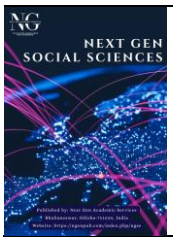

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Climate Vulnerability, Community Resilience, and Social Justice: A Multilevel Analysis

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ABSTRACT

Climate change is an environmental, socio-economic and ethical issue that exacerbates inequality in terms of income, gender, ethnicity and geography. People's vulnerability to climate hazards depends on exposure, adaptive capacity, and institutional support. This paper presents a mixed-methods approach to a multilevel analysis of climate vulnerability, social justice, and climate resilience, incorporating global vulnerability indices, community-based case studies, and qualitative literature. The data presented by the IPCC, the World Bank, the UNDP and ND-GAIN are combined with field cases from Bangladesh, Nicaragua and Australia. The results show that almost 3.3–3.6 billion people are in very climate-vulnerable situations, and that mortality rates from floods, droughts, and storms in vulnerable regions are 15 times higher than in low-risk regions. SIDST contributes just 0.2% of the global emissions but experiences disproportionate damage. Another 158 million women and girls will also be pushed into poverty by 2050 due to climate change. Community-based adaptation, such as Anticipatory Evacuation, Agro-ecological learning and Urban heat resilience programs, have been shown to have an important impact on climate risks and social resilience in case studies.

1. Introduction

Global warming is a human rights concern and affects the poor and marginalised. The world is already 1.2°C warmer than before the Industrial Revolution, and climate-related hazards, such as heat waves, floods and storms, are occurring more frequently and intensifying. The Intergovernmental Panel on Climate Change (IPCC) estimates that 3.3–3.6 billion people are already highly vulnerable to climate change (IPCC, 2022). Vulnerability hotspots are found in West, Central and East Africa; South Asia; Central and South America; Small Island Developing States (SIDS) and the Arctic. The mortality rate due to floods, droughts, and storms between 2010 and 2020 was 15 times higher in highly vulnerable regions than in very low-vulnerable regions (Ara Begum et al., 2022).

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Climate justice is a principle that acknowledges that climate impacts disproportionately affect those who contribute the least to GHG emissions. However, SIDS contribute only 0.2% of global emissions but face high costs from extreme events (United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States [UN OHRLLS], 2024). Historical emissions have been generated primarily by rich countries, which have a moral imperative to help (Dankelman & Jansen, 2022). Vulnerability is also shaped by gender, class and ethnicity: The UN Women Gender Snapshot 2024 (Rao et al., 2023) estimates that by 2050, climate change could cause an additional 16 million women and girls to fall into poverty compared to men and boys. Women already have a greater likelihood of food insecurity than men, with 47.8 million more women being food insecure, and women are disproportionately responsible for caring for others without remuneration and for collecting natural resources.

Climate risk is unevenly distributed worldwide and highly unequal across groups. Climate risk is distributed like economic inequality; it is very unequal across groups. Financial resources, strong institutions, and technological capacity are advantageous factors that enable adaptation in high-income countries in northern Europe, North America, and parts of Asia. According to the ND-GAIN Country Index, which combines indicators of exposure to change, sensitivity to change and adaptive capacity, Norway, Finland, Switzerland, Denmark and Sweden are the most resilient countries (Chen et al., 2021). However, other countries, including Somalia, Chad, and Niger, are among the most susceptible, owing to conflict, poverty, and poor governance. This is also reflected in the German Watch Climate Risk Index (CRI): Dominica, Myanmar, and Honduras were the worst-hit countries during 1995-2024, with high numbers of deaths and economic losses from hurricanes and flooding (Eckstein et al., 2021). In 2023, the flooding in Libya, known as Cyclone Daniel, resulted in over 13,200 deaths and losses of around USD 6 billion, demonstrating the impact of a combination of infrastructure gaps and governance failures exacerbated by climate-related events (Eckstein et al., 2021).

While there is growing understanding of climate justice, there remains a need for integrative analyses that bring together macro-level vulnerability indicators and micro-level community experiences. Although numerous studies focus on national-level vulnerability patterns and some on local vulnerabilities and capacities, few cross scales to examine how structural inequality becomes a lived reality for individuals. This paper aims to fill this gap by exploring the combined multilevel analysis that integrates quantitative indices, qualitative case studies, and theory. It asks: (1) What are some differences in vulnerability across the world between developed and developing countries? (2) What are the gender, class and marginalization based distributional impacts of climate change? (3) What are the factors that can help communities to be resilient? (4) What policies can lead to climate justice and equitable adaptation? This study is an attempt to combine social justice with climate science to inform policy-making that not only lessens risk but also changes the social conditions that create vulnerability.

2. Conceptual and Theoretical Framework

According to the IPCC (2022), vulnerability is 'the susceptibility to be adversely affected'. These include harm sensitivity, hazard exposure and adaptive capacity. Vulnerability is not fixed; it results from socio-economic status, political power, resources, and culture. For instance, households with lower incomes may live in flood-prone areas because of lower land prices, and marginalised households may be discriminated against and thus unable to access relief. Risk is a function of vulnerability, exposure, and hazard; that is, hazard alone, without vulnerability or exposure, is not a risk. The IPCC risk framework also acknowledges that the factors that make people vulnerable and exposed are socially created, including historical and structural issues like colonialism, systemic racism and patriarchy (Ara Begum et al., 2022).

Indices of vulnerability can be used to measure these intangible concepts. ND-GAIN merges 45 indicators of exposure, sensitivity, and readiness and generates scores for 182 countries, allowing cross-national comparisons (Chen et al., 2021). The German Climate Risk Index ranks countries by the number of people killed and the associated economic losses from extreme events, adjusted for per-capita income (Eckstein et al., 2021). The new Multidimensional Vulnerability Index (MVI) seeks to reflect economic, environmental, and social vulnerabilities, as well as Gross National Income (GNI). SIDS have small carbon footprints, are exposed to high disaster costs and debt, and traditional income-based measures are insufficient to account for this (Betzold & Weiler, 2017; Nurse et al., 2022).

Resilience is the ability of social, economic and ecological systems to withstand shocks, restructure, and continue to function (Norris et al., 2008; Aldrich et al., 2021). In a climate context,

resilience is defined as the ability to cope with shocks and adapt to change. It also includes the possibility of transformation, that is, fundamental shifts in a social or ecological system that cannot be achieved through incremental adjustments. The concept of resilience has evolved from engineering analogies (bouncing back) to social-ecological frameworks that emphasise diversity, learning, and equity. Community resilience emphasises the importance of social networks, local knowledge and collective action in mitigating risk (Aldrich et al., 2021). In some instances, however, the concept of resilience has been criticised for neglecting power relations – resilience without addressing inequity could simply be a way for communities to survive injustice (Pelling & Navarrete, 2011; Fedele et al., 2020).

Environmental justice began with the struggles of United States citizens with the siting of toxic waste and has grown to reflect global climate justice. It promotes the equitable distribution of environmental benefits and burdens and represents inclusive stakeholder involvement in decision-making processes. Intersectional frameworks acknowledge that race, gender, class, disability, and other identities overlap to influence levels of vulnerability (Kaijser & Kronsell, 2014; Sultana, 2021). Whilst women use natural resources more than men, they have less access to them, and climate change has been shown to worsen gender-based violence and maternal health outcomes (UN Women, 2025). The invisibility of indigenous people, Afro-descendant women, people with disabilities and LGBTIQ+ people exposes them to compound vulnerabilities. Rights, redistribution, and representation are key tenets of feminist climate justice, reflecting the fact that women's knowledge and agency are critical for adaptation (Dankelman & Jansen, 2022).

3. Literature Review

According to the IPCC (2022), vulnerability is 'the susceptibility to be adversely affected'. These include harm sensitivity, hazard exposure and adaptive capacity. Vulnerability is not fixed; it results from socio-economic status, political power, resources, and culture. For instance, households with lower incomes may live in flood-prone areas because of lower land prices, and marginalised households may be discriminated against and thus unable to access relief. Risk is a function of vulnerability, exposure, and hazard; that is, hazard alone, without vulnerability or exposure, is not a risk. The IPCC risk framework also acknowledges that the factors that make people vulnerable and exposed are socially created, including historical and structural issues like colonialism, systemic racism and patriarchy (Ara Begum et al., 2022).

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to compound vulnerabilities. Rights, redistribution, and representation are key tenets of feminist climate justice, reflecting the fact that women's knowledge and agency are critical for adaptation (Dankelman & Jansen, 2022).

4. Methodology

The study employs a mixed-methods design that includes a qualitative case study, a quantitative cross-national analysis, and an interpretive policy analysis. A multilevel perspective connects meso-institutional responses to macro-vulnerability indices with micro-community experiences. Three analytical steps were carried out: (1) grouping countries into developed and developing regions by using World Bank income classification; (2) thematic coding of case studies from Bangladesh, Nicaragua and Western Sydney to explore community-level resilience patterns; and (3) stratification analysis using UN Women statistics, IPCC vulnerability hotspots and local observations to look at gender and class dimensions.

Some quantitative data sources include the ND-GAIN Country Index (2023–2025), the Germanwatch Climate Risk Index (1995–2024), the IPCC AR6 Working Group II Summary for Policymakers (2022), UNDP National Adaptation Plan reports, and the U.S. Climate Vulnerability Index (2023). Qualitative sources include peer-reviewed literature on vulnerability and resilience (2010-2025), reports from the UN Women and feminist climate justice organisations, and case study reports from PrepareCenter on Bangladesh (Paul et al., 2022), Nicaragua (Turnhout et al., 2020), and Australia (Loughnan et al., 2021).

5. Results

5.1. Cross-Regional Comparison: Developed vs. Developing Countries

When comparing ND-GAIN vulnerability scores and CRI country rankings across a sample of high-income and low- and middle-income countries, there is a substantial difference. Countries with high ND-GAIN scores, like Norway, Finland, and Switzerland, ranked between 74 and 77 on the ND-GAIN readiness scale and were among the least vulnerable (Chen et al., 2021). These are countries that have well-developed social safety nets, high GDP per capita, well-developed infrastructure, and strong governance. Low-income countries such as Niger, Sudan and Mozambique, meanwhile, had scores under 30 and were among the lowest on the list. GDP per capita remains a strong predictor of ND-GAIN readiness, with a correlation of around 0.75.

Table 1. ND-GAIN Scores and Climate Risk Index Rankings for Selected Countries

Country	Income Group	ND-GAIN Readiness Score (2023)	CRI Ranking (1995–2024)	Key Vulnerability
Norway	High income	76.8	>100 (low risk)	Low exposure, strong institutions
Finland	High income	74.8	>100	Resilient infrastructure
Switzerland	High income	74.7	>100	Low climate exposure
Germany	High income	~72	~42	Flood risk, aging infrastructure
India	Lower-middle income	~35	9	Heatwaves, monsoon extremes
Philippines	Lower-middle income	~38	7	Typhoons, coastal flooding
Bangladesh	Lower-middle income	~32	5	Cyclones, sea-level rise
Dominica	Upper-middle income	~40	1	Catastrophic hurricane losses
Myanmar	Lower-middle income	~33	2	Cyclones, political instability
Honduras	Lower-middle income	~42	3	Repeated hurricane impacts

Note. ND-GAIN scores sourced from Chen et al. (2021); CRI rankings from Eckstein et al. (2021). Scores marked (~) are approximations based on 2023 rankings.

The top-ranked countries in the CRI are developing countries. While Dominica suffered the highest relative economic losses from hurricanes Maria and Erika, Myanmar lost a large number of lives during Cyclone Nargis, and Honduras suffered from multiple hurricanes over time, resulting in high

cumulative economic losses (Eckstein et al., 2021). India and the Philippines are included in the top 10 because of deadly cyclones and floods (Eckstein et al., 2021). These findings show that there is a gap in coping capacity: Rich countries can withstand losses and invest in preparedness, while poor countries face permanent harm. Table 1 offers a comparison.

5.2. Community-Level Resilience Patterns

Bangladesh: Myanmar and Bangladesh were hit by Cyclone Mocha (May 2023) at Category 5 level. The Bangladesh Cyclone Preparedness Programme (CPP), with more than 76,000 community volunteers, alerted people, opened shelters, and liaised with the local administration. The Bangladesh Cyclone Preparedness Programme (CPP), with more than 76,000 community volunteers, warned people, opened shelters, and coordinated with the local administration. This led to the evacuation of over 700,000 people, and no fatalities were reported (Paul et al., 2022). The success is in contrast with Cyclone Nargis (Myanmar, 2008), in which there was a lack of preparedness that resulted in the death of more than 130,000 people. Early warning systems, trust in volunteers, gender-sensitive shelters, integration of disability considerations, and strong partnerships between government, the Red Crescent, and NGOs are all key factors.

Nicaragua: The Tapacalí and Inalí river sub-watersheds are home to the Partners for Resilience project. The degradation of the environment caused by the agricultural frontier, deforestation and unsustainable practices increased the vulnerability to floods and droughts. The project established Learning Schools and Field Schools to provide practice-based learning to teach farmers about the linkage between disaster risk reduction, climate adaptation and ecosystem management (Turnhout et al., 2020). Communities learned agroecological practices such as contour bunding and crop diversification, and replanted riparian plants. Mid-term evaluation indicates higher production and less soil erosion, but scaling remains a challenge due to limited funding and policy support.

Western Sydney: The Australian Red Cross and partner organisations (IFRC, ICLEI, C40 Cities) have been delivering the Urban Climate Resilience Program in Western Sydney since 2023, and in nine other cities around the world. The programme responds to extreme heat through cooling centres, provision of heatwave preparedness kits, urban greening and community education (Loughnan et al., 2021). Low tree cover and a lack of socioeconomic opportunity in western Sydney contribute to a high urban heat. They have been effective in shaping our programme. Community involvement and working together are seen as effective in shaping our programme, according to programme evaluations**.** To enhance uptake in partnership with local councils, particularly the culturally diverse and services for elderly and disabled populations.

These case studies highlight similarities in effective resilience, such as multi-stakeholder coordination; inclusion and knowledge from the local community; early warning and anticipatory action; and social inclusion, both from a gender, disability, and ethnicity perspective. The results for the three sites are summarised in Table 2.

Table 2. Community Resilience Case Study Outcomes

Region	Climate Hazard	Resilience Intervention	Reported Outcomes
Bangladesh	Cyclone	Community early warning, shelters, 76,000+ volunteers	700,000+ evacuated; zero reported deaths (Paul et al., 2022)
Nicaragua	Drought & flooding	Agroecological Field Schools, ecosystem restoration	Increased crop yields; reduced soil erosion (Turnhout et al., 2020)
Western Sydney	Extreme heat	Cooling centres, urban greening, community education	Improved heat preparedness; increased community cohesion (Loughnan et al., 2021)

5.3. Social Stratification of Climate Impacts

The cross-national analysis shows that vulnerability is not just about a country's wealth; it is also about inequality within a country. The CVI reveals that, in the United States, highly vulnerable census tracts tend to overlap with communities of colour and low-income areas. The Settegast neighbourhood in Houston is in the 99th percentile for overall vulnerability due to low chronic disease prevention, high exposure to pollutants, and low food access (Berberian et al., 2022). Berberian et al. (2022) identify petrochemical pollution and flood risk as two of the greatest impacts on climate vulnerability, and how they intersect with environmental injustice and health disparities in the state of Louisiana, specifically in St. John and Iberville counties.

The gender gap exists in all settings. As women bear a greater burden of care, they are at greater risk of exposure to climate impacts, particularly during droughts, when they travel farther to fetch water or fuel (Rao et al., 2023). Climate change is also associated with a rise in gender-based violence, with heat waves correlating with a 28% rise in femicide, and, during a disaster, women are more likely to suffer from injuries than men, owing to their differences in mobility, decision-making and access to information (Rao et al., 2023). Indigenous and Afro-descendant women, LGBTIQ+ people and people with disabilities are at even greater risk. Table 3 shows social group stratification of climate impacts.

Table 3. Social Stratification of Climate Impacts

Social Group	Major Climate Risks	Structural Constraints	Justice Implications
Women	Food insecurity, water scarcity, GBV	Land rights, wage gap	Gendered vulnerability
Indigenous peoples	Ecosystem loss, displacement	Political exclusion	Climate injustice
Urban poor	Heat stress, flooding	Informal housing	Spatial inequality
Smallholder farmers	Crop failure, drought	Limited credit access	Livelihood insecurity
LGBTIQ+ individuals	Compounded disaster risks	Policy invisibility	Recognitional injustice

6. Discussion

The findings show significant differences in vulnerability and resilience. While high-income countries have the resources to spend on adaptation and strong institutions, there are still areas of high vulnerability stemming from historic injustice. Systemic challenges—poverty, debt, political instability—worsen the impacts of climate hazards in low-income countries. The vulnerability hotspots in South Asia, Africa, and Latin America are consistent with the IPCC's findings that vulnerability is greater where economic constraints and governance weaknesses are greater, and poverty is higher (Ara Begum et al., 2022).

These patterns highlight the moral obligation towards equity in adaptation and mitigation from a justice standpoint. Historically, the richest countries have released the bulk of GHGs but have more resilience. The need for climate justice is the recognition of historical responsibility and funding and technology transfer to vulnerable countries. Only 3% of climate aid addresses gender equality, and wealthy countries are responsible for 92% of excess emissions (Dankelman & Jansen, 2022). If adaptation is not done to address these imbalances, it can further exacerbate inequities. Learning, diversity, and transformation are key concepts in resilience theory. The Bangladesh example demonstrates anticipatory resilience through evacuations and shelters (Paul et al., 2022). Nicaragua is a case of adaptive resilience as it incorporates ecosystem restoration and livelihood diversification (Turnhout et al., 2020). Western Sydney identifies urban resilience as encompassing infrastructure and social services (Loughnan et al., 2021). These cases are within the Community Capitals Framework and underscore that resilience is not only a technical issue but also a sociopolitical one: trust, inclusion, and empowerment are essential.

The process of exposure and vulnerability is affected by structural inequality. Colonial history has excluded Indigenous people from land, forcing them to live in marginalised areas, and racial segregation in the United States and caste-based systems in South Asia have restricted the lives of the marginalised to hazardous spaces. Economic policies have contributed to the degradation of ecosystems and the diminishment of natural buffers. These patterns are seen in the IPCC's acknowledgement of the impact of colonialism and governance failures on vulnerability (Ara Begum et al., 2022). Gender, race, and class are interconnected, as Indigenous women can have multiple forms of violence, environmental contamination and poverty all at once (Rao et al., 2023). But climate policies can also be seen as a driver of inequalities if not carefully thought through—carbon pricing could disproportionately impact poor people unless the money generated is reallocated, whilst large-scale renewable energy projects can push communities over the edge if they are not consulted.

7. Policy Implications

International funds need to consider multidimensional vulnerability, not solely GDP. Financing for SIDS and other vulnerable countries can be directed by the UN's proposed MVI (Betzold & Weiler, 2017; Nurse et al., 2022). The gendered burden needs to be tackled through adaptation programmes that focus on investments in water infrastructure, clean energy, and healthcare. Donors need to ramp up their efforts to support gender equality and ensure that it is a key component of climate aid; currently, only 3% of climate aid focuses on gender equality

(Dankelman & Jansen, 2022). Hence, the need to scale up community-based early warning systems, which are already operational in Bangladesh (Paul et al., 2022), in other vulnerable areas, and to provide female- and youth-oriented training. The restoration of mangroves, wetlands, and forests can help absorb the impact of storms and offer livelihoods, as seen in Nicaragua's model of practice-based learning (Turnhout et al., 2020).

Countries should institutionalise risk and vulnerability assessments in their National Adaptation Plans (NAPs). The UNDP's experience across 34 countries indicates that interventions can be informed by targeted assessments (Dazé et al., 2021). Governments need to coordinate adaptation plans with development plans, budget for them, and track their implementation. Local governments and communities should be empowered to have greater say over adaptation resources through participatory budgeting, community representation on climate committees, and free, prior, and informed consent for projects. Governments should gather SEND data on climate impacts and make it publicly available, such as using the U.S. CVI to identify vulnerable neighbourhoods to inform investments.

Rich countries need to honour and increase commitments to $100 billion annually for climate finance, including for gender equality and adaptation. Fossil fuel profits (e.g. progressive taxation) can finance climate justice efforts (Dankelman & Jansen, 2022). Support for fossil fuel workers, social protection, skills development and participatory planning are primary elements of the transition to low-carbon economies, and can be used to counteract green gentrification. Reducing structural vulnerability requires acknowledging the right to a healthy environment, expanding Indigenous land rights and ensuring that anti-discrimination laws are implemented. In Table 4, key policy instruments are summarised by governance level.

Table 4. Policy Instruments for Climate Justice and Resilience

Policy Domain	Key Measures	Target Level	Justice Outcome
Adaptation	National Adaptation Plans; multidimensional financing	National	Reduced vulnerability
Disaster risk	Early warning systems; gender-sensitive shelters	Local	Lives protected
Social protection	Climate insurance; cash transfers for informal workers	Household	Income stability
Governance	Participatory budgeting; community representation	Community	Procedural justice
Finance reform	MVI-based grants; progressive fossil fuel taxation	Global	Distributive justice

8. Conclusion

The paper has revealed critical linkages among climate vulnerability, climate resilience, and social justice. The multilevel analysis demonstrates the vulnerability patterns that are created and shaped at different levels by structural inequalities, including economic, gender-based and racial inequalities. High income countries have less vulnerable national scores, but have pockets of extreme vulnerability due to historical injustice. While these countries are not responsible for much of global emissions, they face compounded risks in low-income countries, especially SIDS and low-lying countries. Resource constraints and governance issues are, to a certain extent, the limitations of community resilience initiatives that can have a big impact when they are ecosystem-based, participatory and inclusive. There are several directions for future research. The data used in this study were secondary to conduct cross-national analysis, and future studies could use primary surveys and participative mapping to reflect intra-country variations. The sustainability of interventions to foster resilience requires longitudinal studies. Additionally, research on how digital technologies, such as machine learning and mobile apps, can be used to enable early warning and adaptation without digital divides is needed. Last but not least, scholars and practitioners need to keep developing decolonising methodologies that foreground the Indigenous and marginal voices and ensure climate research is not only techno-centric, but also has transformative impacts on social change.

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