Journal of Climate Change
ISSN 2395-7611 Volume 11 (2025) No.3. pp. 297–315

https://doi.org/110.70917/jcc-2025-021
Article

Factors of Vulnerability Forming Considerations For Informed Legal-Policy Formulation In Addressing Climate Change-Induced Internal Displacement: Case Study on Munroe Island

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Abstract: Globally, the effects of climate change are felt increasingly than ever before with significant implications for human mobility. At one end, extreme climatic conditions raise displacement risks and migration, on the other, mobility constraints may prevent people from leaving, thereby trapping them in places exhibiting high levels of climatic stress. In situ adaptations are becoming difficult entailing risks for livelihoods and health of populations; and migration destinations are also becoming affected by adverse climate impacts. The vulnerability of the migrating populations further creates novel challenges to climate resilience and human security. This premise is evaluated in the paper by employing a case study involving Munroe Island in the State of Kerala in India. The paper is premised on the proposition that effective redressal of issues caused by climate change require legal-policy interfaces. Now, the issue revolves around identification of determinants which should form the basis of such interfaces. The case study undertaken reveals vulnerability as the primary criterion to be considered relevant in formulation of legal-policy interfaces. The study concludes that when different sections of a geographically homogenous community are subjected to climate change adversities, the ill-effects though expected to be similar across the board, vary owing to differing socio-economic vulnerabilities of the units of the study population. Since climate change effects remain constant, such adverse effects can be pacified through modifications directed towards socio-economic indicators through targeted interventions.

Keywords: climate-change; vulnerability; displacement; resilience; adaptation

1. Introduction

It is the harsh reality that often or rather nearly always disasters, unfortunate events, and mishappenings disproportionately affect their victims. Even when climate change is primarily an ecological issue, it results in serious socio-economic and cultural issues. Similarly, socio-economic and cultural vulnerabilities can contribute further to the challenges posed by climate change. In this context, an attempt is made to evaluate the correlation between socio-economic vulnerabilities and displacement induced by climate change.

There exist legal-policy protection gaps in addressing the issue of internal displacement caused by climate change. It is pertinent to identify the premises and considerations upon which a corrective legal-policy interface is formulated while attempting to close such protection gaps. The proposition put forth is that socioeconomic inequalities, vulnerabilities, and climate intersectionality markers qualify as valid determinants, and the paper analyses the veracity and plausibility of such a proposition.

To this end, the paper subjects a case study to scrutiny for evaluating this premise by formulating an index of identified vulnerability markers and determining the correlation between these factors and climate change-induced migration and forced displacement. The hypothesis here is that incorporating factors of consideration premised on vulnerability can produce an informed legal-policy interface capable

of producing justice-oriented solutions.

2. Vulnerability, Intersectionality, and Climate Change-Induced Displacement

Though patently subjected to indifference largely in legal-policy formulations and political discourses for a substantial period of time owing to various unfortunate and often criticised as selfish motives (Kamarck, 2019), climate change as a discipline and global concern has gained a peculiar status in the modern sense in dialogues concerning global cooperation, international legislative endeavours and regional coordination, with policy, political and business elites forming consensus for urgent climate action. (Dolšak, 2018)

Climate change, among its various other results, causes large-scale mobility of people across borders and within the national boundaries. As early as 1990, the Intergovernmental Panel on Climate Change (IPCC) had identified that human migration would be the "*greatest single impact"* of climate change (IOM, 2008). This projection by IPCC is validated by recent trends which are also extensively codified. (Sherbinin, 2020)

Law and policy plays primary role in addressing any social issue. However, law and policy are not be identified as two isolated remedial measures, rather as a confluence with interlinkages (Kim, 2014). While law delineates the substantive rights and obligations, policy acts as the vehicle to carry out the role of law as a tool for social transformation (Kammerer, 2020). It is for this reason that sound laws cater to issues that it may encounter even in the future. Such legislative actions require comprehensive understanding of the ground realities and the various factors to be considered during the drafting process so that an effective policy framework which would stand the test of difficulties can be formulated.

Climate change, too, like any other social issues affect its victims disproportionately. It is highly important that such vulnerabilities are identified and evaluated before any drafting is attempted. The instant study aims at correlating the effect of various vulnerabilities on the disproportionate effect of climate crisis on those who are internally displaced, which can potentially form the basis of a model legislation and policy framework with graded and target-specific action-plans.

An all-fit-in-one-box formula is inappropriate when it comes to adaptation strategies. Such an approach can lead to much deeper discriminatory results and would cause inequity and injustice. For this reason, it becomes important that an informed adaptation strategy be formulated. Such legal-policy interfaces are currently not in place in India or much of the world. In India, though environmental jurisprudence has evolved substantially, its prongs haven't brought within their ambit the issue of climate change (Nachmany, 2015). Policy initiatives exists with no legislative backing. The Disaster Management Act of 2005 cannot be resorted to in its current form for it isn't fashioned to deal with the particular pitfalls that climate change reveal and such general treatments are insufficient to cater to the specialised challenges that the issue at hand offers (Patnaik, 2023). The need of the hour is thus, a sound and informed legal-policy formulation comprehensively catering to the various dimensions of crises emanating from climate change as a disrupter and its various contributing elements.

There is too often an uncritical acceptance of a direct causal link between environmental degradation and population displacement. Implicit in these writings is the belief that environmental degradation – a possible cause of population displacement – can be separated from the other social, economic or political causes. It must be recognised that the degradation of the environment is socially and spatially constructed; only through a structural understanding of the environment in the broader political and cultural context of a region or country can one begin to understand the 'role' it plays as a factor in population movement. (Lonergan, 1998, p.8)

Lonergan's finding maintains that addressing the issue of displacement as solely caused by climate change adversities without giving due regard to the socio-economic factors of the affected communities would not produce adequate results. In other words, as Jayawardhan (2017) puts it, "*environmental displacement is a multicausal problem where ecological and socioeconomic vulnerability act together to displace marginalized people*" (p. 104). While climate change may act as the initiating force for displacement and population movements, it cannot be seen as the sole source of persecution. It would not be wrong to state that climate change exacerbates social vulnerability, which further contributes to displacement, opines Jayawardhan (2017, p. 104).

An introspection of the issue of climate change-induced displacement through the lens of intersectionality reveals a picture validating Jayawardhan's findings. Intersectionality is defined as "*the interconnected nature of social categorizations such as race, class, and gender, regarded as creating overlapping and interdependent systems of discrimination or disadvantage*" (Oxford, 2015). Akin to the conclusions made by Jayawardhan, an analysis of the issue using intersectionality markers also recognizes that adversities caused by climate change vary disproportionately based on various socioeconomic factors (India Development Review, 2023).

Now, before delving into the assay of these propositions, an attempt must be made to apprise the term

'vulnerability' in a better fashion. The Intergovernmental Panel on Climate Change (IPCC) defines vulnerability as "*the degree to which a system is susceptible to and unable to cope with, adverse effects of climate change, including climate variability and extremes*" (International Panel on Climate Change, 2007, p. 833). At the outset, this is a purely ecological definition. However, it is an expansive definition, which though brings in the realm of adverse effects, climate variability, and extremes, doesn't exclude other non-ecological factors. While a strict interpretation based on the rule of *ejusdem generis* may fail such a conclusion concerning the interpretation of 'adverse effects', in my opinion, the term 'system' cannot be subjected to such limited connotations. Thus, a 'system' would encompass its ecological, socioeconomic, and political aspects and dimensions. The definition adopted by the United Nations Office for Disaster Risk Reduction aligns with this approach: "*the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard*" (The United Nations Office of Disaster Risk Reduction, 2016). In this definition, a more comprehensive approach is adopted whereby socioeconomic vulnerability is impliedly accepted as a criterion in determining the vulnerability of a community to climate adversities. As opposed to vulnerability, resilience is defined as the "*ability of communities to absorb external changes and stresses while maintaining the sustainability of their livelihoods*" (Tacoli, 2009, p. 513). In that sense, where the vulnerability is high, the resilience would be proportionately low and consequently lower capacity to adapt (Jayawardhan, 2017, p. 114). A lower capacity to adapt can result in population displacement. It is this context that forms the premise of this research. The absence of targeted informed legal-policy framework dealing with climate-changed induced mass mobility contours the very boundaries of this study.

Thus, the review of the literature on this aspect reveals three conclusions having considerate support:

(i) *Firstly,* that differing socioeconomic vulnerability results in disproportionate and differing results on different communities hit by climate adversities;

(ii) *Secondly,* that climate change adversities exacerbate socioeconomic vulnerability; and

(iii) *Thirdly,* that higher vulnerability leads to lower resilience and consequently lower adaptive capacity.

For the purpose of proving the proposed hypothesis, the given three propositions are identified as the three prongs of the proposed hypothesis. In the following sections of the paper, these three propositions are verified. For this purpose, non-doctrinal research involving a case study is adopted wherein a community affected by climate change is identified and stratified, and the vulnerability index of these strata is determined. Based on the quantitative data obtained, which are further subjected to correlation analysis, the veracity of these propositions is evaluated.

Existing literature, though addresses the interlinkages between vulnerability and resilience, fails to substantiate the same using empirical evidence. Further, gaps exist in consolidating the proposition as a workable formula which can in effect forms the foundational analytical tool in guiding and perfecting legal-policy interfaces. The study aims to address these gaps.

3. Case Study

The study undertaken intends to analyze the correlation between climate change-induced displacement and socioeconomic vulnerabilities. For this purpose, Munroe Island in Kollam, Kerala is identified as the area for conducting the case study. The location was selected for the study as it has been identified as one of the areas of prime importance in India by UNDP in their project report titled "Enhancing Institutional and Community Resilience to Disaster and Climate Change" (Government of India, 2019). The relevance of the study in the identified location was further examined through a literature review.

3.1. Executive Summary

Climate change is wreaking havoc across the globe in the form of direct and indirect ecological, socioeconomic, political, and cultural adversities among different communities. Among the various factors playing a role, geographical and geophysical factors primarily determine the areas of initial incidences. Low-lying areas and islands are particularly susceptible and vulnerable to such harsh effects and Munroe Island has been the talk of the town for such unfortunate reasons for some time now.

3.1.1. Munroe Island: A Picturesque Haven Torn by Rails and Misery

Located at the confluence of Ashtamudi Lake and Kallada River in the Kollam district of Kerala, India, Munroe Island or Mundrothuruthu is an amalgamation of eight islets comprising a total area of 13.4 sq. km. In recent times, dubbed as the 'Sinking Island of Kerala', Munroe Island is identified as one of the locations suffering the brunt of climate change. Torn into two halves by the railway passing through the island, Mundrothuruthu is divided into 13 administrative units (wards). While the eastern half thrives with its tourism activities, the western half is a stark contrast to its counterpart with misery looming in its airs. The 2004 tsunami, other anthropogenic activities, and climate change have made life on the island challenging with a substantial number of households on the western half having to battle with high tide surges and inundation almost daily or for at least half of a year. Flood water during high tides enters and causes damage to dwelling units. Waterlogging, soil water intrusion, serious accessibility issues, agricultural losses leading to loss of traditional employment, etc. have resulted in widescale migration and displacement from the island. For the study, it is essential to establish a causal link between these issues and climate change, for which existing literature is relied.

3.1.2. The Plight of Munroe Island: Role of Climate Change

In 2015, The National Centre for Earth Science Studies conducted investigations at Munroe Island and concluded that it is subjected to flooding, saltwater intrusion, and subsidence affecting housing, livelihood, agriculture, potable water, etc., due to 'vulnerable natural setting and typical environmental conditions' (as answered by the Minister of Earth Sciences on Aug. 9, 2023 in the Lok Sabha to Unstarred Question No. 3298). In 2017, a study conducted by the Kerala Sasthra Sahitya Parishad concluded that Munroe Thuruthu was sinking because of water level rise caused by global warming and tectonic movement (cited in Saranya et. al, 2019, p.178). Further, in 2018, in the 6th Report on the Serious Environmental Adversities Faced by Mundrothuruthu Gramapanchayat, the Kerala Legislative Assembly called for further studies on the causal links between climate change and water level rise in the island.

A 2020 study revealed that there exist various causative factors responsible for flooding in Munroe Island, among which one is sea level linked to climate change (Nair et. al, 2020). A 2022 study on the major reasons for the sinking of Munroe Island observed mass displacement from the island and identified climate change among other reasons such as sea level rise, faulty agricultural practices, etc. to be contributing to the issue (Prathapan et. al, 2022).

While suggesting special assistance to Munroe Thuruthu, the Kerala State Human Rights Commission in 2022, categorically attributed climate change and 2018 floods to the unfortunate plight of the inhabitants of the island (The Hindu, 2022). Identifying the local population to be economically and socially backward, the Commission observed that the traditional agricultural sector has collapsed due to climate change and that tidal flooding has actively contributed to unemployment. While CRZ norms foreclose the possibility of resilient structures being built anymore, an approach rooted in sustainable development was identified as a plausible remedy by the Commission.

The wetland systems across the globe are threatened by the rising sea level caused by climate change. Munroe Island is no exception to this phenomenon, found in a 2023 study. Climate change and its impacts also contribute to the severity of the existing environmental conditions and have thereby affected the socio-environmental attributes of the island (Rafeeque et. al, 2023, p. 1458).

3.1.3. Methodology

The case study aims to determine the correlation between climate change adversities and socioeconomic vulnerabilities. This was done by collecting data from sample units within the study area and based on identified determinant parameters, an index depicting vulnerability was calculated. The obtained index was correlated with data on reported displacement.

Research Design

The research design employed for conducting the case study analysis is non-doctrinal and analytical. Doctrinal descriptive research was employed for setting the premise of the study covering a review of literature on vulnerability and climate change displacement linkages and climate change concerns in the area of study.

Sampling

For the study, two levels of sampling were adopted. In the first level, out of the total of 13 wards on the island, 4 wards were chosen for conducting the study. For the sampling of wards and calculation of the vulnerability index, the 2018 study by Rajeev R, Swathi Krishna P S, and Malavika Ramesh K (2018),

titled '*Climate Resilient Planning for Backwater Islands: A Case of Munroe Thuruthu,* Kerala' was chosen as the parent study. The parent study involves the calculation and analysis of the socio-economic, geophysical, and bio-physical vulnerabilities of the 13 wards in Munroe Thuruthu. However, the parent study does not delve into the issue of displacement. Based on the calculated index of various wards in the parent study, judgment sampling or purposive sampling was adopted in choosing Ward 2, Ward 7, Ward 12, and Ward 13 for conducting the study.

The households in the area of study were chosen as sample units with the sample size 'n' fixed at 80 units wherein 20 units were chosen from each chosen ward. For sampling household units from each ward, stratified random sampling was adopted after stratifying the households in each ward into five strata based on area and 4 units were randomly selected from each strata. Thus, 20 units were chosen from one ward and a total of 80 units were chosen from four wards.

Data Collection

Both primary and secondary data were collected. Primary data was collected through the schedule method using enumerators. The questionnaire comprised questions on various demographic indicators of the units, and data relevant to deciphering the status of socio-economic and bio-physical assets of the unit. Secondary data on existing policies, action plans, and demographic statistics of each ward were collected from the Panchayat office and ward members of Wards 2, 7, and 13, and ASHA worker of Ward 12.

Permission to conduct the interviews for the purpose of this research was obtained from all respondents, who were fully informed about *the purposes of this research and how their responses would be used and stored. All interviewees have been anonymised.*

3.2. Analysis of Collected Data

The data collected include the status of awareness about climate change, prospects, possibilities, motivations, and hurdles of displacement, and data concerning legal-policy protection gaps. The detailed analysis of the collected data is presented hereafter.

3.2.1. Instances of climate/environmental adversities

The response to the query as to whether the units are subjected to climatic adversities, 57% answered affirmatively and 43% negatively. However, a closer look at the ward-wise data reveals that the macro-level analysis does not provide the right picture. The incidence of climatic adversities shows stark contrasts between wards 2 and 12 (95%) on one side and wards 7 (10%) and 13 (25%) on the other. This is because ward 7 and the western half of ward 13 lie on elevated levels as opposed to wards 2 and 12 which are predominantly low-lying areas.

3.2.2. On intention of leaving the island and relocating

On asked whether they have ever thought of leaving the island and relocating outside, the results were gathered as given in Figure 1 and Figure 2. Here too, macro-level analysis without appreciating ward-wise results would render the conclusion skewed. It is to be noted that wards facing climate adversities (2 and 12) wish to relocate majorly; however, the orange bands throw light on the fact that there exist other factors that make such decisions to migrate difficult too. Similarly, data on ward 13 (which hardly faces climate adversities) also has a significant population wanting to leave, signaling that factors other than climatic adversities may also lead to displacement.

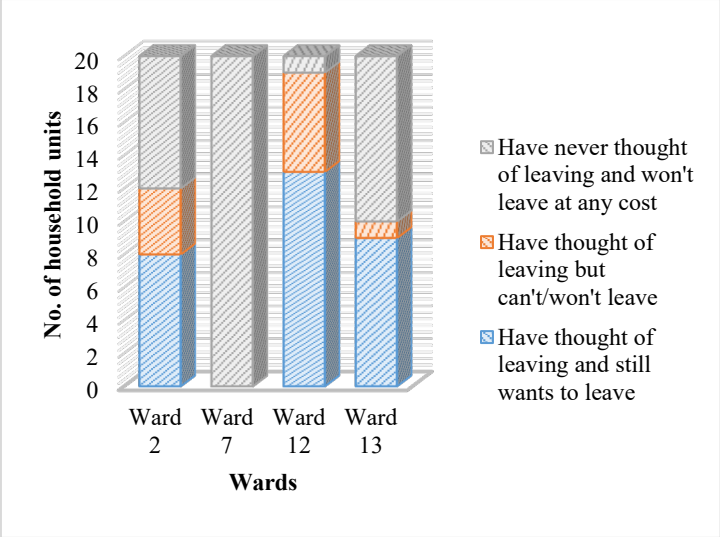

Figure 1. Intention to leave the island and relocate – Ward-wise.

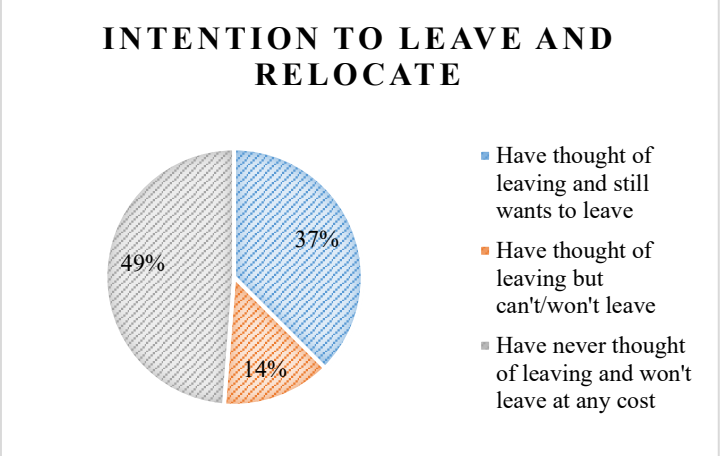

Figure 2. Intention to leave the island and relocate – Consolidated.

3.2.3. Motivations favouring relocation

While the primary motivation for the majority of respondents in ward 13 to relocate is accessibility issues, the major motivation in ward 2 is fear of disasters. Whereas, in ward 12, both accessibility and climatic adversities are vulnerable factors making their daily life difficult. Thus, the vulnerable factors form the major motivations for relocating. As seen from Figure 3, in wards 2, 12, and 13, the standard of living is an issue due to the above-identified factors, however, in ward 7, since accessibility issues and climatic issues are absent, the standard of living is satisfactory and hence, there exists no motivation to relocate. Figure 4 consolidates the findings.

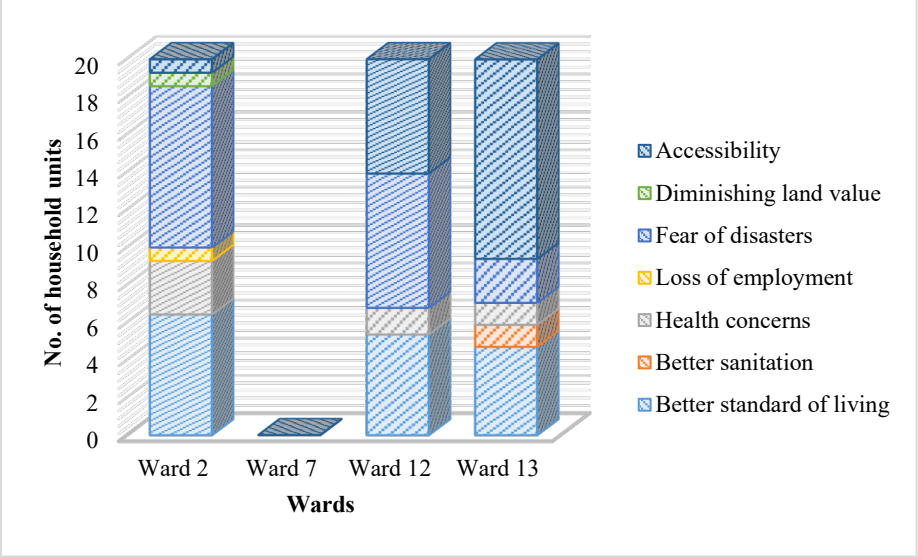

Figure 3. Motivations favouring relocation – Ward-wise.

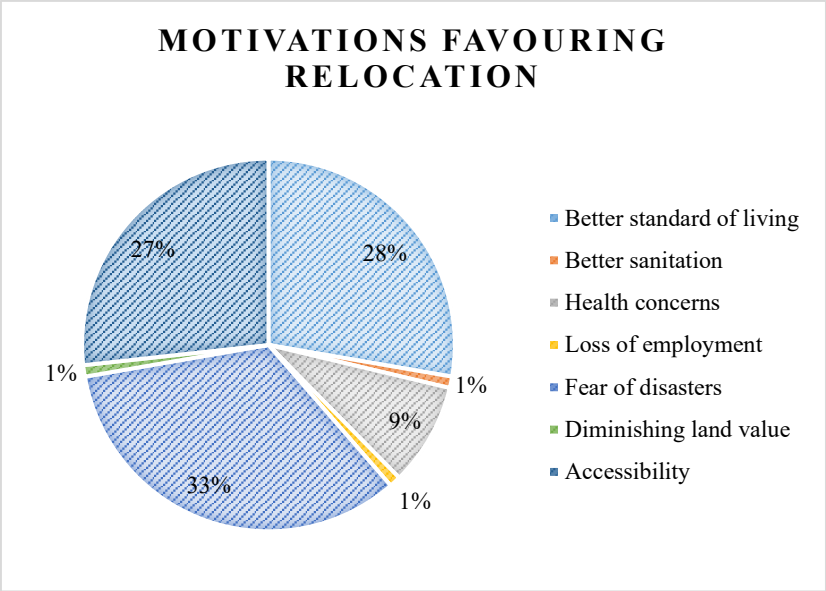

Figure 4. Motivations favouring relocation – Consolidated.

3.2.4. Motivations for questioning relocation/finding it difficult to relocate

Barring ward 7, all other wards face issues as seen from Figure 5. Yet they choose not to leave or find it hard to leave primarily because of the economic and financial constraints. As the land value is low, those who relocate are forced to leave without selling their properties, which is not a viable solution for most of the affected households due to their financial position. Further, many fear that upon relocation, they would be treated as outsiders in the new setting, thereby might have to subject their freedoms. The cost of living on the island is too low. The average educational qualification is 12th grade. Many fear that relocation will raise their cost of living with no alternate job, as seen from Figure 6.

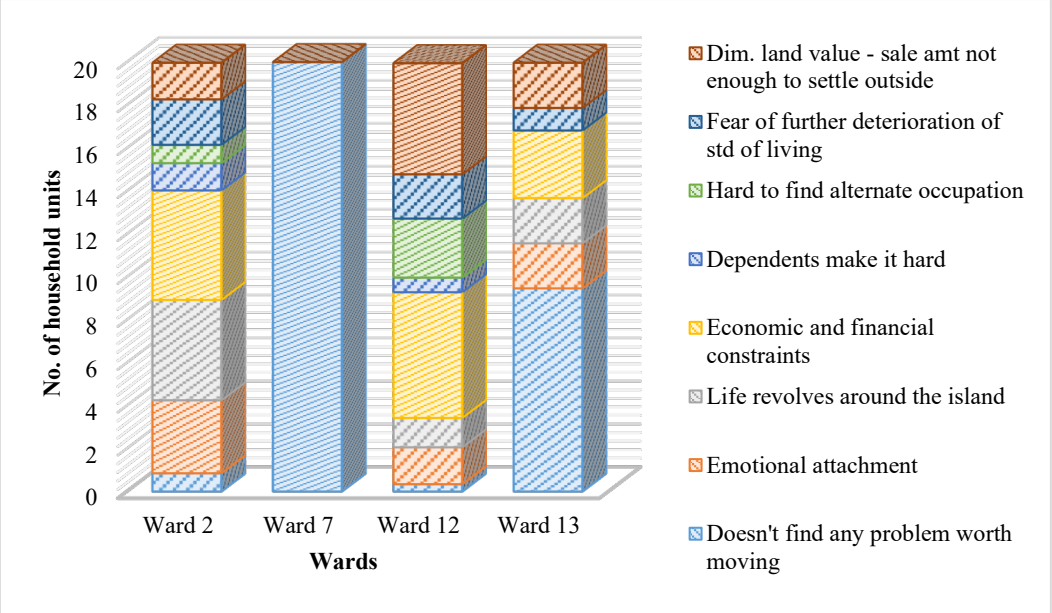

Figure 5. Factors disfavouring relocation – Ward-wise.

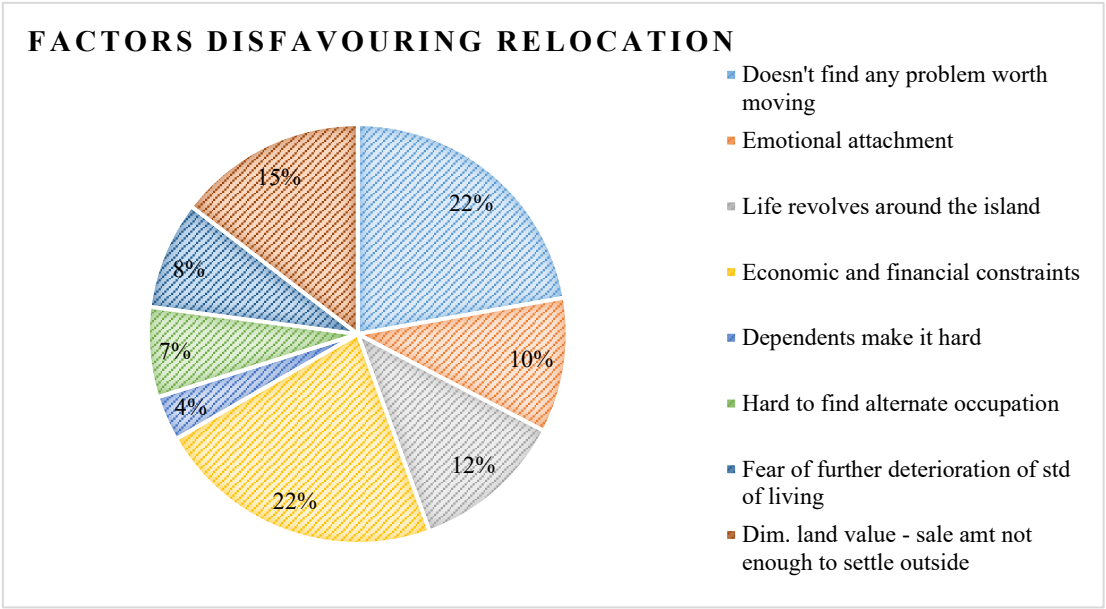

Figure 6. Factors disfavouring relocation – Consolidated.

3.2.5. Pre-Requisites to Return If Have to Leave

The majority of the sample units responded to the query on the prerequisites to be satisfied to be able to return to their lands in the event of being forced to leave in favour of assurance on non-recurrence of such instances and stable and sound governmental interventions. It is to be noted that even those who have the financial ability to rebuild dwellings resiliently, CZR limits such constructions. For others, adaptation and mitigation efforts are unaffordable. Further, other socio-economic vulnerability factors like accessibility, water supply and sanitation can only be ensured through active governmental intervention.

3.2.6. Right Strategy To Be Adopted

While the majority of the population found mitigation and adaptation to be the right strategy to be adopted, only units from ward 12 favoured relocation. Revisiting the findings in Figure 6, 27% of the

sample size recorded emotional attachment to the island and their homes to be the factor demotivating them from leaving the island. This can be accounted for the majority finding a strategy that would let them stay on the island to be ideal. However, as seen from Figure 5, ward 12 recorded the lowest in favour of emotional motivations, and the maximum share of the population intending to leave also came from ward 12 (Figure 1), which is reflected in their choice of strategy too. The whole 14% favouring relocation is from ward 12.

In addition to the data discussed, for evaluating the prongs of the three identified propositions, certain other information was sought and the vulnerability index for each household and wards was calculated, the details of which are discussed in the next section.

3.3. Calculation of the Vulnerability Index

3.3.1. Analytic Hierarchy Process Method

For calculating the vulnerability index, the Analytic Hierarchy Process (AHP) method is used. In applying this method, the ultimate goal to be achieved is set as the formulation of legal-policy interfaces. The study does not intend to create a legal-policy interface, rather, the study quantifies certain criteria identified to be relevant in providing a rational framework for achieving the demarcated goal which can be used as an evaluative marker in choosing between possible legal-policy interfaces. In another sense, using this evaluative marker, an ideal intervention interface can be modelled, and attempts can be made to manifest the same into fruition.

3.3.2. Parameters and Weighted Average

A total of 14 parameters were identified under three indicators, viz. geophysical, socioeconomic, and physical: climate/environmental adversities (C/EA), age dependency ratio (AD), family size (FS), literacy (Li), unemployment (UE), occupational vulnerability (OV), household income (HI), ownership status (OS), structural conditions (SC), educational facility (EF), health facility (HF), water supply (WS), sanitation (Sa), and accessibility (Ac). Each criterion was assigned weightage as given in Table 1 and vulnerability index (V.I) was calculated from the weighted average values of each criterion using the following formula.

$$V.I = W_{Av} = \frac{\sum W.C}{\sum W}$$, where W = Weightage assigned, C = Criteria value of relevant variable

$$\text{i.e., } V.I = W_{Av} = \frac{(W1.C1+W2.C2+\cdots\ldots\ldots\ldots\ldots+W14.C14+W15.C15)}{W1+W2+\cdots\ldots\ldots\ldots\ldots+W14+W15}$$

In carrying out this study, the human rights framework is adopted as climate change adversities has a profound impact on effective realisation of human rights. It is an evolving argument, gaining ground, that since the negative impacts of climate change extend to violation of human rights, the adaptation and mitigation efforts should not be merely based on the international climate regime, but one modelled also on the experiences from international human rights law (Knur, 2014). According to Siobhan (2009), there are at least three ways in which these complementarities and points of convergence can be characterised: firstly, climate change affects the enjoyment of human rights; secondly, secondary human right impacts caused by the measures taken to address climate change may have a bearing on enjoyment of human rights; and thirdly, human rights may be relevant to the design and implementation of responses to climate change. Considering these propositions, variables are identified based on the potential human rights upon which adversities caused by climate change will have a bearing. Weightages are given based on the directness and intensity of influence each of the variable has on the life of affected units of population with higher weightages corresponding to more intense effects.

The weighted average is calculated for both households (micro-level) and the four wards studied (macro-level) and the total vulnerability index is obtained.

Table 1. Vulnerability Index: Criteria and Weightage Key.

Indicator	**Variable**	**Weightage**	**Vulnerability Assessment Range**				
			Very Low (1)	**Low (2)**	**Medium (3)**	**High (4)**	**Extreme (5)**
Geo-physical	Climate/ Env. adversity	2		Rare	Seasonal	Frequent	Almost always
Socio-economic	Age-Dependents	1.5	<60%	60-65%	65-70%	70-75%	>75%
	Family size	1.5	<5	6	7	8	>8
	Literacy	1	>93%	93-91%	91-89%	89-87%	<87%

	Unemployment [1]	1.75	<60%	61-70%	71-80%	81-90%	>90%
	Occupational vulnerability	2	Dep. occu. coupled with marked success		Dep. occu. not coupled with failure[2]	Dep. occu. coupled with failure; but alt. income	Dep. occu. coupled with failure; no alt. income
	Household income (₹/month)	2	>12000	12000-10000	10000-9000	9000-8000	<8000
Physical	Ownership status	1.25		Own property in island located in geo. stable area		No land nor own house outside island	No land nor own house
	Structural conditions	2	>90% good	90-85% good	85-80% good	80-75% good	<75% good
	Educational facility	0.5	<0.8 km	0.8 – 1 km			>1km
	Health facility	0.5	<0.8 km	0.8 – 1 km			>1km
	Water supply	1.5			No free/ supply; but hygienic	Unstable supply not meeting needs	Unusable or unhygienic supply
	Sanitation	1.5				Unusable/ unhygienic at intervals	No sanitation facilities
	Accessibility	1				Motorable roads present halfway or below	Motorable roads absent

3.3.3. Analysis of the Calculated Vulnerability Index

To be noted, all wards considered for the study are climatically homogenous, thereby making the climate adversities constant. However, due to topographical differences, like increased proximity to water body in the west and increased elevation of land in the certain wards, particularly ward 7 has resulted in the varying visible results of such adversities. This has accounted for different values attributed to 'C/EA' for different units and ward 7 being an extreme exception.

While wards 2, 12, and 13 are located to the west, ward 7 is located to the east. An analysis of the the vulnerability index of the surveyed households (Table 2) in each of these wards reveals that wards 2 and 12 are high – extremely vulnerable, whereas ward 13 is moderately vulnerable and ward 7 shows low vulnerability.

Though the consolidated analysis (Table 3, Figure 7) reveals that nearly half of the households fall within low vulnerability, a closer look reveals that the effect of climate adversities is disproportionate on individual wards. This leads to the conclusion that in formulating an effective response strategy, regional disparities and the causative vulnerability indicators contributing to such disparities are to be identified. Each ward differs in terms of the vulnerability factors worsening or bettering the situation there. A targeted approach is ideal wherein these identified factors relevant to individual wards are focused on while creating adaptation and mitigation plans.

[1] Calculated as the percentage of unemployed individuals to total labor force (members who are above 16 years).

[2] Dependent occupation, for this study refers to an occupation dependent on the specific topography and other geo-physical factors of the location, mostly primary activities and secondary activities whose raw materials are exclusively obtained from the island and tertiary activities involving tourism and ancillary occupations.

Table 2. Micro-level vulnerability index.

	C/EA	AD	FS	Li	UE	OV	HI	OS	SC	EF	HF	WS	Sa	Ac	Index
WARD 2															
W2S1	5	1	1	1	0	3	2	4	2	5	5	4	4	4	2.7
W2S2	4	5	1	1	5	0	5	4	1	5	5	4	0	0	2.7375
W2S3	5	1	1	1	3	0	1	4	3	5	5	3	0	0	2.0875
W2S4	2	5	1	1	5	0	5	4	1	5	5	3	0	3	2.6125
W2S5	5	1	1	1	2	3	3	4	4	5	5	3	0	0	2.6
W2S6	4	1	2	1	3	0	2	4	1	5	5	3	0	0	1.9625
W2S7	3	0	1	1	0	0	1	4	3	5	5	3	0	0	1.55
W2S8	3	1	1	1	2	0	1	4	3	5	5	3	0	0	1.8
W2S9	0	1	1	1	0	0	1	0	1	5	5	3	0	0	0.875
W2S10	4	0	1	1	3	3	1	4	3	5	5	4	0	5	2.5375
W2S11	4	1	1	1	2	0	3	4	2	5	5	3	0	5	2.25
W2S12	2	1	1	1	0	3	2	4	2	5	5	3	0	5	2.075
W2S13	5	1	1	1	2	3	4	4	4	5	5	3	0	5	2.95
W2S14	5	5	1	1	0	0	3	4	2	5	5	3	0	5	2.475
W2S15	5	1	1	1	2	3	5	4	5	5	5	3	4	5	3.45
W2S16	2	5	1	1	1	3	5	4	2	5	5	3	0	5	2.7625
W2S17	2	1	1	1	1	0	2	4	3	5	5	3	0	5	1.9625
W2S18	3	1	1	1	1	3	3	4	3	5	5	3	0	5	2.4625
W2S19	5	5	1	2	5	0	5	4	5	5	5	3	0	5	3.4625
W2S20	5	1	1	1	0	3	3	4	5	5	5	5	4	5	3.225
WARD 7															
W7S1	0	1	1	1	1	0	1	2	1	5	2	3	0	0	1.0125
W7S2	0	0	1	1	0	0	1	2	1	5	2	3	0	0	0.85
W7S3	0	0	1	1	0	0	1	2	1	5	2	3	0	0	0.85
W7S4	0	0	1	1	0	1	1	2	1	5	2	3	0	0	0.95
W7S5	0	1	1	1	1	1	1	2	1	5	2	3	0	0	1.1125
W7S6	0	1	1	1	1	0	1	2	1	5	2	3	0	0	1.0125
W7S7	0	0	1	1	0	1	2	2	1	5	2	3	0	0	1.05
W7S8	0	1	1	1	0	0	1	0	1	5	2	3	0	0	0.8
W7S9	2	0	1	1	2	1	3	2	2	5	1	3	0	0	1.6
W7S10	0	0	2	1	1	0	1	2	1	5	1	3	0	0	0.9875
W7S11	0	1	1	1	0	1	1	2	1	5	1	3	0	0	1
W7S12	0	1	1	1	2	1	1	0	1	5	1	3	0	0	1.05
W7S13	0	0	1	1	0	1	1	2	1	5	1	3	0	0	0.925

W7S14	0	0	1	1	0	1	2	2	1	5	1	3	0	0	1.025
W7S15	2	2	1	1	1	0	2	4	1	5	2	3	0	0	1.5125
W7S16	0	1	2	1	1	1	2	0	1	5	2	3	0	0	1.1625
W7S17	0	0	1	1	1	0	2	2	1	5	2	3	0	0	1.0375
W7S18	0	1	1	1	0	1	1	2	1	5	2	3	0	0	1.025
W7S19	0	1	1	1	1	0	3	2	1	5	2	3	0	0	1.2125
W7S20	0	0	1	1	0	1	1	2	1	5	2	3	0	0	0.95
WARD 12															
W12S1	0	1	1	1	2	3	4	2	1	5	5	3	0	0	1.775
W12S2	4	1	3	1	1	0	1	4	3	5	5	3	0	0	1.9625
W12S3	5	1	1	1	0	0	5	4	4	5	5	3	0	0	2.325
W12S4	5	5	1	1	5	0	5	4	5	5	5	3	0	4	3.3625
W12S5	3	1	1	1	3	3	5	4	5	5	5	5	4	5	3.4875
W12S6	5	1	1	1	1	4	5	4	5	5	5	5	4	5	3.6125
W12S7	3	1	1	1	1	0	2	4	1	5	5	5	0	5	2.0125
W12S8	5	1	1	1	3	3	2	4	4	5	5	5	4	5	3.2875
W12S9	3	0	1	1	0	0	2	4	3	5	5	5	0	5	2.05
W12S10	5	0	1	1	0	0	2	4	5	5	5	5	5	5	2.825
W12S11	5	0	1	1	1	0	1	4	3	5	5	5	4	5	2.5375
W12S12	4	0	1	1	0	3	4	4	3	5	5	5	0	5	2.65
W12S13	5	0	1	1	1	0	5	4	4	5	5	4	4	5	2.9625
W12S14	3	0	1	1	1	0	4	4	3	5	5	4	0	5	2.2625
W12S15	3	1	1	1	1	3	4	4	1	5	5	3	0	5	2.3625
W12S16	3	1	1	1	5	0	5	4	4	5	5	5	0	5	2.9625
W12S17	5	0	1	1	0	0	4	4	3	5	5	3	0	5	2.3
W12S18	5	1	1	1	2	0	3	4	3	5	5	3	0	5	2.45
W12S19	3	1	1	1	1	0	5	4	1	5	5	3	0	5	2.1625
W12S20	5	0	1	1	2	0	5	4	4	5	5	3	4	5	2.975
WARD 13															
W13S1	2	0	1	1	5	0	5	5	2	2	5	3	0	5	2.425

W13S2	0	1	1	1	0	0	2	2	1	2	5	3	0	5	1.275
W13S3	0	1	1	1	1	0	2	2	1	2	5	3	0	5	1.3625
W13S4	0	1	1	1	1	0	3	2	1	2	5	3	0	5	1.4625
W13S5	0	1	2	1	2	0	1	2	1	2	5	3	0	5	1.425
W13S6	0	0	1	1	1	0	4	2	1	2	5	3	0	5	1.4875
W13S7	3	0	1	1	0	0	5	4	2	1	5	3	0	5	2
W13S8	4	1	1	1	3	0	4	4	3	1	5	3	0	5	2.4375
W13S9	2	1	1	1	1	3	3	4	1	1	5	3	0	5	2.0625
W13S10	3	0	1	1	1	3	1	4	2	1	5	3	0	5	1.9875
W13S11	4	0	3	1	3	3	3	4	2	1	5	3	4	5	2.9125
W13S12	0	1	1	1	0	0	1	2	1	1	5	3	0	5	1.15
W13S13	0	1	1	1	1	0	2	2	1	1	5	3	0	5	1.3375
W13S14	0	1	2	1	1	0	1	0	1	1	5	3	0	5	1.1875
W13S15	0	1	1	1	2	0	1	0	1	1	5	3	0	5	1.2
W13S16	0	5	1	1	1	0	1	2	1	1	5	3	0	5	1.5375
W13S17	0	1	1	1	1	1	1	0	1	1	5	3	0	5	1.2125
W13S18	0	1	2	1	3	1	1	2	1	1	5	3	0	5	1.5875
W13S19	0	3	1	1	0	1	2	2	1	1	5	3	0	5	1.5
W13S20	0	0	1	1	1	1	1	2	1	1	5	3	0	5	1.2625
Low	**0 – 1.60**	**Moderate**		**1.61 – 2.0**		**High**	**2.01 – 2.90**			**Extreme**	**>2.91**				

Table 3. Macro-level Vulnerability Index.

Indicator	**Ward 2**	**Ward 7**	**Ward 12**	**Ward 13**
Climate/Environmental adversity	3.65	0.2	3.95	0.9
Age-dependent ratio	1.9	0.55	0.8	1
Family size	1.05	1.1	1.1	1.25
Literacy	1.05	1	1	1
Unemployment	1.85	0.6	1.5	1.4
Occupational vulnerability	1.35	0.55	0.95	0.65
Household income	2.85	1.45	3.65	2.2
Ownership status	3.8	1.8	3.9	2.35
Structural conditions	2.75	1.05	3.25	1.3
Educational facility	5	5	5	1.3
Health facility	5	1.7	5	5
Water supply	3.25	3	4	3

Sanitation	0.6	0	1.45	0.2
Accessibility	3.1	0	4.2	5
Socio-economic vulnerability Index	**2.29097**	**1.1513**	**2.46805**	**1.72291**
Total Vulnerability Index	**2.42687**	**1.0562**	**2.61625**	**1.64062**

Ward 2 for its geographically vulnerable topography is innately vulnerable to climate adversities. The survey revealed that such adversities exacerbate the socioeconomic vulnerability in the ward. The population in the ward reported frequent climatic adversities which are even non-seasonal. Further, their vulnerability is heightened by worsened structural conditions of the dwellings, unstable water supply, and accessibility issues. Ward 2 comprises many households that have been disowned as its inhabitants were either struggling with climate adversities or such adversities had caused irreparable damage to the property.

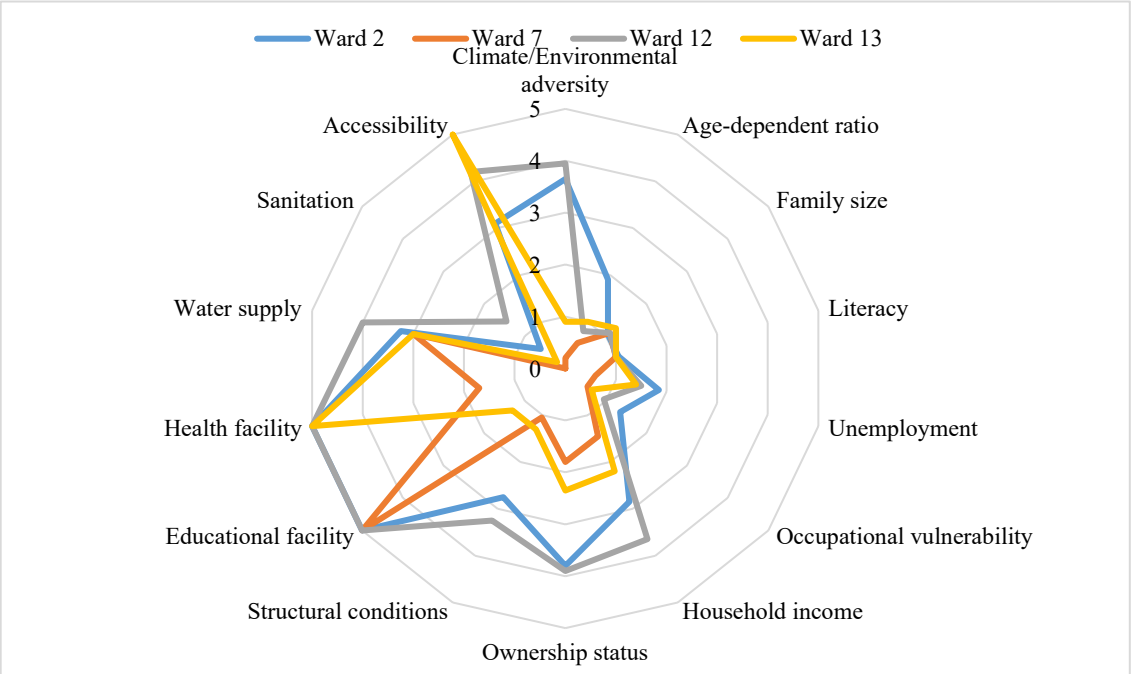

Figure 7. Macro-level Vulnerability Index: Comparison.

Ward 7 is situated on the eastern side of the island and hardly faces climatic adversities. The socioeconomic vulnerability is also relatively low as the ward is decently connected with tourism and allied commercial activities flourishing. Compared to its western counterpart, the ward has motorable roads and an uninterrupted water supply.

Ward 12 is the most vulnerable among the surveyed wards. The climatic adversities are harsh here. The climatic vulnerability is exacerbated by socioeconomic vulnerability marked primarily by serious accessibility issues, unavailability of water, and dwellings with extreme structural damage. Most parts of the ward are accessible only via water.

Ward 13 is marked by moderate vulnerability. It is to be noted that the ward rarely faces climatic adversities as the majority population of the ward is settled in elevated terrains. The vulnerability of the ward is predominantly marked by its accessibility issues. Motorable roads connecting to other wards are absent in the ward though limited motor vehicular transport is possible within the ward. The ward is accessible from other wards only via water and two bridges connecting ward 13 to the outside world remain collapsed post-2018 floods.

3.4. Deciphering the linkages between vulnerabilities and displacement

From the ongoing discussions on the results of the survey conducted and the calculated vulnerability index, it can be safely concluded that differing socioeconomic vulnerability results in disproportionate and differing results in different communities. Further, it is also understood that climate adversities exacerbate socioeconomic vulnerabilities. Now the question to be answered is whether such vulnerabilities can lead to displacement and what would be the impact of vulnerabilities on the adaptive

capacity of the affected communities. To this end, a correlation study is preferred.

Correlation Analysis

Correlation study refers to a research design that enquires into the relationship between two or more variables. Consequently, where one variable positively changes with another variable, there exists a positive correlation, marked by a value ranging between 0 and 1. When the change is negative, the correlation is negative and is marked by a value ranging between -1 and 0. A value of 0 means there exists no correlation.

For the study, the Pearson correlation coefficient is employed, which is obtained using the following formula:

$$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}}$$

$$r = correlation\ coefficient$$

$$x = values\ of\ the\ x\ variables\ in\ a\ sample$$

$$\bar{x} = mean\ of\ the\ values\ of\ the\ x\ variable$$

$$y = values\ of\ the\ y\ variables\ in\ a\ sample$$

$$\bar{y} = mean\ of\ the\ values\ of\ the\ y\ variable$$

Data on reported displacements in each ward chosen for the study and the total number of households in each ward was obtained from ward members of wards 2,7 and 13 and the ASHA worker of ward 12. After determining the rate of displacement in each ward, the correlation coefficient of (i) climate vulnerability and rate of displacement (r_1) and (ii) socioeconomic vulnerability and rate of displacement (r_2) was obtained.

The details of the computation are furthered in Table 4.

Table 4. Statistics on displacement from wards studied.

	Climate Vulnerability	**Socioeconomic Vulnerability**	**Total Households**	**Reported Displacement**	**Rate of displacement**
Ward 2	3.65	2.29097	212	81	38.2
Ward 7	0.2	1.1513	226	0	0
Ward 12	3.95	2.46805	257	115	44.74
Ward 13	0.9	1.72291	220	48	21.8

r_1 (climate adversity (x), rate of displacement (y)) = 0.948

r_2 (socioeconomic vulnerability (x), rate of displacement (y)) = 0.998

Thus, as r_1 is a positive integer, it can be concluded that climate adversity and displacement are positively correlated. Similarly, as r_2 is also a positive integer, a positive correlation between socioeconomic vulnerability and displacement can also be inferred.

4. Discussion

The undertaken study on vulnerability index and correlation analysis clarified that both climatic adversities and socioeconomic vulnerabilities can result in displacement and also that regions which are more vulnerable are susceptible to disproportionate results. Comparing wards 2 and 12, both the wards face near to similar climatic challenges; however, ward 12 is more affected as they exhibit higher socioeconomic vulnerability. Hence, *the first prong of the hypothesis is proved.*

Referring to IPCC's definition of vulnerability, it is determined by the ability of a system to cope with the adverse effects of climate change. Where these indicators of vulnerabilities are faring well, as in the case of ward 7, the system might be in a position to tide over the harshness of the hit though losses may accrue. However, where the indicators of vulnerability don't fare well even in the absence of climatic

issues as in the case of wards 2 and 12, when climatic adversities hit, they put an unreasonable burden on the system, thereby exacerbating socioeconomic vulnerabilities. Hence, *the second prong of the hypothesis is also proved*.

While climatic challenges and vulnerabilities may form pathways for displacements, socioeconomic vulnerabilities can also unsettle the trend by acting as a hurdle in relocation prospects. This is also evidenced by the study results. In ward 12, majority of the surveyed population have intended to leave the island and still harbours the thought. However, their vulnerabilities make this harder for them, thereby forcing them to continue to live in the island. This further worsens the situation, particularly when effective interventions are not adopted. Interventions can be in the form of adaptation and mitigation strategies or those interventions aimed at addressing socioeconomic vulnerabilities so that its index can be improved. However, it is to be noted that only when both of these strategies are adopted together that the issue of climate change can be effectively addressed. Such an approach would only align with the human rights framework. While adaptation and mitigation can be used to address the direct effects of climate change, strengthening socioeconomic indicators puts the system in a better position to recoup and withstand the adversities. Socioeconomic indicators correspond to socioeconomic rights, the non-satisfaction of which would allow climate adversities to deteriorate the 'haven't withered away' possibilities of realisation of such rights. Thus, if one is to conclude that bettering the socioeconomic vulnerability indexes can improve the adaptive capacity of the system, then its corollary would be that higher vulnerability lowers resilience and thereby adaptive capacity. Hence, *the third prong of the hypothesis is also proved*. This is depicted in Figure 8:

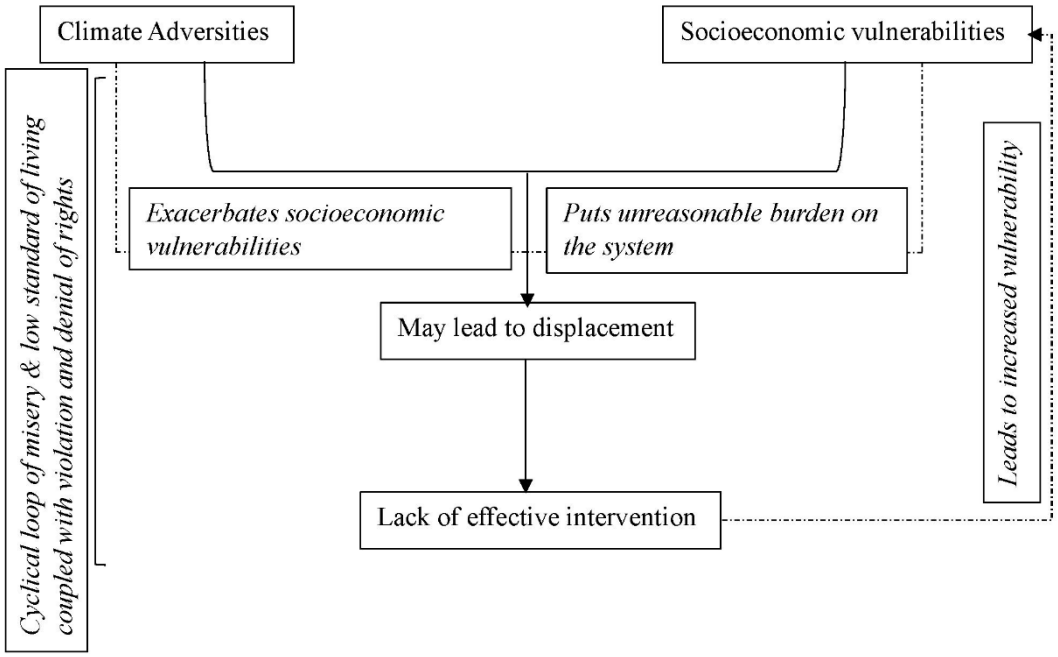

Figure 8. Interrelation between climate adversities, socioeconomic vulnerabilities and displacement.

In summarising, resilience of a system is inversely proportional to vulnerability. i.e., when vulnerability increases, the resilience and adaptive capacity falls. Now, these socioeconomic vulnerabilities can be addressed through appropriate interventions by the governments or other appropriate actors. Ideally, these actors would be striving to achieve an ideal socioeconomic index good enough to withstand climate adversities. This can be expressed as follows:

Let

R = Resilience of the community to climate adversities
V = Socioeconomic vulnerabilities of the community
I = Government interventions (positive interventions reduce vulnerabilities)
V* = Ideal socioeconomic vulnerability level for climate resilience

Now, based on the findings,

Resilience is inversely proportional to vulnerabilities:

$$R \propto \frac{1}{V}$$

$$R = \frac{k}{V} \text{ ..... (1)}$$

Thus, the formula starts with the idea that resilience is inversely proportional to vulnerabilities. To form the equation, a proportionality constant (k) is supplied. This is a factor that scales resilience based on other underlying conditions which are not directly included in the equation, like natural resource availability, community organization, or technological advancement.

Government interventions reduce vulnerabilities:

$$V = f(I)$$

$$V = V_0 e^{-\alpha I} \text{ ..... (2)}$$

Since, government interventions (I) reduce vulnerabilities, we model this reduction using an exponential decay function. A larger I (corresponding to more interventions) lead to a smaller V, thereby improving resilience. Here, V_0 represents the initial socioeconomic vulnerability of the community before any governmental interventions. It acts as the starting point for vulnerability. It reflects the existing socioeconomic conditions (in our case, the vulnerability index calculated using various identified determinants, such as poverty levels, healthcare access, education, economic stability, etc.). Different communities have different baseline vulnerabilities, so V_0 varies from place to place. Here, 'α' represents the effectiveness of intervention. This represents how efficiently government actions reduce socioeconomic vulnerabilities. A higher 'α' means interventions have a greater impact in reducing vulnerabilities, leading to faster improvement in resilience. 'e' corresponds to Euler's number ($e \approx 2.718$), which is a fundamental mathematical constant used in exponential growth and decay functions.

*The government should aim for an ideal vulnerability level V**, i.e., to ensure resilience, the government must implement enough interventions to bring vulnerabilities down to V*:

$$V^* = V_0 e^{-\alpha I_{opt}} \text{ ..... (3)}$$

The government should aim for I_{opt}, which is the amount of intervention needed to bring vulnerabilities down to an ideal level V^*.

Combining equations (1), (2), and (3), we get:

$$R = \frac{k}{V_0 e^{-\alpha I}}$$

i.e.,

$$\boldsymbol{R = \frac{k e^{\alpha I}}{V_0}}$$

The function $e^{\alpha I}$ means that small changes in I lead to exponential changes in resilience, *i.e.*, even small but effective interventions can significantly boost resilience over time. Thus, when no intervention is made ($I = 0$),

$$R = \frac{k e^0}{V_0} = \frac{k}{V_0}$$

i.e., the vulnerability remains at the baseline and there is no improvement in the resilience. However, when intervention increases ($I > 0$), $e^{\alpha I}$ increases, and consequently, R increases exponentially. *This means, small, well-planned interventions can lead to major improvements in resilience*.

Since V_0 is the natural level of vulnerability that the government must work to reduce through effective intervention, a low V_0 means the community starts off with higher resilience. If V_0 is low, the community is already in a relatively good position, so fewer interventions are needed.

Thus, the mathematical relation enables the governments in assessing and analysing the existing position of communities in terms of their vulnerabilities and resilience and can model their intervention plans and policies in an informed directed manner. Thus, the relation plays two roles, *firstly* as a tool to assess the vulnerabilities and resilience of the communities in the pre-interface formulation phase, and *secondly*, as a feedback mechanism evaluating the effectiveness of interventions made in the post-interface formulation phase.

5. Conclusion

The key finding from the research, supported by empirical data is that resilience of a community to climate change adversities are closely linked with the socioeconomic indicators of that community. Even when geographically homogenous communities are subjected to climate change adversities, the impact of such challenges would differ depending on the varying vulnerabilities of the communities marked by varying socioeconomic indicators. Thus, it is to be understood that socioeconomic status of the affected

community and their vulnerability to climate change are inextricably linked. Any isolated interventions directed towards adaptation or mitigation with hardly any regard to improving socioeconomic indexes of the affected community will not be sufficient. The above identified cyclical loop can be interfered with only by improving the resilience of the community, which in turn requires active improvement of socioeconomic prospects of the community.

The whole exercise undertaken in this paper is to demonstrate that consideration of vulnerability factors as determining indicators of probable impact of climate change in formulating legal-policy interfaces (which is essentially a blueprint of the intervention strategies to be adopted or one which would determine the contours of such intervention) can result in such interfaces being more informed and hence exhibiting higher probabilities of effectiveness. The exercise uses scientific tools, techniques, knowledge, and coordinated support of scientific community in formulating a legal solution backing a workable policy. The above-mentioned mathematical relation can show the light towards this path. Thus, the findings of the study can be summarised as thus:

- Climate change and its adversities are to be identified as a human rights concern in any discussions or efforts in legal-policy making as the human rights approach is much wider a framework as opposed to environmental justice or sustainable development.
- In formulating responses, isolated approaches involving legal measures or policy initiatives may not be effective. Rather a combined approach augmenting the best practices in both realms should be the way.
- Impacts of climate change being experienced differently by different communities owing to varying socioeconomic vulnerabilities, vulnerability should be identified as a key determinant in formulations of interfaces. The various prongs of 'vulnerability' can be delineated according to the needs of the specific region under consideration by employing human rights approach. The case study undertaken can be seen as a micromodel for this purpose.
- Creation and adoption of such data driven models will help in understanding the ground realities of the regions under consideration and their peculiar needs, thereby aiding in formulating informed, precise, targeted, and region-specific interventions, rather than umbrella policies.
- Such data driven models incorporating scientific methods and tools are suggested as it would also provide a feedback loop mechanism enabling the policy makers to evaluate the progress of their actions. Mathematical formulae and statistical tools come in handy in realising this potential effectively.

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