SOCIAL DIMENSIONS OF VULNERABILITY TO FLOODING IN GREATER ACCRA METROPOLITAN AREA, GHANA

Introduction

Flooding poses a significant global challenge, affecting over 2.2 billion people worldwide. However, the impact of floods is not distributed equally. Socially vulnerable populations, especially those living in low-resource settings, face disproportionate risks. In Greater Accra Metropolitan Area (GAMA), Ghana, these risks are magnified by a combination of biophysical and social vulnerabilities. While GAMA is frequently affected by floods due to its geography, it is the socioeconomic and demographic characteristics of its population such as age, education, wealth, and social networks that exacerbate vulnerability. A critical gap persists in understanding how social factors intersect with biophysical risks to increase flood vulnerability. This research addresses the urgent need to examine the demographic, socioeconomic, and adaptive factors that contribute to social vulnerability in GAMA. The research aims to explore how demographic and socioeconomic factors—such as age, gender, education, wealth, and social support networks—interact with GAMA's biophysical environment to increase or reduce flood vulnerability

Methods

This study utilized secondary data from the 2018 "Cities and Climate Change" Survey. The dependent variable, "social vulnerability," was constructed by aggregating responses from multiple variables related to physical damage to assets, financial impact, school attendance, health, and relocation due to flooding. This aggregation involved summing and recoding variables to capture various dimensions of social vulnerability.

ANOVA and correlation analysis were used to examine relationships between the dependent variable and various independent variables like age and household size. Poisson regression was chosen as the method for multivariate analysis. This allowed for a deeper understanding of how factors like wealth, education, and flood experience influence social vulnerability. The Poisson regression model not only helped to quantify these relationships but also provided insights into the incidence rate of vulnerability in households affected by flooding.

Results and Findings

The Poisson regression model, which analyzed 544 observations, demonstrated a statistically significant fit with a likelihood ratio chi-square of 93.44 ($p < 0.01$) and a log likelihood of -793.0787. This indicates that the model effectively captures the relationship between the predictors and social vulnerability.

Key Findings:

1. **Household Head Characteristics:**
   - **Age:** The age of the household head significantly predicts social vulnerability, with a p-value of 0.014. The relationship exhibits a U-shape, with vulnerability decreasing until around age 45, after which it increases. Specifically, a one-unit increase in age results in a 4.12% increase in social vulnerability.
   - **Education:** Household heads with tertiary education are 57.63% less likely to experience social vulnerability compared to those with no education ($p = 0.003$).

- **Religion:** Household heads identifying as "Other" religions are 74.56% more likely to be socially vulnerable compared to Christians ($p < 0.01$).

2. **Wealth:** The wealth index, derived from PCA, shows that households in the middle-income category experience a 17.41% decrease in social vulnerability compared to the poor ($p = 0.040$). No significant difference was observed between the rich and poor.
3. **Social Support:** Households that received support during flooding are 54.05% more likely to be socially vulnerable compared to those that did not receive support ($p < 0.001$).
4. **Early Warnings:** Receiving early warnings about floods increases social vulnerability by 21.99% ($p = 0.020$).
5. **Flood Prediction:** Households able to predict floods are 40.05% more likely to be socially vulnerable compared to those unable to predict floods ($p < 0.001$).
6. **Non-significant Variables:** The variables for elevation of entrance and household size did not show statistically significant effects on social vulnerability.

Interpretation and Novel Insights:

- **Age:** The U-shaped relationship is novel, indicating that social vulnerability decreases in younger age groups but increases again as individuals age beyond 45. This suggests that older household heads may face unique vulnerabilities.
- **Religion and Education:** The significant effects of religion and education highlight disparities in vulnerability across different groups. Specifically, non-Christians and those with lower education levels are more vulnerable.
- **Wealth and Support:** The findings on wealth and social support provide new insights into how economic status and assistance during floods impact vulnerability. Interestingly, receiving support and early warnings were associated with higher vulnerability, which could imply that the support may not always be adequate or effectively targeted.

Discussion and Implications

The study's findings highlight critical aspects of social vulnerability to flooding in the Greater Accra Metropolitan Area (GAMA), providing nuanced insights into the complex interplay of socio-economic and demographic factors. The results underscore that social vulnerability is not merely a product of immediate flood impacts but is deeply intertwined with underlying socio-economic conditions and adaptive capacities.

First and foremost, the study reveals that wealth, education, and social support are significant determinants of social vulnerability. Contrary to initial expectations, middle-income households exhibited lower vulnerability compared to poor households. This suggests that while the affluent may endure substantial losses, their resources and networks enable quicker recovery. In contrast, the poor face prolonged recovery challenges due to inadequate resources and inferior housing conditions. This finding aligns with the literature suggesting that wealth disparities significantly impact flood resilience (Flanagan et al., 2011; Cutter et al., 2012).

Again, the protective role of higher education in reducing social vulnerability is consistent with previous research, indicating that educational attainment enhances flood preparedness and

recovery capabilities (Rufat et al., 2015; Chen et al., 2013). Similarly, the study highlights that Christian household heads experience lower social vulnerability compared to those of other religions. This may be attributed to the robust social support systems prevalent in Christian communities (Garnier, 2019; Taylor & Peace, 2015).

To add up, the paradoxical finding that households receiving early warnings and those able to predict floods exhibit higher social vulnerability calls for further examination. It suggests that early warnings and predictive capabilities might be associated with heightened awareness of flood risks, potentially leading to increased stress or inadequate preparation (Babcicky & Seebauer, 2021; Alvalá et al., 2019). This underscores the need for more effective communication strategies and preparedness measures to mitigate stress and enhance resilience.

Finally, the significant relationship between social support and vulnerability indicates that while support systems are vital, the type and timing of support received can influence vulnerability outcomes. The study suggests that both formal and informal support systems play roles in recovery, with the potential for delays in formal support affecting the speed of recovery (Yang et al., 2010).

To conclude, the study advances our understanding of social vulnerability by highlighting the intersection of education, religion, and socio-economic status with flood risk. This nuanced perspective enriches the existing literature by illustrating that social support and flood prediction are not always straightforward indicators of vulnerability but rather reflect complex, context-specific dynamics.

Conclusion

This study provides valuable insights into the socio-economic and demographic factors influencing social vulnerability to flooding in the Greater Accra Metropolitan Area (GAMA). The findings reveal that wealth, education, and religion significantly impact vulnerability, while the roles of early warnings and social support systems present a complex picture of flood resilience. The study underscores the importance of considering both traditional and non-traditional factors in flood risk management and highlights the need for targeted interventions that address the specific vulnerabilities of different socio-economic and demographic groups.

The key takeaway is that understanding and addressing social vulnerability requires a multifaceted approach that considers not only immediate flood impacts but also underlying socio-economic conditions and adaptive capacities. Effective flood management strategies should integrate education, enhance social support systems, and improve communication and preparedness measures. By addressing these factors, policymakers and practitioners can develop more comprehensive and effective strategies to reduce social vulnerability and build resilience in urban settings like GAMA.

Future research should explore the role of trust in early warning systems and its interaction with socio-demographic factors in influencing flood preparedness and vulnerability. Additionally, categorizing social vulnerability into different levels could provide more targeted insights for flood risk management and resilience-building efforts.

Table: Poisson Regression of overall model Effect

Number of observations = 554 LR chi2(20) =93.44

Prob > chi2 = <0.01 Pseudo R2 =0.0556 Log likelihood = -793.0787

Social Vulnerability	IRR	P-value	95% Confidence Interval		Significance
			Lower	Upper	
Age					
Age of HH head	1.0412	0.014	1.0081	1.0755	**
Age of HH head square	0.9996	0.008	0.9992	0.9999	***
Religion					
Christianity (R.C)	1				
Muslim	1.0378	0.828	0.7427	1.4500	
Others	1.7456	0.001	1.2437	2.4499	***
Education					
No education (R.C)	1				
primary	0.9592	0.792	0.7034	1.3080	
Junior	0.8880	0.370	0.6850	1.1510	
Secondary	0.8997	0.478	0.6718	1.2049	
Tertiary	0.5763	0.003	0.3992	0.8320	***
Wealth					
Poor (R.C)	1				
Middle	0.8259	0.040	0.6881	0.9915	**
Rich	0.9572	0.526	0.8007	1.1443	
Social support					
No support received (RC)	1				
Received support	1.5293	<0.001	1.2565	1.8614	***
Early warnings					
No information (R.C)	1				
Received information	1.2199	0.020	1.0323	1.4415	
Prediction of flood					
Unable to predict (R.C)	1				
Able to predict	1.4005	<0.001	1.2101	1.6208	***
Elevation of household					
Less than a block (R.C)	1				
1 block	0.9249	0.436	0.7598	1.1258	
2 blocks or more	0.8830	0.189	0.7333	1.0632	
Household size					
1(R.C)	1				
2	0.8354	0.098	0.6751	1.0337	
3	0.126	0.308	0.7655	1.0879	
4	0.9820	0.877	0.4702	2.4194	
5	1.0665	0.805	0.6647	1.6918	
6+	1.0604	0.460	0.8044	1.6177	
_cons	0.6432	0.282	0.2879	1.4371	

Asterisks indicate significant levels: ** implies significant at 5%; *** implies significant at 1%