# Exploring differentiated nature of livelihood vulnerability in the context of climate change: An Intersectional Analysis of Flood-Prone Areas in Bangladesh

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# Problem Statement

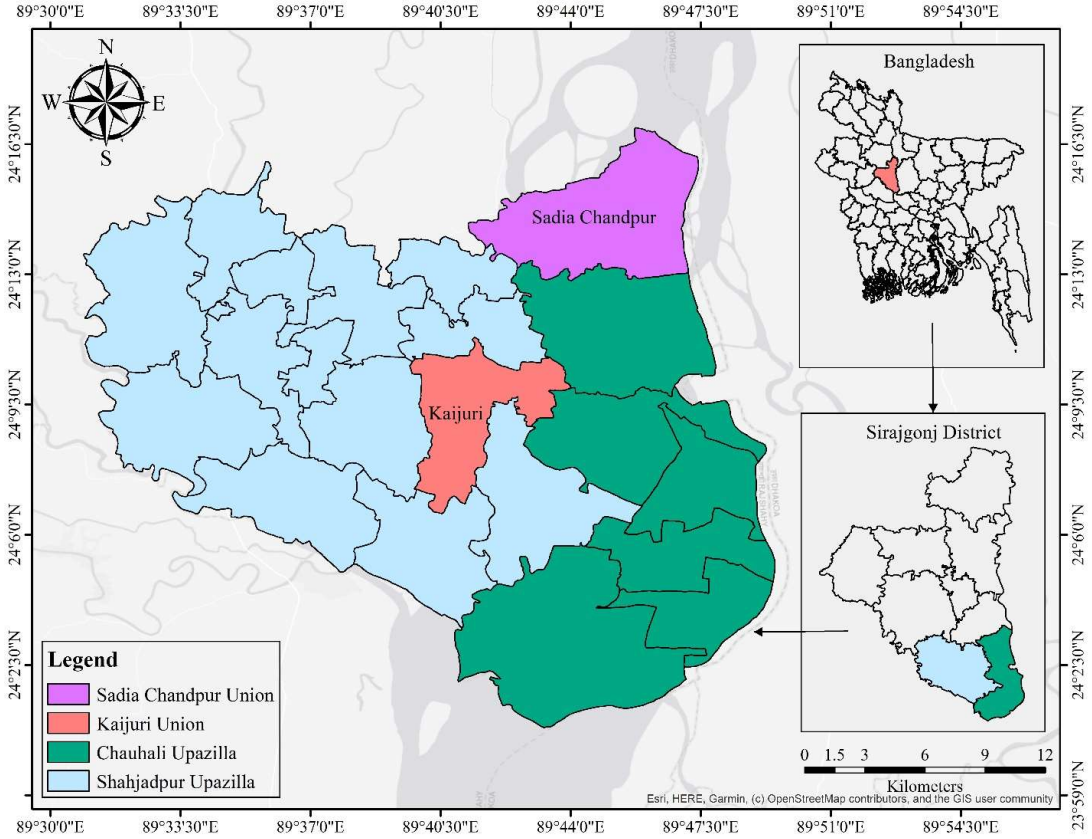
Introduction

- The intersectional theory primarily concerns how the exercise of power, through intersecting domination and oppression, affects individuals who face multiple social inequities, consequent multiple marginalisation [1]. It has been applied to, e.g., sustainable development [1], climate change vulnerability [2], and human rights [3].
- Within the vulnerability realm, the intersectional perspective illuminates how multiple social differences create differential vulnerability in responses to hazards and crises [1,2].
- Therefore, the central focus of this research is to identify these intersectional perspectives of climate change vulnerability based on a case study of a flood-prone area in Bangladesh.
- The findings will be instrumental for planners, administrators, decision-makers, and disaster managers in identifying vulnerability to climate change through different lenses and acting accordingly to achieve optimal outcomes.

# Study Area

Research Strategy

- The Sadia Chandpur Union and Kaijuri Union of the Sirajgonj District were selected as this research's case study site.
- These unions are situated in the riverine islands of the Jamuna River, which are susceptible to different climate-induced hazards.
- It experiences floods and river erosions almost every year.
- Moreover, because of the remote geographical location of this area, it experiences extreme poverty that makes the people more vulnerable and less resilient to different climatic shocks.



# Determining Sample Size

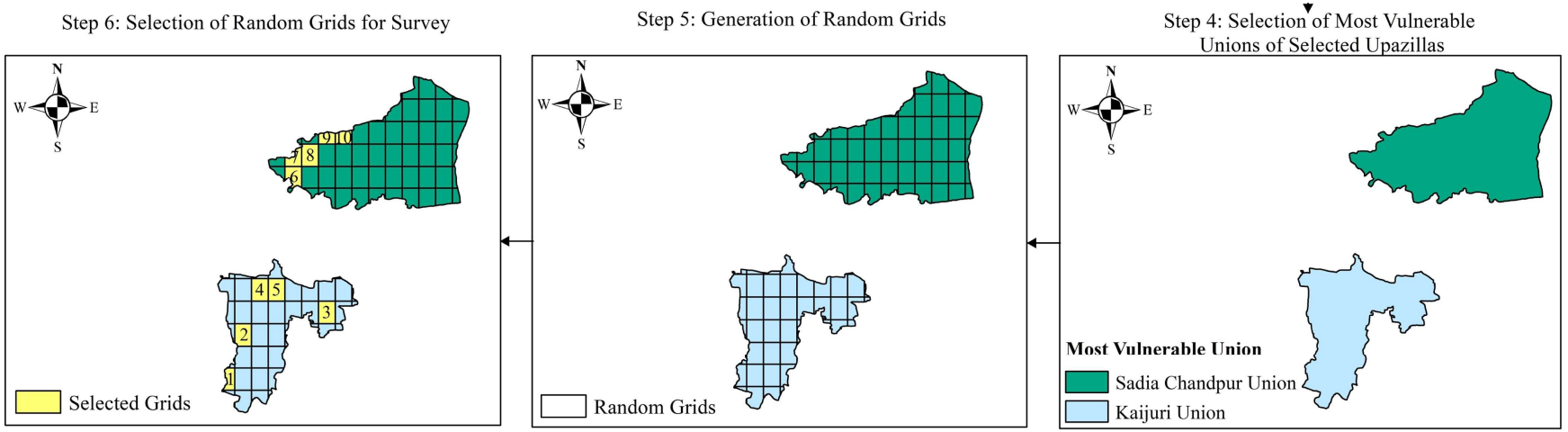


This research adopted Cochran's (1977) formula for identifying the sample size;

$$n = \frac{Z^2 p(1-p)}{e^2}$$

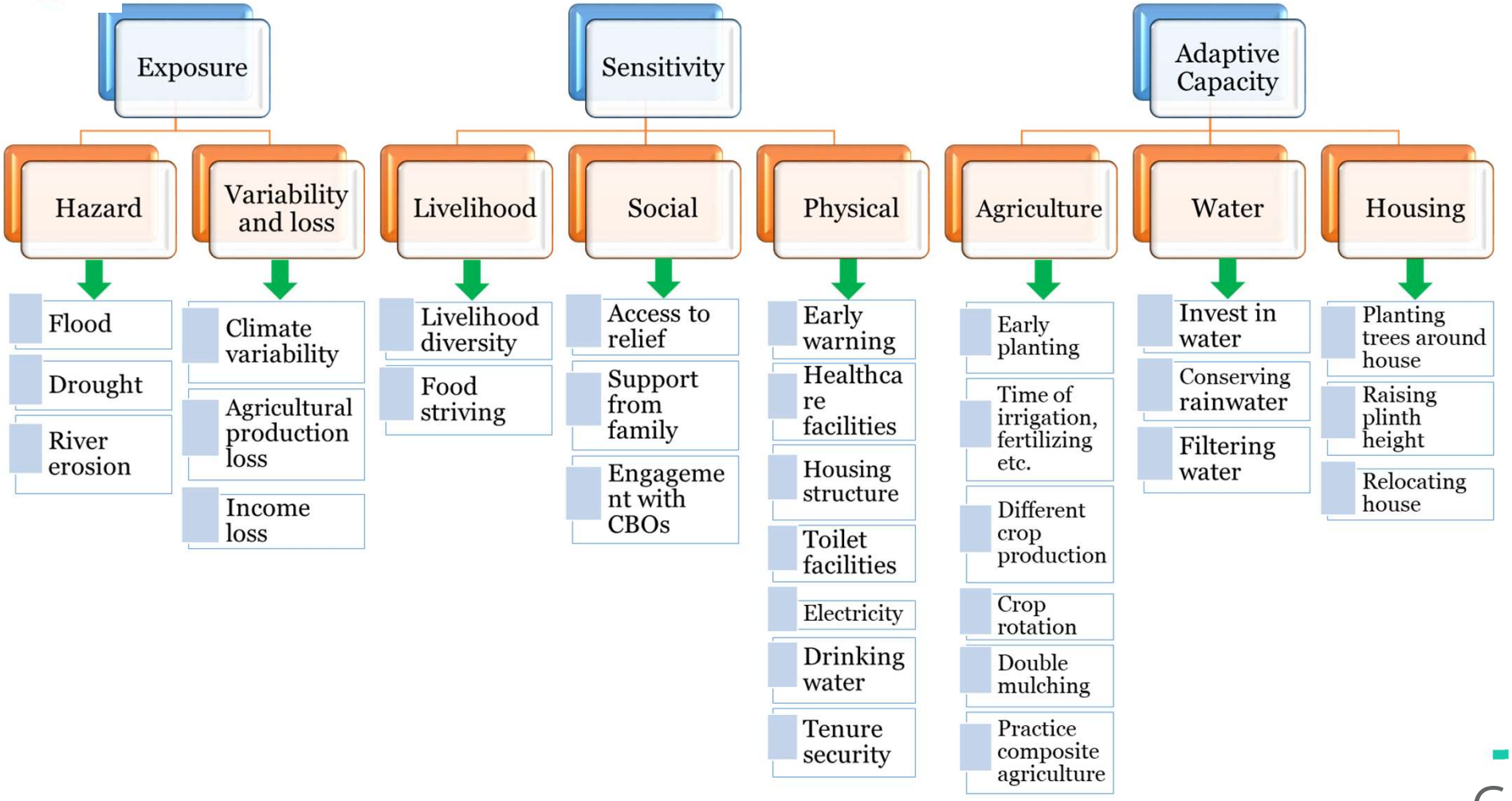
Where, n= sample size; $Z$= Z score; $p$= sample proportion, and e= error margin. Considering a 95% confidence level with an error margin of 5% and a sample proportion of 50%, the obtained sample size is 384 households.

# Sample Distribution Technique




Research Strategy

# Indicators of Livelihood Vulnerability Index (LVI)




Research Strategy

# Construction of Livelihood Vulnerability Index (LVI)

**Eq. (1)** has been used for indicators that have a positive functional relationship with vulnerability.

**Eq.** has been used for the indicators that have a negative functional relationship with vulnerability.

$$Index\ V_x = \frac{V_x - V_{min}}{V_{max} - V_{min}} \qquad (1)$$

$$Index\ V_x = \frac{V_{max} - V_x}{V_{max} - V_{min}} \qquad (2)$$

*where IndexVx is the normalized index value, and Vx is the original value of the indicator for household X. Vmax* and *Vmin* are the maximum and minimum values of the indicator at the household level.

Once each indicator was standardized, the value of the sub-dimensions was calculated through **Eq. (3)**.

$$SD_x = \frac{\sum_{i=1}^{n} Index\ V_x i}{n} \qquad (3)$$

*where, SDx is the value of one of the sub-dimensions of vulnerability for household X, (which are Hazard, Variability and loss, Livelihood, Social, Physical, Agriculture, Water, and Housing), IndexVxi is the standardized value of ith indicator under the respective sub-dimension for household X, and n is the number of indicators under that sub-dimension.*

# Construction of Livelihood Vulnerability Index (LVI)

In step 3, upon calculating the value of the sub-dimensions for each household, we compute the value of dimension using **Eqs. (4), (5) and (6).**

$$Exposure = \frac{(Hazard \times W_{Hazard}) + (Variability\ and\ loss \times W_{Variability\ and\ loss})}{W_{Hazard} + W_{Variability\ and\ loss}} \quad 4$$

$$Sensitivity = \frac{(Livelihood \times W_{Livelihood}) + (Social \times W_{Social}) + (Physical \times W_{Physical})}{W_{Livelihood} + W_{Social} + W_{Physical}} \quad 5$$

$$Adaptive\ Capacity = \frac{(Agriculture \times W_{Agriculture}) + (Water \times W_{Water}) + (Housing \times W_{Housing})}{W_{Agriculture} + W_{Water} + W_{Housing}} \quad 6$$

Where, *Exposure, Sensitivity* and *Adaptive Capacity* are the values of these mentioned dimensions respectively for each household. Additionally, *Hazard, Variability and loss, Livelihood, Social, Physical, Agriculture, Water* and *Housing* are the values of these mentioned sub-dimensions respectively and $W_{Hazard}$, $W_{Variability\ and\ loss}$, $W_{Livelihood}$, $W_{Social}$, $W_{Physical}$, $W_{Agriculture}$, $W_{Water}$ and $W_{Housing}$ are the weight of these respective sub-dimensions.

Finally, the value of the livelihood vulnerability index (LVI) is calculated using Eq (7).

$$LVI = \frac{(Exposure \times W_{Exposure}) + (Sensitivity \times W_{Sensitivity}) + (Adaptive\ Capacity \times W_{Adaptive\ Capacity})}{W_{Exposure} + W_{Sensitivity} + W_{Adaptive\ Capacity}} \quad 7$$

Where, for Eq. (7), *LVI* is the value of livelihood vulnerability index for each household. *Exposure, Sensitivity* and *Adaptive Capacity* are the value of these mentioned dimensions respectively and $W_{Exposure}$, $W_{Sensitivity}$ and $W_{Adaptive\ Capacity}$ are the weights of these respective dimensions.

Research Strategy

# Analytical Hierarchy Process (AHP) for Weight

- We used an analytical hierarchy process (AHP) (Saaty 1980) to calculate the livelihood vulnerability index.
- Step 1, the AHP starts creating a pairwise comparison matrix on a scale of 1–9 based on the experts' responses, in which 1 refers to equally important factors and 9 indicates the extreme importance of a factor over another.
- Step 2, is related to normalizing the comparison matrix, and the normalized matrix is generated by totaling the value of each column of the comparison matrix and then dividing each entry of a column by the sum of that column.
- After normalization of each column through the same process, the sum of each matrix column must EQ. 1.
- Step 3, the consistency ratio (CR) is measured to evaluate the consistency of experts' judgments. CR>0.10 indicates the comparison matrix has an unacceptable consistency. Thus, it must be iterated or revised until CR< 0.1.

# Indicators to Analyze Intersectionality

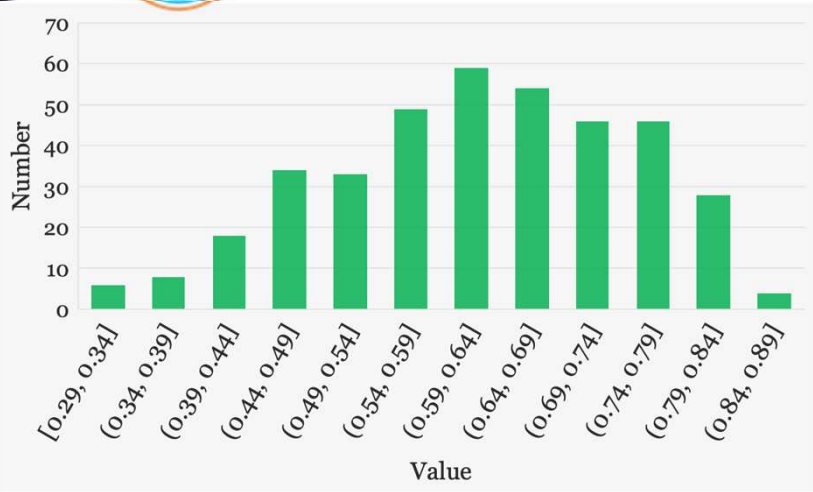
Research Strategy

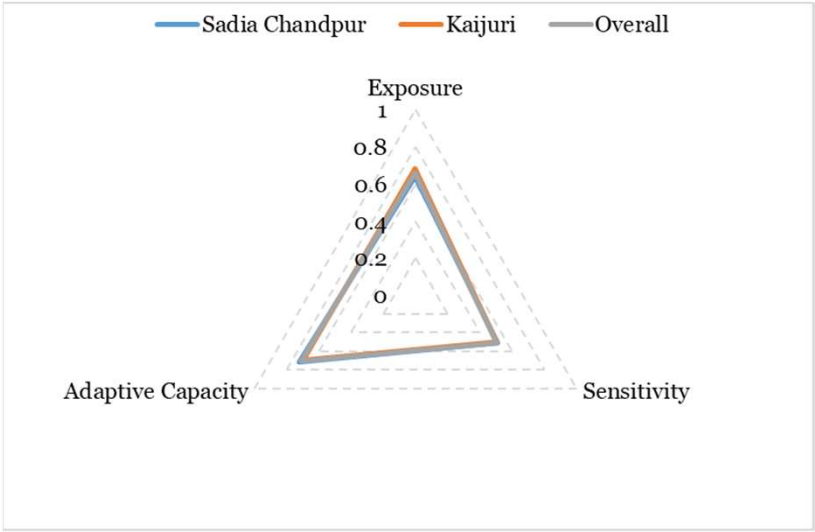
| Indicators | Category |
|---|---|
| **Geography** | *Char (River island)* |
| | *Non-Char* |
| **Occupation** | *Agricultural* |
| | *Non- agricultural* |
| **HH Income** | *<10,000* |
| | *10,000-20,000* |
| | *>20,000* |
| **Education of HHH** | *Primary* |
| | *Secondary* |
| | *Higher* |
| **No. of earning member** | *<2* |
| | *2-3* |
| | *>3* |
| **Formal employment** | *Without formal employment* |
| | *With formal employment* |
| **Savings** | *Without saving* |
| | *With saving* |

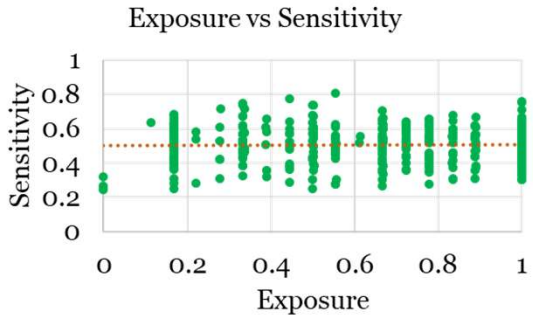
| Indicators | Category |
|---|---|
| **Asset Value** | *<20,000* |
| | *20,000-50,000* |
| | *>50,000* |
| **Safety nets** | *Without safety net* |
| | *With safety net* |
| **Sex ratio** | *<1* |
| | *1-2* |
| | *>2* |
| **Household size** | *<4* |
| | *4-5* |
| | *>5* |
| **No. of dependent** | *<2* |
| | *2-3* |
| | *>3* |
| **Disability** | *With disable* |
| | *Without disable* |

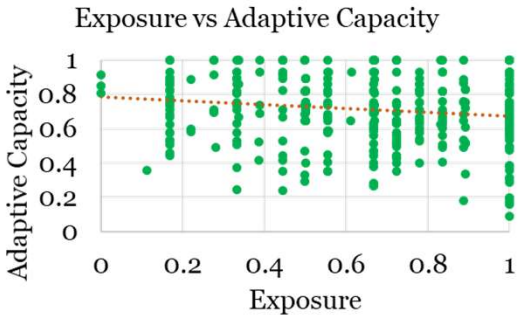
# Dynamics of Livelihood Vulnerability

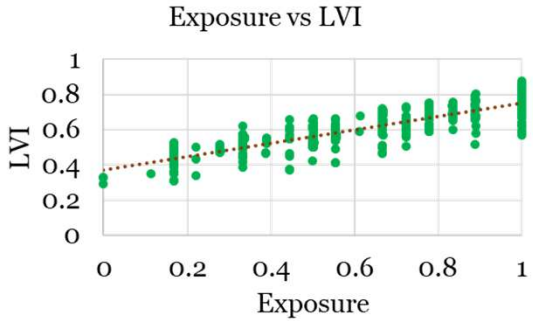
Results and Discussion

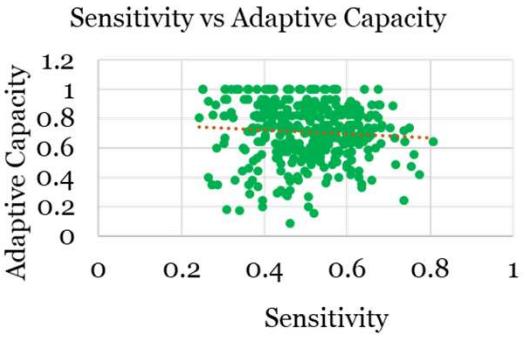


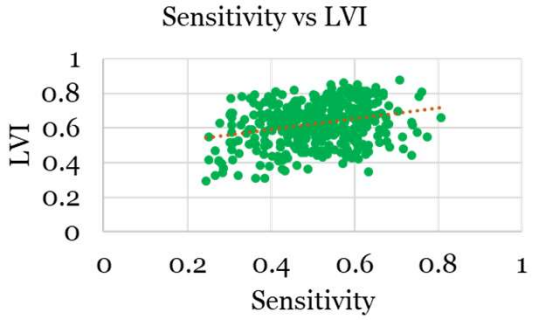



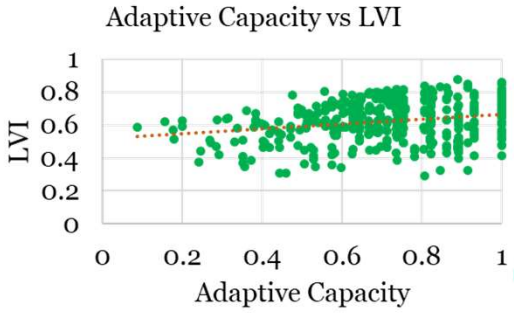



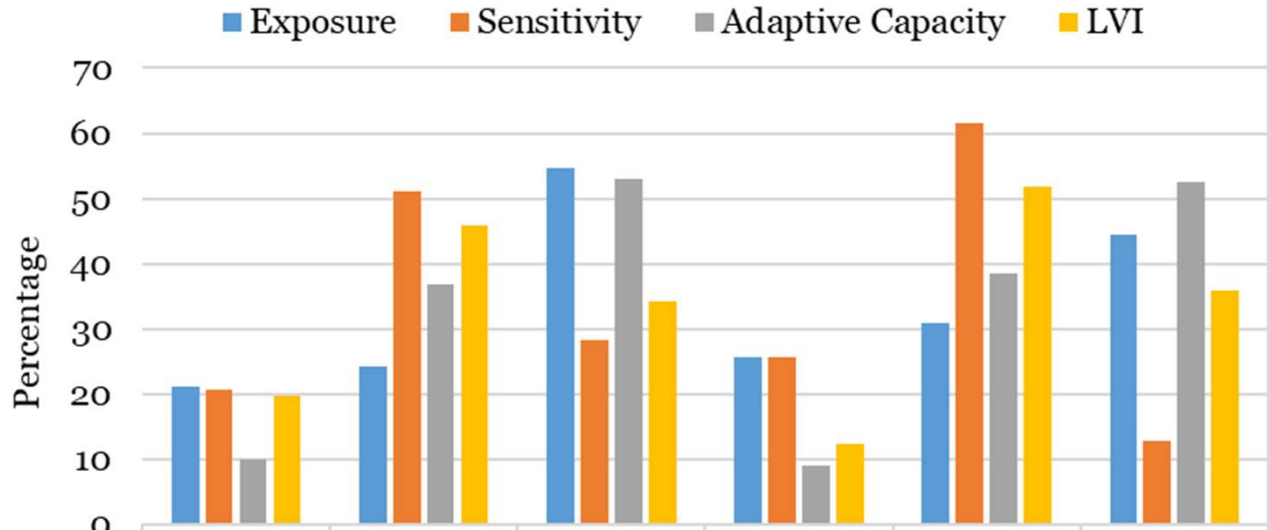



# Percentage Under Different Vulnerability Category




| | Sadia Chandpur | | | Kaijuri | | |
|---|---|---|---|---|---|---|
| | Low | Moderate | High | Low | Moderate | High |
| Exposure | 21.21 | 24.24 | 54.55 | 25.67 | 31.02 | 44.39 |
| Sensitivity | 20.71 | 51.01 | 28.28 | 25.67 | 61.50 | 12.83 |
| Adaptive Capacity | 10.10 | 36.87 | 53.03 | 9.09 | 38.50 | 52.41 |
| LVI | 19.70 | 45.96 | 34.34 | 12.30 | 51.87 | 35.83 |

# Household Vulnerability Vs Intersectionality



**Major Findings:**

The results are evident that the mean of households' livelihood vulnerability varies among different intersectional groups. The difference is significant in terms of their:

- *Geographical location****
- *HH Income****
- *Education of HHH****
- *Formal employment**
- *Asset value****
- *Safety nets***
- *Household size****
- *No. of dependent****
- *Disability**

The p-values are used to assess the statistical significance of the observed differences or relationships within each intersectionality indicator and household vulnerability, with significance levels denoted as *** ($p \leq 0.001$), ** ($p \leq 0.01$), and * ($p \leq 0.05$).

# Intersectionality vs Different Vulnerable Groups

**Table:** Chi-square Test for Understanding Intersectionality Differential within Vulnerability Category (Continued...).

| Indicators | Category | Vulnerable Groups | | | Chi-Square (P value) | Cramer's V |
|---|---|---|---|---|---|---|
| | | Low | Moderate | High | | |
| Geography | Char | 15 (3.9%) | 106 (27.5%) | 124 (32.2%) | $\chi^2(2)=92.40$ (0.000***) | .490 |
| | Non-Char | 47 (12.2%) | 82 (21.3%) | 11 (2.9%) | | |
| Note: * Significant at p ≤ 0.05, ** Significant at p ≤ 0.01, *** Significant at p ≤ .001 | | | | | | |

Occupation, HH Income, Education of HHH, No. of earning member, Formal employment, Savings, Asset value, Safety nets, Sex ratio, Household size, No. of dependent, Disability

Most of the indicators are **highly correlated with the vulnerability progression** such as:

- Geographical location*** (0.490),
- Household income*** (0.383),
- Education*** (0.495),
- No. of earning member*** (0.418),
- Household size*** (0.498),
- No. of dependent*** (0.450)

# Extent of Influence of Intersectionality on Livelihood Vulnerability

**Table:** Extent of Influence of Intersectionality on Livelihood Vulnerability.

| Indicators | | Estimate | Odds Ratio | Wald | S.E | Sig. |
|---|---|---|---|---|---|---|
| Threshold | LVI=1 | -14.999 | 0.000 | 78.527 | 1.693 | .000 |
| | LVI=2 | -8.322 | 0.000 | 35.717 | 1.393 | .000 |
| Geography | | -1.678 | 0.187 | 22.721 | .352 | **.000**** |
| Occupation | | -1.821 | 0.162 | 16.944 | .442 | **.000**** |
| HH Income | | -1.416 | 0.243 | 36.545 | .234 | **.000**** |
| Education of HHH | | -2.012 | 0.134 | 38.981 | .322 | **.000**** |
| No. of earning member | | -2.066 | 0.127 | 29.917 | .378 | **.000**** |
| Formal employment | | -3.079 | 0.046 | 39.343 | .491 | **.000**** |
| Savings | | -.932 | 0.394 | 7.729 | .335 | **.005*** |
| Asset Value | | -.902 | 0.406 | 20.817 | .198 | **.000**** |
| Safety nets | | -.908 | 0.403 | 9.231 | .299 | **.002*** |
| Sex ratio | | -.171 | 0.843 | .394 | .272 | .530 |
| Household size | | 1.972 | 7.184 | 32.485 | .346 | **.000**** |
| No. of dependent | | .562 | 1.754 | 2.640 | .346 | .104 |
| Disability | | .719 | 2.052 | 3.090 | .409 | .079 |

Note: Bold values are used to highlight the significant factors/variables and their statistics.
$\chi^2$ (13): 456.43, p=.000, $p \leq 0.05$
Pseudo- $R2$ (Nagelkerke): 0.800
Test of Parallel Lines: (13): 18.78, p=.536, $p \geq 0.05$
* Significant at $p \leq 0.01$, ** Significant at $p \leq .001$

# Extent of Influence of Intersectionality on Livelihood Vulnerability

- The predictive power of the model is significant (**Pseudo-$R^2$ (Nagelkerke)= 0.80, $p \leq 0.05$**).
- It means the **model is statistically 80% successful** while predicting the livelihood vulnerability of the household based on their intersectionality dynamics.
- The result of the **ordinal logistic regression** evident that all the indicators of intersectionality have a significant influence to define household vulnerability except sex ratio, number of dependent, and disability.
- The results reflect that the **chance of being in a highly vulnerable groups** are **increased** if
    - *The household is living in the Char area* ***(Odds Ratio: 0.187***)***
    - *The household's main occupation is agriculture* ***(Odds Ratio: 0.162***)***
    - *The household have low income* ***(Odds Ratio: 0.243***)***
    - *The household have lack of higher education* ***(Odds Ratio: 0.134***)***
    - *The household have small number of earning members* ***(Odds Ratio: 0.127***)***
    - *The household do not have formal employment* ***(Odds Ratio: 0.046***)***
    - *The household have lack of savings* ***(Odds Ratio: 0.394**)***
    - *The household have low asset holding* ***(Odds Ratio: 0.406***)***
    - *The household have low access to social safety nets* ***(Odds Ratio: 0.403**)***

# Policy Implications

- **Tailored Interventions:** Policymakers can design interventions that address the specific needs and challenges faced by different social groups. By considering intersecting identities such as gender, age, ethnicity, and socioeconomic status, policies can be more targeted and effective in reducing vulnerability.

- **Equitable Resource Allocation:** An intersectional perspective can inform resource allocation to ensure that vulnerable communities receive adequate support. Policies can prioritize resources for communities facing multiple forms of marginalization, such as those with low-income, disabilities, or limited access to healthcare.

- **Inclusive Decision-Making Processes:** Policymakers can adopt inclusive decision-making processes that involve diverse stakeholders representing various intersecting identities. This ensures that the voices and concerns of marginalized groups are heard and integrated into policy formulation and implementation.

- **Addressing Root Causes of Vulnerability:** Intersectionality highlights the underlying structural inequalities and power dynamics that contribute to vulnerability. Policies can aim to address these root causes by promoting social justice, economic empowerment, and equitable access to resources, education, and healthcare.

# Conclusion

- Integrating intersectionality into policy frameworks ensures that considerations of multiple social identities and their interactions are systematically incorporated into climate change adaptation and mitigation strategies.
- This helps avoid one-size-fits-all approaches and promotes more holistic and context-specific solutions.
- This research can support capacity-building initiatives and awareness campaigns that promote understanding of intersectionality among policymakers, practitioners, and communities.
- This fosters a more nuanced understanding of vulnerability and encourages empathy, solidarity, and collaboration in addressing climate change impacts.
- Policymakers can prioritize data collection and research efforts that capture the intersectional dimensions of vulnerability.
- This includes disaggregating data by various social identities and conducting intersectional analyses to better understand the differential impacts of climate change and inform evidence-based policy decision-making.

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# Thank you

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