Bill of 2017* in Bangladesh allows marriages to occur before age 18 in special circumstances.

The proportion of women age 20–49 who had married before age 18 was calculated for each cluster using the BDHS women's 2017–18 survey dataset. Each cluster was then grouped into the following categories based on the proportion of women who had experienced child marriage:

- Lowest level: prevalence less than 0.25
- Minimal level: prevalence between 0.25 and 0.5
- Moderate level: prevalence between 0.5 and 0.75
- Extreme level: prevalence between 0.75 and 1.0

To observe differences in child marriage prevalence by division and region, we generated maps using the GIS locations of the clusters. We also constructed a climate vulnerability index (CVI)[11] from the variables available in the BDHS datasets, including the geospatial covariates, at the cluster level. CVI can be calculated using different equations. Most agree that CVI is a function of exposure, sensitivity, and adaptive capacity,[12,13] although some consider it simply a function of sensitivity and adaptive capacity.[14, 15] The equation used in this study was:

$$CVI = \frac{Exposure + Sensitivity + Lack\ of\ Adaptive\ Capacity}{3}$$

Each dimension of CVI could attain a maximum value of 1 and a minimum value of 0.

Table 1 shows the variables from each domain that were used to construct the CVI.

Table 1 Variables used for computing the climate vulnerability index

Serial no.	Variable	Definition/computation	Dimension	Data source
1	Aridity index	The aridity index was calculated in units between 0 (most arid) and 300 (most wet). It was expected to affect crop production, poverty status, and household vulnerability. Data from 2000–2015 and the standard deviations over the years were ranked for each cluster, where more deviation contributed to more vulnerability.	Exposure	BDHS geospatial covariates dataset
2	Enhanced vegetation index	This index was the average vegetation index value at each BDHS survey cluster location at the year of measurement. Data from 2000–2015 and the standard deviations over the years were ranked for each cluster, where more deviation contributed to more vulnerability.	Exposure	BDHS geospatial covariates dataset
3	Average temperature	Average temperature was a modeled surface based on weather station data from each BDHS survey cluster. It was the average of the 12 monthly datasets for a given year. Data from 2000–2015 and the standard deviations over the years were ranked for each cluster, where more deviation contributed to more vulnerability.	Exposure	BDHS geospatial covariates dataset
4	Rainfall	Average annual rainfall was calculated at each BDHS survey cluster location. Even though heavy rainfall causes flash flooding in some areas in Bangladesh, rainfall is an important factor for crop harvesting. Data from 2000–2015 and the standard deviations over the years were ranked for each cluster, where more deviation contributed to more vulnerability.	Exposure	BDHS geospatial covariates dataset
5	Elevation	Elevation was defined as the distance between an object and the standard mean sea level. Lower elevation increased vulnerability.	Exposure	BDHS geospatial covariates dataset
6	Flood	Clusters were ranked on the basis of population exposed to the risk of flood, which was categorized in 5 scales. Clusters with higher rankings were considered more vulnerable.	Exposure	*Global Flood Exposure: Gridded Exposure by Headcounts by Country* (World Bank Data Catalog; worldbank.org)
7	Dependency ratio	The dependency ratio was the ratio of the cluster-level population under age 15 and above age 65 to the population over age 15 and below age 65. Higher dependency ratios meant more household vulnerability.	Adaptive capacity	BDHS household dataset
8	Proportion of households where household head is illiterate	This variable was calculated at the cluster level. Higher educational levels decreased vulnerability.	Adaptive capacity	BDHS household dataset
9	Proportion of households with more than four members	This variable was calculated at the cluster level considering average family size as four persons since the total fertility rate has been stagnant at 2.3 since 2010. Larger family size increased vulnerability.	Adaptive capacity	BDHS household dataset
10	Proportion of households living in the lowest wealth quintiles	This variable was calculated at the cluster level considering that higher proportions of households in lower wealth quintiles increased vulnerability.	Adaptive capacity	BDHS household dataset
11	Proportion of households with nonimproved sanitation	This variable was calculated at the cluster level considering that higher proportions of households with nonimproved sanitation increased vulnerability.	Sensitivity	BDHS household dataset
12	Proportion of households with nonimproved water supply	This variable was calculated at the cluster level considering that higher proportions of households with nonimproved water supply increased vulnerability.	Sensitivity	BDHS household dataset

BDHS = Bangladesh Demographic and Health Survey

Exposure was an index of climate variability constructed with the geospatial variables found from the DHS website. We considered the values of each variable from 2000 to 2015 and used the variation (standard deviation), if given, to identify changes in the variable. However, the elevation and flood data did not involve time series. The greater the variations observed, the more vulnerable the clusters.

Adaptive capacity was an index constructed with the sociodemographic and economic variables found in the BDHS survey data detailed in Table 1.

Sensitivity was an index constructed with the health and water variables found in the BDHS survey data.

Other studies have categorized the variables in Table 1 into domains that differed from ours. For example, Mandi 2020[14] categorized variables into either adaptive capacity or sensitivity domains. We grouped the indicators into three domains, following the standard process. All variables were normalized, measured to have a positive functional relationship, and assigned with equal weight. The following formula was used for normalization:

$$X_n = \frac{(X - minX)}{(maxX - minX)}$$

where X_n was the normalized value of the indicator, X was the raw value of the indicator, $maxX$ was the maximum value of the distribution X, and $minX$ was the minimum value of the distribution X.

The index for each domain was constructed as the weighted average of subcomponents. The number of subcomponents in each major component was used to determine the weight of the major component.

For example,

$$Sensitivity = \frac{W_{health} * Health + W_{water} * Water}{W_{health} + W_{water}}$$

Each listed variable was identified at the cluster level from the BDHS survey and geospatial covariate datasets. Although the literature suggests using more variables, we focused on the variables available from the BDHS.

All analyses to calculate the different indices were conducted with Stata. Maps of the distribution of child marriage and the different components of the CVI across clusters were created using the QGIS geographic information system software.

3 RESULTS

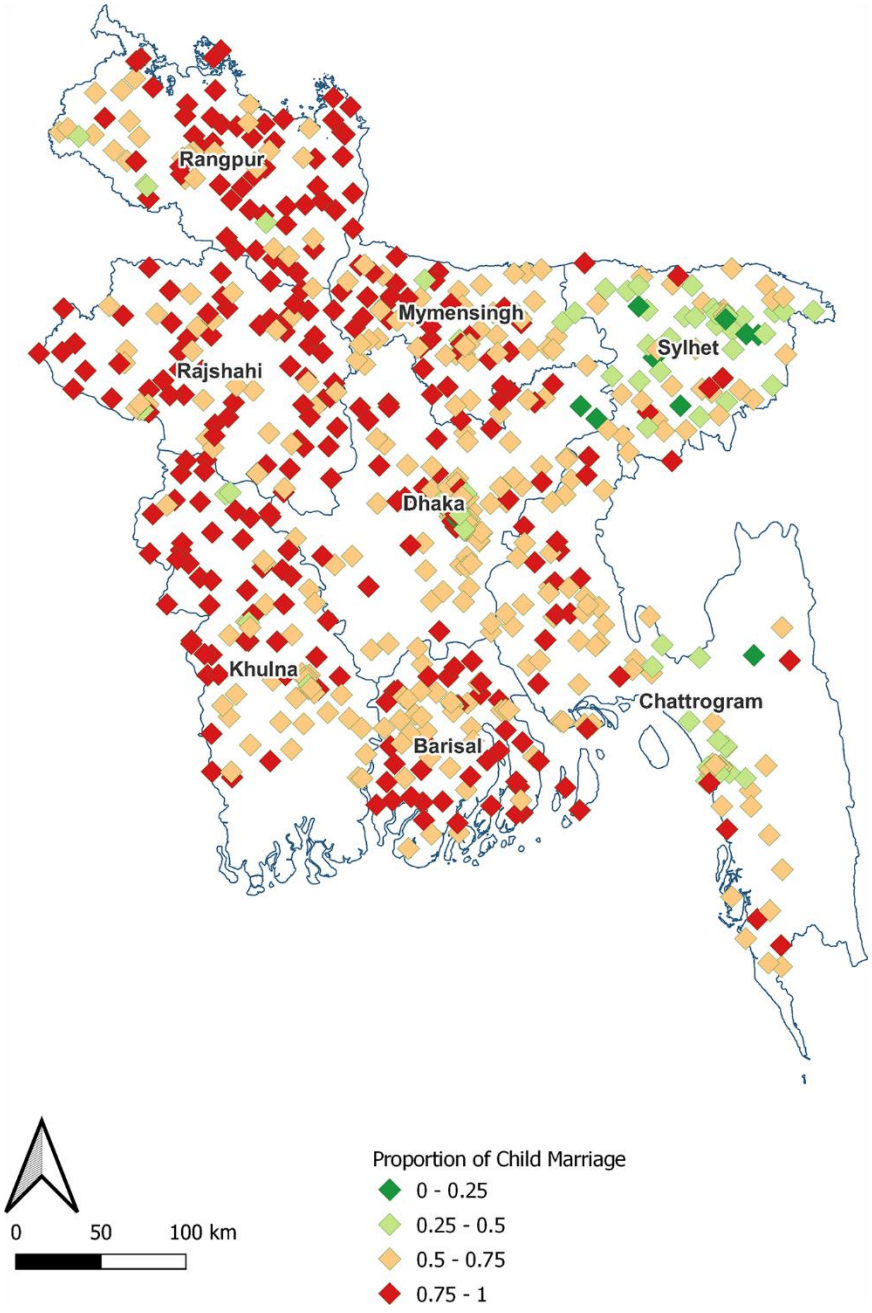
Table 2 shows the distribution of the 672 Bangladesh Demographic and Health Survey (BDHS) clusters according to the proportions of women who had experienced child marriage, calculated among women age 20–49. In the majority of clusters (almost 88%), the prevalence of child marriage was higher than 0.50.

Table 2 Distribution of clusters according to proportion of women age 20–49 who had experienced child marriage, 2017–18 Bangladesh DHS

Child marriage prevalence	No. of clusters (%)
Lowest level (<0.25)	11 (2%)
Minimal level (0.25 to 0.50)	70 (10%)
Moderate level (0.5 to 0.75)	310 (46%)
Extreme level (0.75 to 1.0)	281 (42%)
Total	**672 (100%)**

Map 1 shows how the proportions of women age 20–49 who had experienced child marriage were distributed across the clusters. In the coastal areas in Barishal, Khulna, and Chattogram and in the northwest areas of Rajshahi, Rangpur, and Mymensingh, the prevalence of child marriage was higher than in other areas. In Sylhet Division, child marriage was less prevalent than in the other seven divisions.

Map 1 Distribution of child marriage in Bangladesh

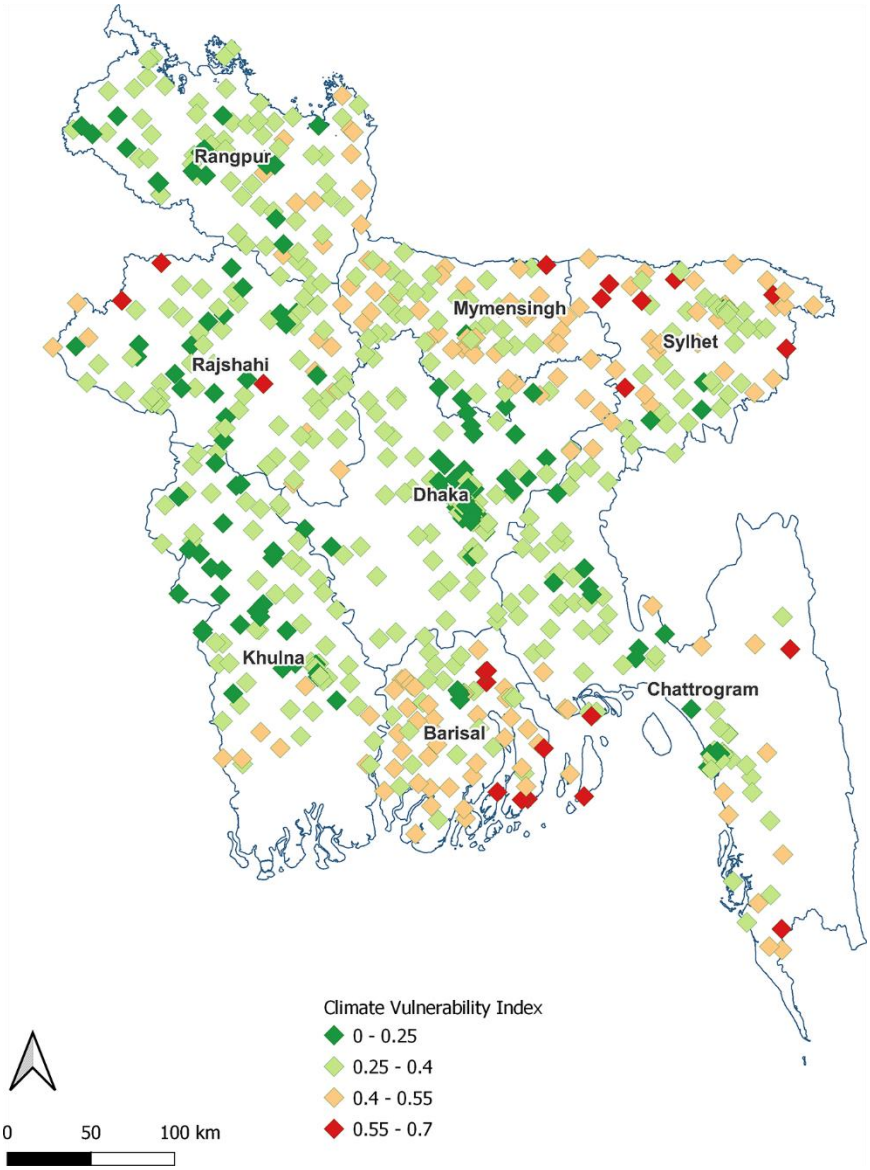


Source: BDHS 2017–18

We plotted the overall climate vulnerability index (CVI) and the corresponding indices of exposure, sensitivity, and adaptive capacity at the cluster level. Overall, as shown in Map 2, clusters from the coastal areas of Khulna, Barishal, and Chattogram; from the northeast regions; and from Sylhet (which are always prone to flash flooding) were more vulnerable to the climate than other clusters. In Rangpur Division, some clusters were more vulnerable than others, with the more vulnerable clusters being in drought-prone areas with extreme poverty.

Map 3 shows the distribution of the exposure domain of climate vulnerability across clusters. Regional differences in exposure were clear. Sylhet, Rajshahi, and Mymensingh were the most affected by exposure when we considered geospatial covariates such as rainfall, temperature, and the threat of flood. Clusters in coastal areas in Southern Bangladesh (Barishal and Chattogram) had high exposure indices, demonstrating their vulnerability to climate change.

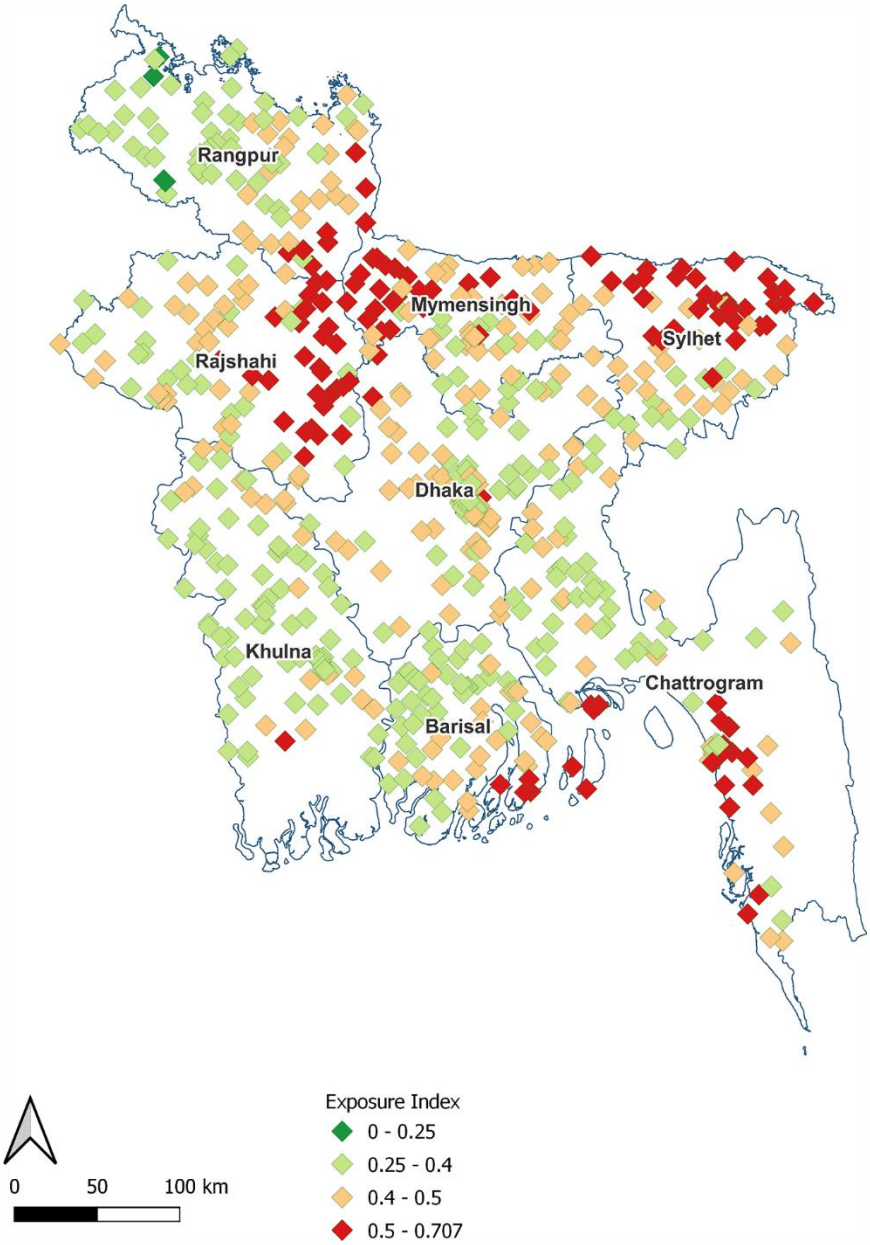
Map 2 Distribution of the overall climate vulnerability index in Bangladesh



Source: Authors' calculation using geospatial data

Plotted maps for adaptive capacity and sensitivity (see Maps A1 and A2 in the Appendix) showed that the clusters were much less vulnerable in these domains than in the exposure domain.

Map 3 Distribution of the exposure index in Bangladesh



Source: Authors' calculation using geospatial data

Figure 1 shows the relationship between child marriage and CVI by division. Among the eight subnational divisions, near linear relationships were observed in all divisions except Sylhet and Chattogram.

Figure 1 **Correlation matrix showing relationship between child marriage and climate vulnerability index by division in Bangladesh**

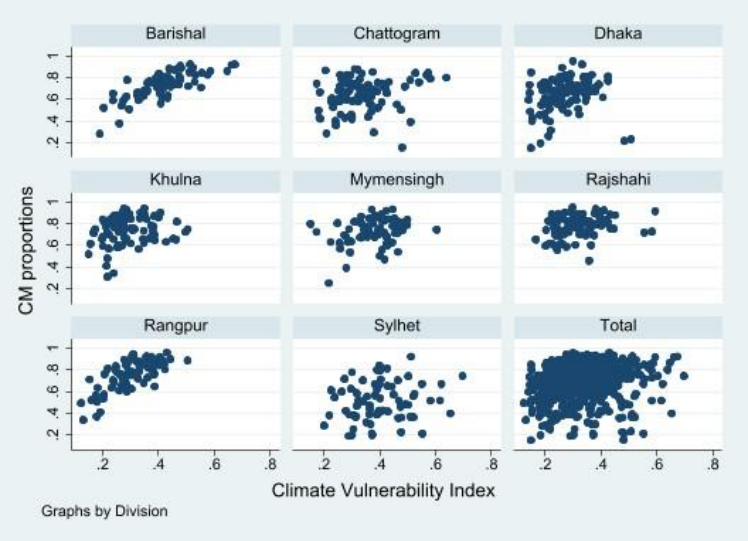


Table 3 shows the correlation coefficients, with significance levels, for these relationships. The relationship between CVI and child marriage was statistically significant in all but two divisions (Khulna and Sylhet). CVI was most strongly correlated with child marriage in Barishal and Rangpur, which are disaster prone in the context of coastal and drought conditions. Nationally, the correlation coefficient between CVI and child marriage was almost 18%, which was also highly significant ($p < .001$).

Table 3 **Correlation coefficients for relationship between child marriage and climate vulnerability index by division, 2017–18 Bangladesh DHS**

Division	Pearson r value for child marriage vs. CVI
Barisal	0.7610***
Chattogram	0.2066*
Dhaka	0.2057*
Khulna	0.1785
Mymensingh	0.3037**
Rajshahi	0.2625*
Rangpur	0.7203***
Sylhet	0.1749
National	**0.1767*** **

* $p < .05$, ** $p < .01$, *** $p < .001$
CVI = climate vulnerability index

4 DISCUSSION

This study showed that climate vulnerability is correlated with the prevalence of child marriage in Bangladesh, and that the strength of the association varies by region. The clusters in regions with a high climate vulnerability index (CVI) and a high exposure index had higher prevalences of child marriage than clusters in other regions. Our results showed that the west and southwest divisions (Rangpur, Rajshahi, and Khulna) of Bangladesh were most affected by child marriage. Since cluster locations can overlap with districts or divisional levels, local government authorities of selected divisions should consider our findings and take precautions to reduce child marriage in their administrative areas. The mapping of the CVI and exposure index data provided evidence that certain portions of the country are vulnerable to climate change, not only from sudden disasters such as typhoons and cyclones but also from disasters such as floods and droughts, which require long-term improvement in the local infrastructure.

In India, Mahapatra et al. has investigated district-level vulnerability to climate change, reproductive health among women, and the health status of children.[15] However, our study is one of the first to use cluster-level data and child marriage data to examine vulnerability to child marriage in the context of climate change. Researchers with expertise in different domains of geography and social science should work together to conduct similar research to identify geographic locations that require further action.

4.1 Policy Implications

Government programs and policies aimed at preventing child marriage should be interested in the relationship between child marriage and environmental vulnerability. Although larger societal and cultural factors can complicate this relationship, identifying variations in child marriage that occur at local community, household, and individual levels is critical. Reducing child marriage and addressing climate vulnerability in coastal countries like Bangladesh requires a multifaceted and integrated approach.

Following are policy recommendations to be considered:

1. *Education and awareness programs:* To draw attention to the detrimental effects of child marriage and the value of education, particularly for girls, implement comprehensive education and awareness campaigns with a focus on children and their families. These campaigns should include instruction on climate change to increase students' understanding of the effects of climate change and of mitigation techniques.

2. *Community empowerment and engagement:* Increase participation from women and girls in local communities' decision-making processes for mitigating and adapting to climate change. This includes community-led programs that consider the local context and expertise and address the risks associated with climate change and child marriage.

3. *Access to quality education:* Acknowledging the fact that increasing girls' education is a proven strategy for delaying marriage,[16] continue to increase the number of girls who have access to high quality education by funding schools and other facilities, offering scholarships, and removing cultural barriers that prevent them from attending school. To establish a comprehensive strategy, integrate educational activities with efforts to adapt to climate change and to enhance resilience.

4. *Legal reforms and enforcement:* Ensure that legal frameworks are in place and are regularly used, by strengthening and enforcing current laws that prohibit child marriage. National, divisional, district-level, upazila-level, and union-level child marriage prevention committees need to be activated. Adopt and enforce laws related to resource management, disaster risk reduction, and land use planning, which are relevant to climate change adaptation and mitigation.

5. *Economic opportunities for families:* Provide training on families' income sources that are susceptible to climate change, especially in coastal areas where they may be more susceptible, to reduce financial strains that could lead to child marriage. Incorporate climate-resilient livelihood programs to improve economic stability in the face of environmental changes.

6. *Health care access and family planning:* To provide women and girls with more control over their reproductive health, increase access to family planning and reproductive health services. Incorporate health care practices that are responsive to climate change.

7. *Climate-resilient infrastructure and housing:* To reduce the susceptibility of coastal areas to climate-related disasters, invest in early warning systems, housing, and infrastructure that are resilient to climate change. Make sure that the needs of the most vulnerable groups, such as women and children, are considered when developing infrastructure.

8. *Social norms and gender equality:* Develop initiatives to question and alter societal practices that support gender inequality and discourage child marriage. Encourage women's empowerment and gender equality as crucial elements of plans for resisting climate change.

9. *Research and data collection:* Promote studies that assess the relationships among child marriage, climate vulnerability, and methods of adaptation. Create extensive mechanisms for gathering data to track the success of policies and initiatives over time.

10. *International collaboration and support:* To execute and finance comprehensive initiatives that address child marriage and climate risks in coastal communities, engage international collaboration and support. Interact with funders and international groups to exchange resources and best practices for successful implementation.

These policy recommendations highlight the need for an integrated strategy that considers the association between child marriage and climate vulnerability. Policymakers should engage in collaborative efforts with civil society, local communities, and international partners to customize interventions to the unique requirements of coastal areas in Bangladesh and other similar nations.

4.2 Limitations

The study considered only the variables available on The Demographic and Health Surveys Program website and at the cluster level dating back to 2000. However, climate change could be measured by collating more than five decades of available data.

Climate vulnerability should be considered with more variables in the exposure, sensitivity, and adaptive capacity domains. Beyond flooding, no other disaster information was available to the researchers. Additional disaster information may have provided a more refined version of the CVI.

REFERENCES

1. Asadullah MN, Islam KMM, Wahhaj Z. Child marriage, climate vulnerability and natural disasters in coastal Bangladesh. *J Biosoc Sci*. 2021;53(6):948967. https://doi.org/10.1017/S0021932020000644

2. United Nations Population Fund (UNFPA). *State of 2020: Defying the Practices That Harm Women and Girls and Undermine Equality.* UNFPA; 2020. https://www.unfpa.org/publications/state-world-population-2020

3. United Nations Children's Fund (UNICEF). *Ending Child Marriage: A Profile of Progress in Bangladesh.* UNICEF; 2020. https://www.unicef.org/bangladesh/media/4526/file/Bangladesh%20Child%20Marriage%20report%202020.pdf.pdf

4. National Institute of Population Research and Training (NIPORT), Ministry of Health and Family Welfare (MoHFW), ICF. *Bangladesh Demographic and Health Survey 2017–18.* NIPORT, MoHFW, and ICF; 2020. https://www.dhsprogram.com/pubs/pdf/FR344/FR344.pdf

5. Pope DH, McMullen H, Baschieri A, et al. What is the current evidence for the relationship between the climate and environmental crises and child marriage? A scoping review. *Glob Public Health*. 2023;18(1): 2095655. https://doi.org/10.1080/17441692.2022.2095655

6. Tsaneva M. The effect of weather variability on child marriage in Bangladesh. *Journal of Development*. 2020;32(8):13461359. https://doi.org/10.1002/jid.3507doi:10.1002/jid.3507

7. Alston M, Whittenbury K, Haynes A, Godden N. Are climate challenges reinforcing child and forced marriage and dowry as adaptation strategies in the context of Bangladesh? *Women's Studies International Forum*. 2014;47:137144. https://doi.org/10.1016/j.wsif.2014.08.005

8. Rahman ML, Kile ML, Rodrigues EG, et al. Prenatal arsenic exposure, child marriage, and pregnancy weight gain: associations with preterm birth in Bangladesh. *Environ Int.* 2018;112:23-32. https://doi.org/10.1016/j.envint.2017.12.004

9. Bhowmik J, Biswas RK, Hossain S. Child marrriage and adolescent motherhood: a nationwide vulnerability for women in Bangladesh. *J Environ Res Public Health*. 2021;18(8):4030. https://doi.org/10.3390/ijerph18084030

10. MacQuarrie KLD, Juan C. Trends and factors associated with child marriage in four Asian countries. *Gates Open Res*. 2019;3:1467. https://doi.org/10.12688/gatesopenres.13021.1

11. United Nations Development Programme (UNDP). *Climate Index (Draft).* UNDP; 2023. https://www.undp.org/bangladesh/publications/climate-vulnerability-index-draft

12. Alam GMM. Livelihood cycle and vulnerability of rural households to climate change and hazards in Bangladesh. *Environ Manage*. 2017;59(5):777791. https://doi.org/10.1007/s00267-017-0826-3

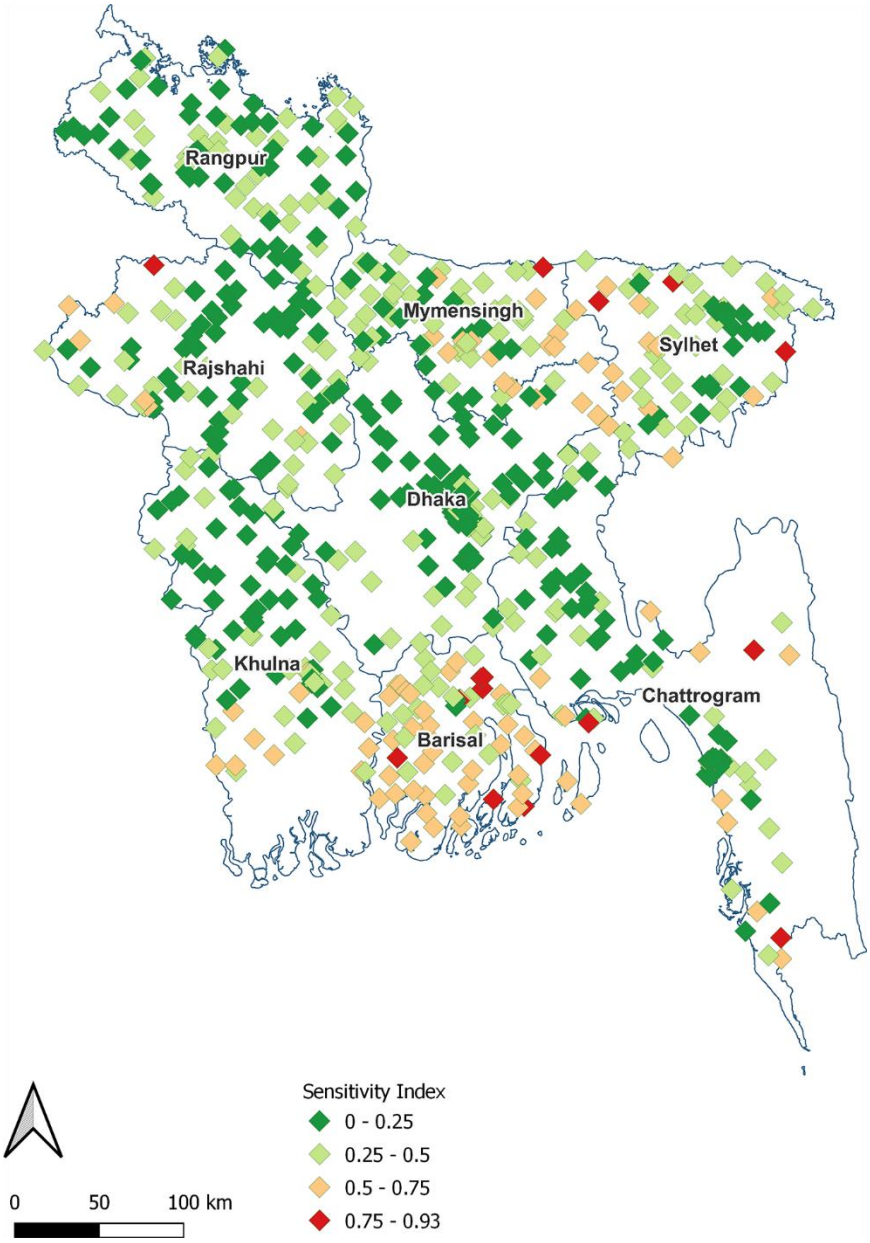
13. Pandey R, Jha S. Climate vulnerability index—measure of climate change vulnerability to communities: a case of rural Lower Himalaya, India. *Mitigation and Adaptation Strategies for Global Change*. 2012;17(5):487506. https://doi.org/10.1007/s11027-011-9338-2

14. Indian Institute of Technology (IIT) Mandi, IIT Guwahati, Indian Institute of Science (IIS) Bengaluru. *Climate Vulnerability Assessment for Adaptation Planning in India Using a Common Framework.* IIT Mandi, IIT Guwahati, and IIS Bengaluru; 2019. https://dst.gov.in/sites/default/files/Full%20Report%20%281%29.pdf

15. Mahapatra B, Chaudhuri T, Saggurti N. Climate change vulnerability, and health of women and children: evidence from India using district level data. *Intl J Obstet*. 2023;160(2):437446. https://doi.org/10.1002/ijgo.14515

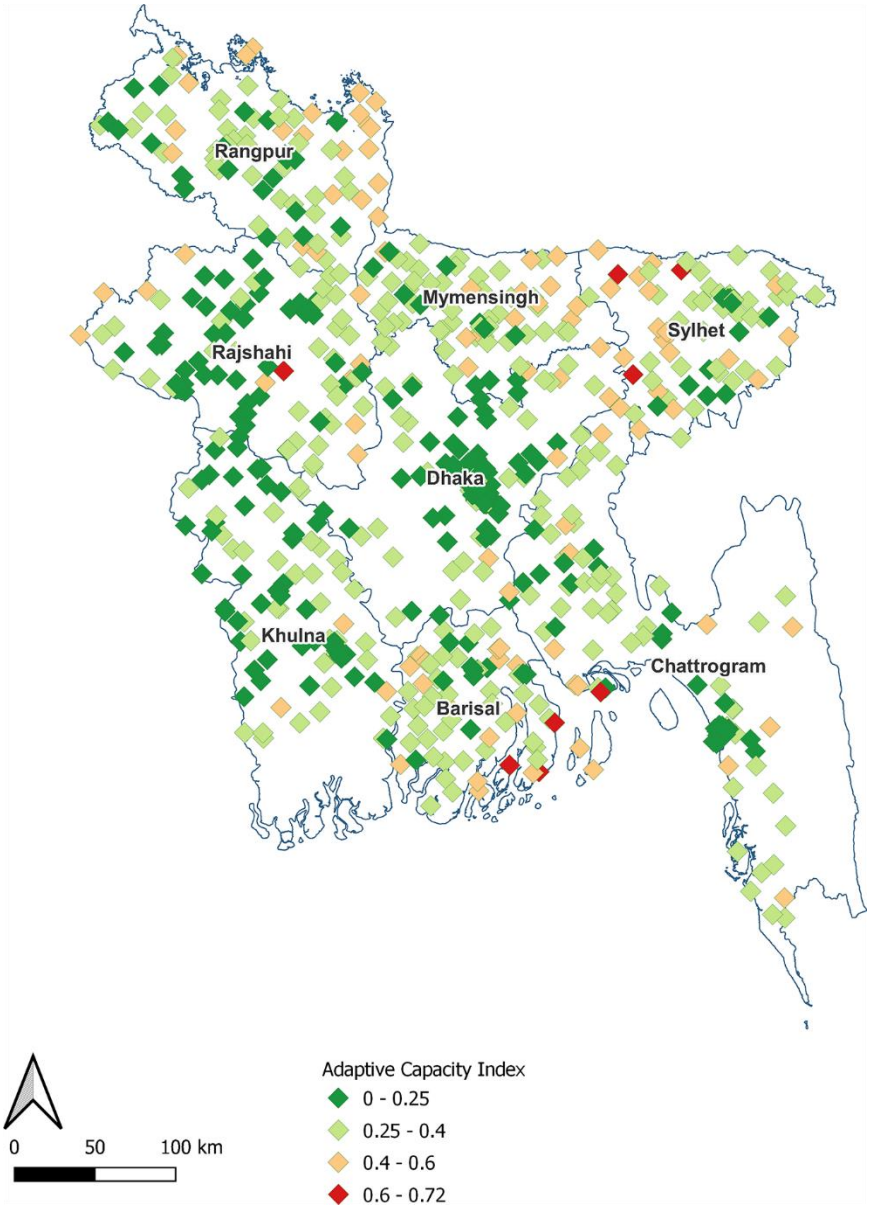
APPENDIX

Map A1 **Distribution of the sensitivity index in Bangladesh**



Source: Authors' calculation using geospatial data

Map A2 **Distribution of the adaptive capacity index in Bangladesh**



Source: Authors' calculation using geospatial data