How does the households' vulnerability to climate-induced disasters influence women's fertility outcomes and fertility intentions in Bangladesh?

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Introduction

Delineating the sophisticated nexus of climate-induced disasters and human fertility is research that falls within the area of environment or climate change and population dynamics. This is particularly concerning given that the variability in climate change and the occurrence of natural disasters are likely to be accelerating in the coming decades. To understand the vulnerability to disasters at the household level and inform approaches to adaptation and mitigation, it is also essential to take into account fertility rates, among other demographic factors (e.g., the growth rate of population, encroachment of populations, and urbanisation), in areas which are "susceptible to climate variation and extreme weather events". Therefore, this research feels the need to incorporate the effects of natural disasters (e.g., floods and cyclones) in studies of fertility in areas extremely vulnerable to frequent natural disasters.

Vulnerability is a positive function of the system's exposure, sensitivity, and negative adaptive capacity function. Vulnerability assessment reflects the social process and material outcomes within the system and identifies the factors that are somewhat sensitive to climate risks. In this study, the climate vulnerability index (CVI) proposed by Pandey and Jha (2012)[1] is adopted and extended to measure communities' vulnerability to climate change and extremes. The study aimed to understand whether households' vulnerability to climate-induced disasters influences women's fertility decision.

Research Methods

This study collects primary data of households' vulnerability to climate-induced disasters and their fertility information from 544 women of reproductive ages (15-49) through household surveys (313 and 231 from cyclone- and flood-vulnerable villages in Bangladesh, respectively). The CVI uses a framework for grouping and aggregating indicators on the spatial level, which leads to development and adaptation planning. The balanced weighted approach was used for the CVI calculation. In the CVI,

[1] Pandey R, Jha S (2012) Climate vulnerability index-measure of climate change vulnerability to communities: a case of rural lower Himalaya, India. *Mitig Ada Stra Glob Change* 17:487–506

each sub-component is assumed to contribute equally to the overall index, even though each major component is comprised of a number of sub-components. Immeasurable parameters were converted to measurable ones through indexing or simply by proportions. Each sub-component is measured on a different scale; therefore, they are first standardised through the index. Other statistical analyses include ANOVA test to show the variations of fertility outcomes and crosstabulations to show the variations of fertility intentions by households' perceived vulnerability level.

Results

Climate vulnerability index

Major components of CVI include households' socio-demographic profile, livelihood strategies, social networks, health, food, water, natural disasters and climate variability. The CVI scores for the major components are presented combined as a spider diagram (Figure 1). The spider scale ranges from 0 (less vulnerable) at the centre, increasing to 0.7 (more vulnerable) at the outside edge in 0.1 unit increments. The spider diagram shows that cyclone-affected village is more vulnerable in livelihood strategies, social network, water, and climate variability. In contrast, the flood-affected village is more vulnerable in terms of socio-demographic dimensions and natural disaster exposure. However, the health and food status were similar in both the villages despite their different physical settings of households and vulnerability to different hazards (Figure 1).

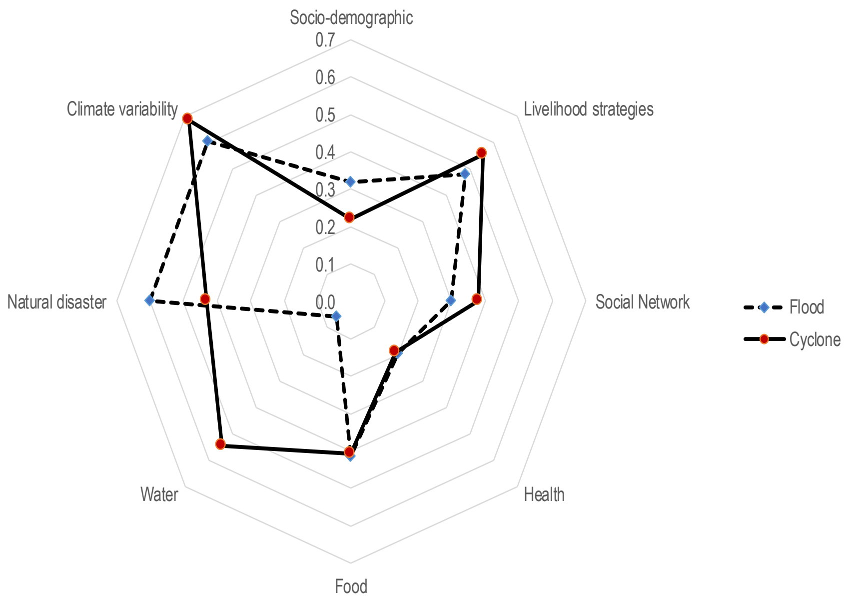

Figure 1 Spider diagram of the major components of climate vulnerability index (CVI)

It was apparent that the adaptive capacity and sensitivity of cyclone-vulnerable households was higher than flood-vulnerable households were. In contrast, the exposure realisation was higher in the flood-affected households (.603) than cyclone-affected households (.579) were. The index value of the three dimensions contributed to the CVI of the households. The higher value of CVI in both areas (.897 for the flood-affected village and .998 for the cyclone-affected village) indicates their higher vulnerability to climate change. In conclusion, cyclone-affected households were more vulnerable than flood-affected households were.

Households' Vulnerability and Current Fertility

Table 1 shows the climate vulnerability index score and fertility information in the study villages. It shows that a cyclone-affected area is more vulnerable than a flood-affected area. The fertility is higher in the flood-affected village, which is almost four children per woman. In contrast, the fertility is below the replacement level in the cyclone-affected village. Age-specific fertility shows that women had more than one child by their age of 25 in the cyclone-affected village and around two children for the flood-affected village. The mean number of children ever born (CEB) for age group 25-29 is 1.80 for the cyclone-affected village and 3.05 for the flood-affected village. Women gave birth to less than three children by their age of 35 in the cyclone-affected village, compared to four children or more for the flood-affected village. Moreover, women's total fertility rate is two times higher in the flood-affected village (5.71) than in the cyclone-affected village (2.36). Interestingly, women of 40-49 years had lower fertility than the previous two cohorts in the cyclone-affected village. In contrast, fertility increased with women's age in the flood-affected village. Similarly, a higher number of women from the flood-affected village wanted more children than from the cyclone-affected village. Fertility intention was comparatively higher for all age groups, except for 40-49 years, of women in the flood-affected village than the cyclone-affected village.

Table 1 CVI, fertility outcomes, and fertility intentions in the study villages

	Study villages	
	Flood	Cyclone
CVI score	.897	.998
Age-specific fertility (Mean CEB)		
18-24	1.79	1.32
25-29	3.05	1.80
30-34	4.09	2.49
35-39	4.78	2.65
40-49	5.71	2.36
18-49	**3.75**	**2.06**
Age-specific fertility intention (Yes, %)		
18-24	95	81
25-29	69	48
30-34	43	25
35-39	15	10
40-49	3	3
18-49	**49**	**38**

An ANOVA test was executed to understand whether there is a statistically significant difference between different vulnerable groups' mean of children ever born. There were no outliers that can impact the overall analysis, and the data was normally distributed for each group as assessed by boxplot and Shapiro-Wilk test ($p<.05$), respectively. Table 2 shows the ANOVA analysis output to understand whether there is a statistically significant difference between different vulnerable groups' mean of children ever born. The table shows that the significant value is .001 (<.05) for the cyclone-affected village, and therefore, there is a statistically significant difference in the mean number of children between the households' vulnerability ranking ($F(2, 310) = 7.222$, $p = .001$). In contrast, the value is not significant for the flood-affected village.

Table 2 Households' perceived vulnerability level to past natural hazards and current fertility (CEB)

Perceived degree of households' vulnerability to past natural hazards	Mean of children ever born			
	Flood		Cyclone	
	Mean	St. Dev	Mean	St. Dev
High	4.00	1.819	1.88	.892
Moderate	3.64	1.928	2.28	.970
Low	3.80	1.848	2.30	1.033
Test of homogeneity of variances (Levene Statistic)	p = .625		p = .140	
ANOVA test: F and p-value	F (2, *228*) = .493, p = .611, N=231		F (2, *310*) = 7.222, p = .001, N=313	

However, it is unknown which of the specific groups differed. The Tukey post hoc test can reveal the differences. A Tukey post hoc test (Table 3) revealed that the mean number of children was statistically significantly higher for 'low' (2.30 ± 1.03, p= .003) and 'medium' (2.28 ± .970, p = .024) vulnerable groups compared to the 'high' (1.88 ± .892) group in the cyclone-affected village. There was no statistically significant difference between the 'low' and 'medium' groups (p = .991). However, the difference within groups was not significant in the flood-affected village (Table 4).

Table 3 Tukey post hoc tests of multiple comparisons, cyclone-affected village

(I) Perceived degree of households' vulnerability to past natural hazards	(J) Perceived degree of households' vulnerability to past natural hazards	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Low	Medium	.021	.169	.991	-.38	.42
	High	.418*	.125	.003	.12	.71
Medium	Low	-.021	.169	.991	-.42	.38
	High	.397*	.151	.024	.04	.75
High	Low	-.418*	.125	.003	-.71	-.12
	Medium	-.397*	.151	.024	-.75	-.04

* The mean difference is significant at the 0.05 level

Dependent variable: Number of ever born children

Table 4 Tukey post hoc tests results of multiple comparisons, the flood-affected village

(I) Perceived degree of households' vulnerability to past natural hazards	(J) Perceived degree of households' vulnerability to past natural hazards	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Low	Medium	.164	.268	.814	-.47	.80
	High	-.195	.399	.876	-1.14	.75
Medium	Low	-.164	.268	.814	-.80	.47
	High	-.360	.387	.622	-1.27	.55
High	Low	.195	.399	.876	-.75	1.14
	Medium	.360	.387	.622	-.55	1.27

Dependent variable: Number of ever born children

Households' Vulnerability and Fertility Intention

This study examined the associations of households' perceived vulnerability to past natural hazards and the perception of future such vulnerability with women's fertility intention. In the flood-affected village, around half of the women of each group who perceived their households had 'moderate' and 'low' vulnerability to past natural hazards wanted to have another child in the next three years. In contrast, this happened for two-fifths of women of the 'high' vulnerability group. Succinctly, in the flood-affected village, though the associations were insignificant, a higher number of women from 'moderate' and 'low' vulnerable households wanted another child compared to the 'high' vulnerable group. The findings of the study revealed significant associations for the cyclone-affected village. The findings suggest that households' high vulnerability to past natural hazards was associated with an increase in women's fertility intention in the cyclone-affected village. More than two-thirds of women of 'moderate' and 'low' vulnerable households living in the cyclone-prone region did not want another child. In contrast, almost half of women of the 'high' vulnerable group wanted to have another (Figure 2).

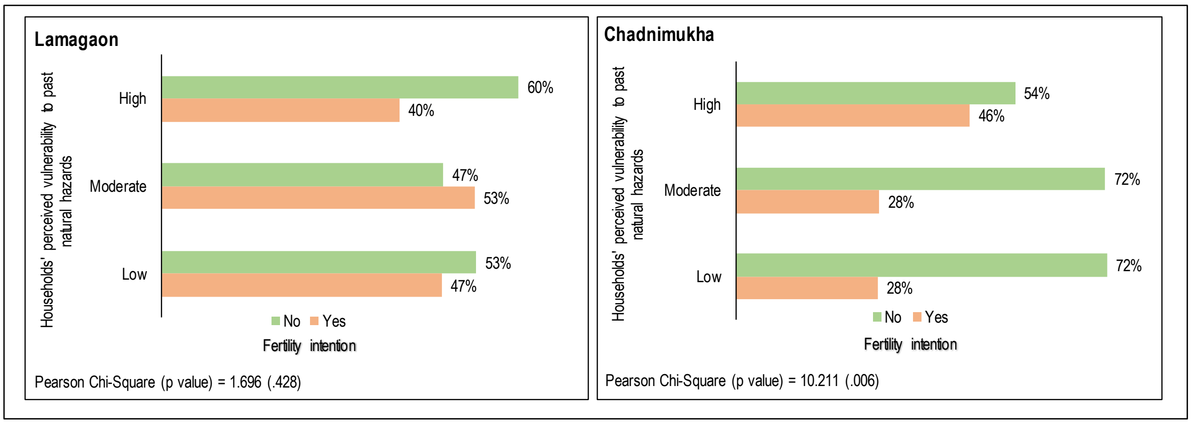

Figure 2 Households' perceived vulnerability to past natural hazards and fertility intention in flood- and the cyclone-affected villages [Lamagaon is a flood-prone area, and Chadnimukha is a cyclone-prone area]

Similarly, households' perceived vulnerability to future natural hazards could be associated with fertility intention. Figure 3 shows that the association is significant for the cyclone-affected village. However, in the flood-affected village, a higher number of women with 'high' and 'low' perceived vulnerability to future hazards had lower fertility intention than the 'moderate' group. More than half of the women of households perceiving 'moderately' vulnerable wanted another child. In the cyclone-affected village, almost half of women of 'high' vulnerable households wanted another child. However, this percentage declined for 'moderate' and 'low' vulnerable households. This finding indicates that women were more likely to have another child if they perceive their households would be highly vulnerable to future natural hazards.

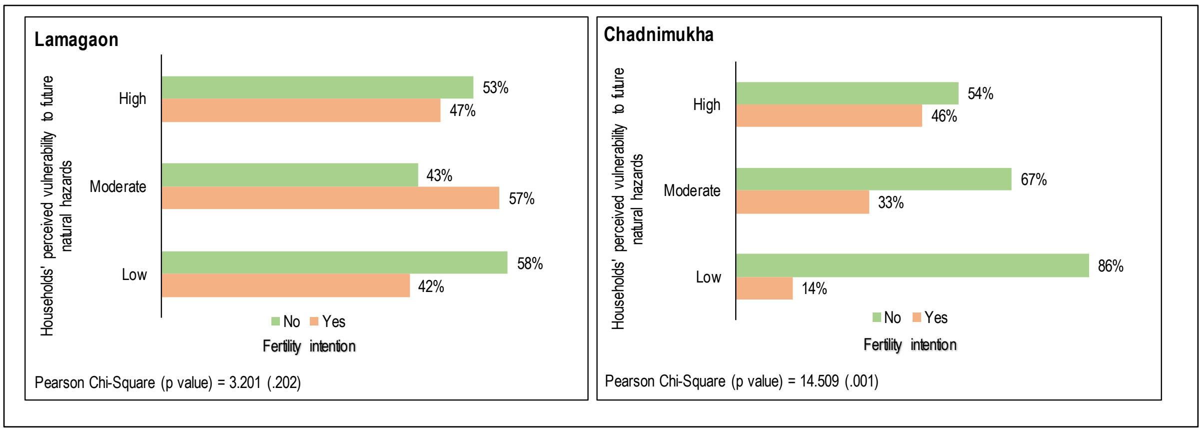

Figure 3 Households' perceived vulnerability to future natural hazards and fertility intention in flood- and cyclone-affected villages [Lamagaon is a flood-prone area, and Chadnimukha is a cyclone-prone area]

Conclusion

Understanding the vulnerability assessment of a community to climate change and extremes is an essential step toward devising and implementing effective climate adaptation measures and sustainable development. This chapter reveals that a cyclone-affected village is more vulnerable than a flood-affected village in Bangladesh. These findings provide evidence that could help policymakers develop disaster prevention measures, mitigation, and preparedness. The findings of vulnerability assessment can also be used for policy development at national and regional levels to devise carbon mitigation strategies and climate adaptation in multi-hazard-active areas.

Findings suggest that the high vulnerable households living in the cyclone-affected village had a below replacement level fertility. This means that low vulnerable households in the cyclone region had higher fertility of above-replacement level. However, the overall fertility is below replacement level in the cyclone-affected village, which is very highly vulnerable to climate change and extremes. In contrast, the fertility is far beyond the replacement level, including for different groups of vulnerable households, in the flood-affected village, which is comparatively less vulnerable than the cyclone-affected village.

Though the fertility differences between vulnerable groups were not significant, a higher level of fertility was observed among highly vulnerable flood dwellers.

Moreover, households' vulnerability was associated with women's fertility intention, particularly in the cyclone-affected village. However, the overall fertility intention was higher in the flood-affected village than the cyclone-affected village. Fertility intention was consistently higher for women who perceive their households were highly vulnerable to past cyclones, and it will be the same in future cyclones, compared to their counterparts of 'moderate' and 'low' vulnerable households. In the flood-affected village, additional child preference was consistently higher for the 'moderate' group than the 'low' and 'high' group. Overall, it can be suggested that intending to have additional children may be a demographic adjustment for highly vulnerable households to the adverse effects of the cyclone.

This research findings have implications for comprehensive disaster management and family planning programs in Bangladesh. Findings of high fertility of low vulnerable households in the cyclone region and high vulnerable households in the flood region suggest immediate attention of family planning programs to address the issue in the short-term and long-term in bringing the fertility below the replacement level. Findings confirm that different hazards could have differential effects on households, including but not limited to its effect on fertility. Hazard specific multi-sectoral disaster management plans could be devised for disaster risk reduction in Bangladesh. Collaboration of multi-sectors such as the disaster management and family planning program can be fruitful to address the fertility issues in areas vulnerable to climatic hazards.