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Small Islands, Big Lessons on Living the Climate Crisis: Local Narratives of Risk, Responsibility and Adaptation from Siargao Island, Philippines

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There is **NO** Competing Interest.

The interviews were conducted after a proper contextual introduction to inform participants of the study's purpose, obtain their consent and willingness to participate, and avoid any conflicts of interest or infringement of privacy. The responses to all questions were not mandatory, and respondents were free to respond only when they were comfortable. Respondents were also given the opportunity to ask questions. The survey and research procedures were reviewed and approved by the Institutional Ethics Committee at the Indian Institute of Technology Hyderabad.

Small Islands, Big Lessons on Living the Climate Crisis: Local Narratives of Risk, Responsibility and Adaptation from Siargao Island, Philippines

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Abstract

Small islands face converging risks from sea-level rise, extreme weather and ecosystem degradation, yet the ways local communities understand and govern these risks remain under-documented. Siargao Island in the Philippines is a rapidly developing tourism destination that has recently experienced severe tropical cyclone impacts, flooding and environmental pressures. We analyzed responses from residents and stakeholders to examine how they describe climate-related changes, attribute responsibility and propose responses. Using content analysis, clustering and topic modelling, we identify flooding, heavy rainfall, heat and storms as the most salient impacts, and find that responsibility is attributed primarily to pollution, land-use change and industrial activity, alongside fossil-fuel use. Proposed actions emphasized stricter environmental law enforcement, improved education, better planning and research, and community practices such as waste management and tree planting. These perspectives show that small-island communities possess practical knowledge of climate risks and possible responses, but its rarely translated into climate action.

Small islands occupy a central place in climate change debates because they are highly exposed to sea-level rise, tropical cyclones, coastal flooding and ecosystem degradation, while often having limited resources and governance capacity to respond (Mycoo et al., 2023; Klöck & Fink, 2019; OECD, 2023). Yet vulnerability alone does not explain why some island communities move from describing hazards to demanding institutional change. For many island communities, climate change is experienced as an everyday reality that intersects with tourism growth, urbanization, land-use change and persistent socio-economic inequalities, particularly in small island developing states whose economies depend heavily on vulnerable natural and tourism assets (Pathak et al., 2021; Klöck & Fink, 2019; Tezar & Setiadi, 2024). This makes small islands

not only sites of exposure, but also sites where climate risk, development and governance are negotiated in especially visible ways.

In the Philippines, an archipelagic nation that routinely ranks among the world's most disaster-prone countries, coastal communities are already grappling with the combined impacts of intense rainfall, rising seas and recurrent typhoons (Paz-Alberto et al., 2021; Paz-Alberto et al., 2024; Bündnis & IFHV 2023), 2023). Recent assessments show that sea-level rise in waters around the Philippines has exceeded the global average, amplifying coastal flooding, erosion and saltwater intrusion risks for low-lying communities (Marine Climate Change Impacts Partnership, 2016). Siargao Island, known internationally for surfing and biodiversity, was severely affected by Super Typhoon Rai (Odette) in 2021 and continues to face rapid tourism-led development, waste-management challenges and pressure on mangroves and coastal ecosystems (Cahigas et al., 2023; UN Decade on Ecosystem Restoration, 2022). These overlapping pressures make Siargao a revealing case for studying how frontline publics interpret and govern climate risk under conditions of rapid social and environmental change.

Existing work on climate change awareness and risk perception in Philippine coastal settings documents high levels of concern and recognition of climate-related hazards, but less is known about how people integrate climate change into broader narratives of environmental degradation, development and governance (Alcantara et al., 2023; Paz-Alberto et al., 2021; Paz-Alberto et al., 2024). In particular, the literature has rarely shown how perceptions of impacts, responsibility and adaptation cohere into a single narrative of climate-risk governance. Understanding this linkage matters because responses to climate change are shaped not only by what people fear, but also by whom they hold responsible and what kinds of interventions they consider legitimate and feasible. Yet a key gap remains although small-island communities often possess detailed, place-based knowledge of climate risks, livelihoods and feasible responses, this knowledge is rarely translated into formal adaptation action. As a result, interventions can remain technically sound but socially thin, overlooking the priorities and practical intelligence of the people most exposed to risk.

Here we analyzed open-ended survey responses from Siargao residents and stakeholders to address three questions: how climate-related changes in the local environment are perceived; who or what is seen as responsible for climate change; and what actions are considered necessary to address it. We treat these

questions not as a simple attitude survey but as a window into how frontline communities interpret risk, assign responsibility and imagine workable futures under pressure. In that sense, the paper speaks to climate risk, adaptation and governance at once: it asks what people notice, who they blame and what they believe should change, and it does so in a small-island setting where development, tourism, ecology and disaster risk are tightly intertwined. Together, these questions allow us to identify local climate-risk storylines that can inform adaptation planning and climate governance beyond the island itself.

Results

Perceived climate impacts

Responses describing notable changes in the surrounding environment emphasized hydro-meteorological hazards and thermal stress. Yet the more important story is not simply which hazards were named, but how respondents turned climate change into a lived diagnosis of everyday disruption. People spoke of flooding that now arrives after short bursts of rain, heat that has become oppressive even in the morning, and shorelines that feel less stable than before. Others linked climate to uneven water supply, eroding coasts, losses in fish and coral, and storms that no longer feel exceptional. In this way, climate change appears in the data as a condition of altered rhythm: seasons that no longer behave, coasts that no longer hold still, and weather that is increasingly experienced as a social as well as a physical force.

Flooding, intense rainfall and heat were the most frequently mentioned impacts, followed by typhoons, drought, coastal erosion and sea-level rise (Figure 1). The prominence of these hazards reflects direct experience of extreme weather as well as the lingering effects of recent cyclones and coastal flooding on housing, infrastructure and livelihoods, consistent with studies showing that direct exposure to flood and storm impacts strongly shapes risk perception in Philippine and Indonesian coastal communities (Peñalba et al., 2021; Tezar & Setiadi, 2024). References to erosion, sea-level rise and habitat loss indicate that some respondents also understand climate change through gradual changes to shorelines and ecosystems, echoing recent projections and vulnerability assessments for Philippine coasts and small islands globally (Marine Climate Change Impacts Partnership, 2016; Mycoo et al., 2023).

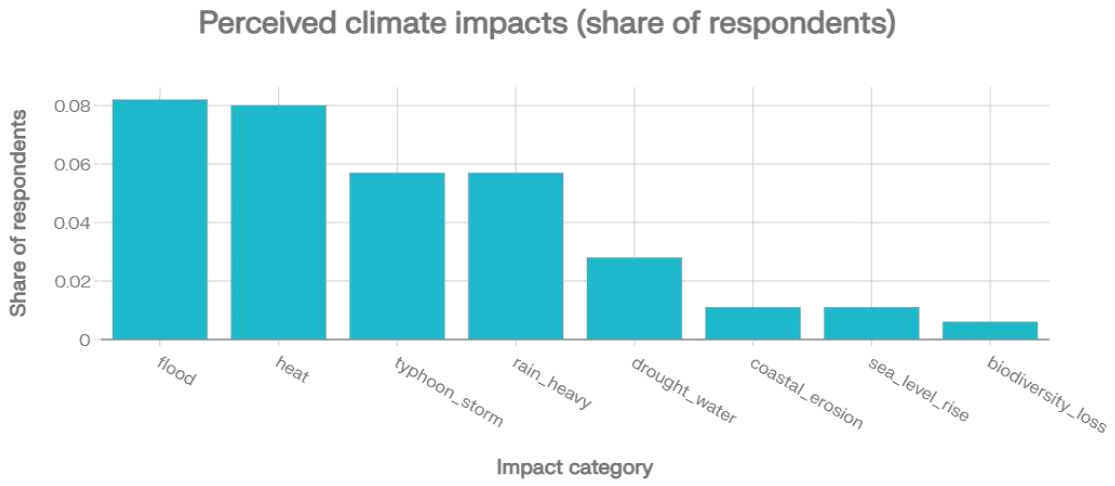


Figure 1. Perceived climate impacts in Siargao. Flooding and heat are the most frequently reported climate impacts, followed by typhoons, heavy rainfall, drought and coastal change.

Perceived drivers of climate change

Answers to the causes question combined global and local drivers. The responses show that respondents do not think about climate change as a single environmental issue, but as a dense knot of pollution, land-use change, industrial growth, consumption and moral failure. In addition to fossil fuels and greenhouse gas emissions, respondents frequently cited waste and pollution, deforestation and land-use change, industrial and corporate activities, population growth and consumption, and tourism-related development as responsible for climate change. This means that Siargao's residents and stakeholders are not only naming emissions, but also diagnosing the island's development path: waste, extractive practices, coastal conversion and the widening footprint of tourism all appear in the same breath as the climate problem.

Waste and pollution, industrial activity and deforestation emerged as the most common drivers in the coded responses, with fossil fuels and energy use also recognised but less frequently invoked (Figure 2). This pattern suggests that respondents experience climate change as closely intertwined with visible environmental degradation and development trajectories on the island, including unmanaged solid waste, land clearing and the expansion of tourism and related infrastructure, a linkage that resonates with work on climate-tourism interactions and environmental pressures in small island destinations (Pathak et al., 2021; Cahigas et al.,

2023). In many narratives, these drivers are discussed together, as respondents move fluidly between blaming distant emitters, criticizing wasteful local practices and questioning how rapid tourism-driven development is managed on the island. This scalar and relational way of assigning responsibility suggests that residents see climate change as produced both by global systems and by decisions taken in their own municipalities and barangays.

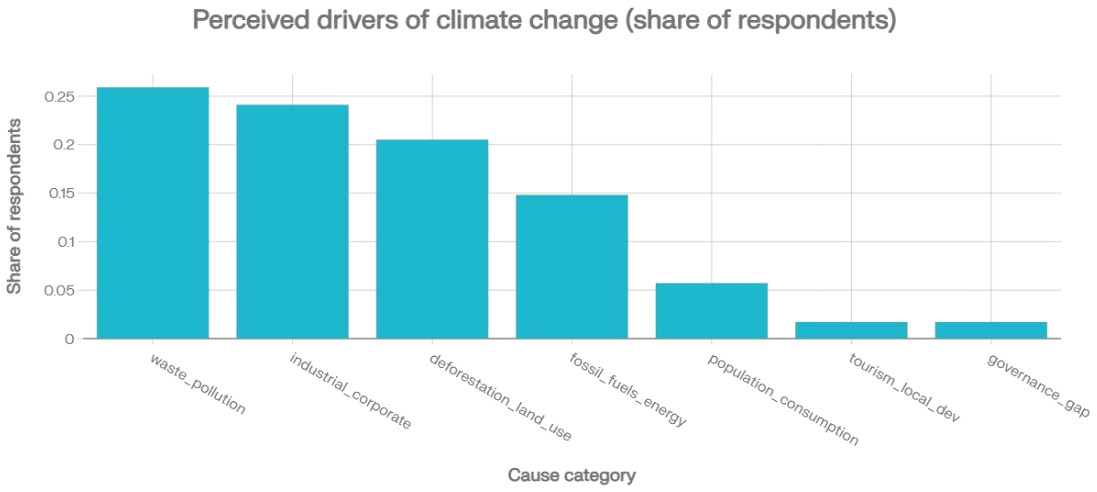


Figure 2. Perceived causes of climate change in Siargao. Respondents mainly link climate change to waste and pollution, industrial and corporate activity, and deforestation, with fossil fuels also prominent.

Proposed adaptation and mitigation actions

In answer to what should be done, respondents articulated a range of actions that emphasized governance, knowledge and practice. These were not isolated suggestions but part of an implied social contract for adaptation: government must enforce rules, schools must teach climate literacy, communities must discipline everyday behaviour, and ecosystems must be protected as infrastructure for survival. The dominant categories were stricter policy and law enforcement related to environmental protection, improved education and awareness, and better planning and research to inform decision-making. Less frequently, but still notably, respondents called for more effective waste management and plastic reduction, tree planting and ecosystem restoration, and stronger community participation in environmental initiatives. Taken together, these responses amount to what we call bottom-up adaptation imaginaries: respondents picture a climate-resilient

Siargao as one where laws are actually enforced, land-use and tourism development follow clear and fair rules, children learn about climate change in school and communities collectively take responsibility for waste and trees. These responses show that Siargao residents are not simply expressing concern; they are generating a detailed body of practical climate knowledge that already points toward viable interventions. The challenge is that much of this local insight remains outside formal planning and implementation, despite its clear relevance for adaptation.

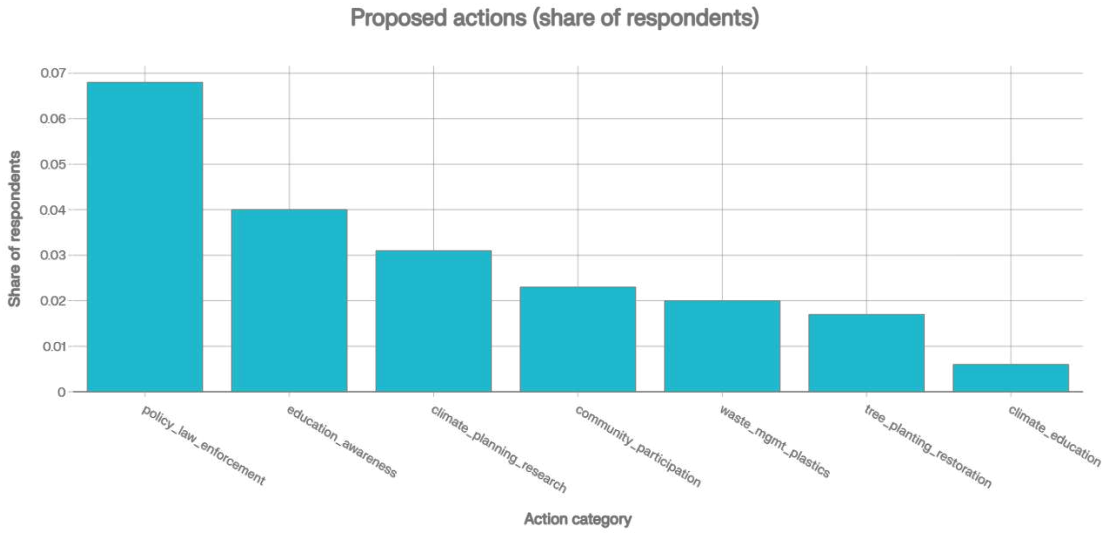


Figure 3. Preferred climate actions in Siargao. The most common responses call for stronger law enforcement, better education and awareness, improved planning and research, and more community participation.

The emphasis on law enforcement and planning reflects expectations that government and institutions should take a leading role in regulating environmental behaviour and integrating climate concerns into land-use and coastal management, consistent with arguments that institutional capacity and policy coherence are central adaptation constraints for small islands (Klöck & Fink, 2019; Mycoo et al., 2023). At the same time, references to education, community engagement and everyday practices such as waste segregation and tree planting highlight the importance of collective learning and social mobilisation, themes also emphasised in recent work on community-based adaptation in the Philippines and other small-island settings (Peñalba et al., 2021; Tezar & Setiadi, 2024).

Linking responsibility and action

To examine how perceived drivers relate to proposed actions, we analysed co-occurrence patterns between cause and action codes and calculated correlations between all impact, cause and action indicators, as shown in Figure 4. The co-occurrence analysis shows that respondents who attribute climate change to waste and pollution tend also to call for stricter enforcement, better education and, to a lesser extent, improved waste management. Those who emphasise deforestation, industrial activities or governance gaps often pair these attributions with demands for stronger regulation, planning and institutional accountability. This matters for policy because it means that people are not simply asking for more action in the abstract; they are mapping specific problems to specific kinds of intervention. The qualitative text makes that mapping explicit: pollution calls forth enforcement, land clearing calls forth regulation and restoration, and governance failure calls forth institutional repair.

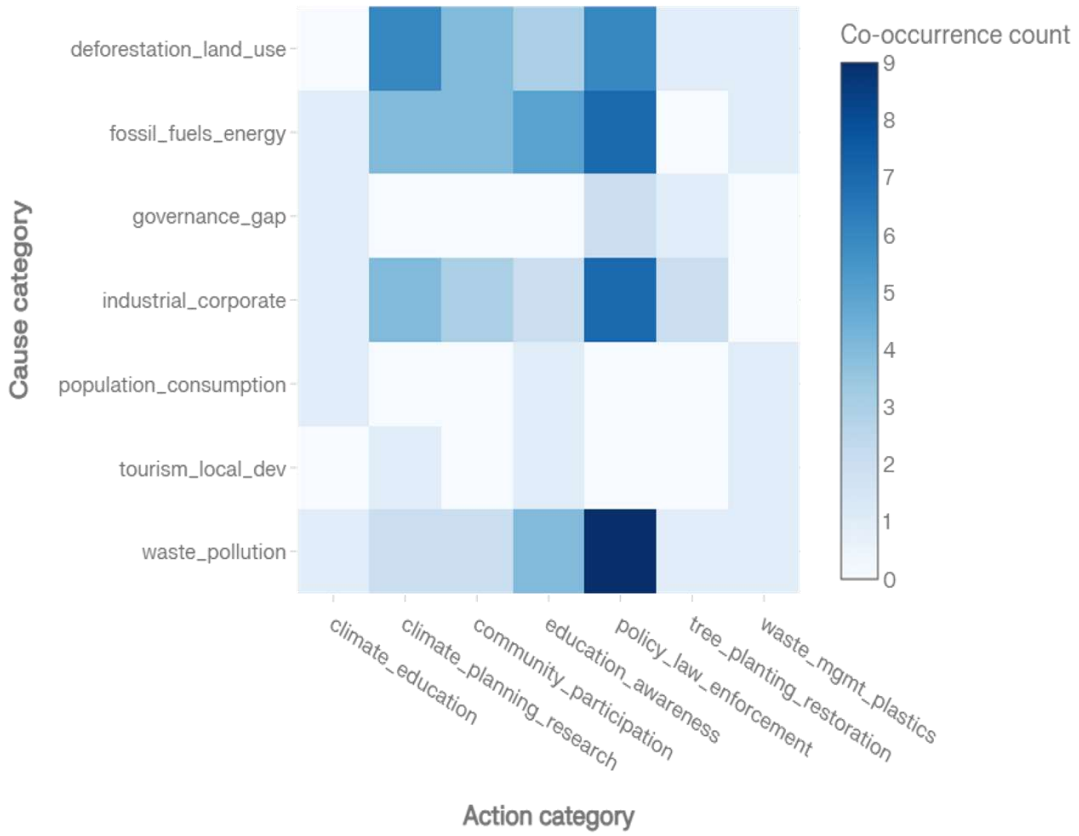


Figure 4. Co-occurrence of causes and actions. The matrix shows which perceived causes are most often mentioned together with specific actions, highlighting links between diagnosis and response.

The correlation heatmap in Figure 5 of key codes indicates that deforestation and industrial responsibility cluster together with waste and pollution, while governance-related action codes are positively associated with ecosystem restoration and education. These patterns suggest that, in local narratives, climate change is deeply entangled with broader social-ecological and governance problems, and that people who see structural drivers at work are more likely to support systemic policy responses rather than only individual behavior change, a linkage also observed in comparative studies of responsibility and adaptation preferences in coastal and island settings (Persson et al., 2021; Tezar & Setiadi, 2024).

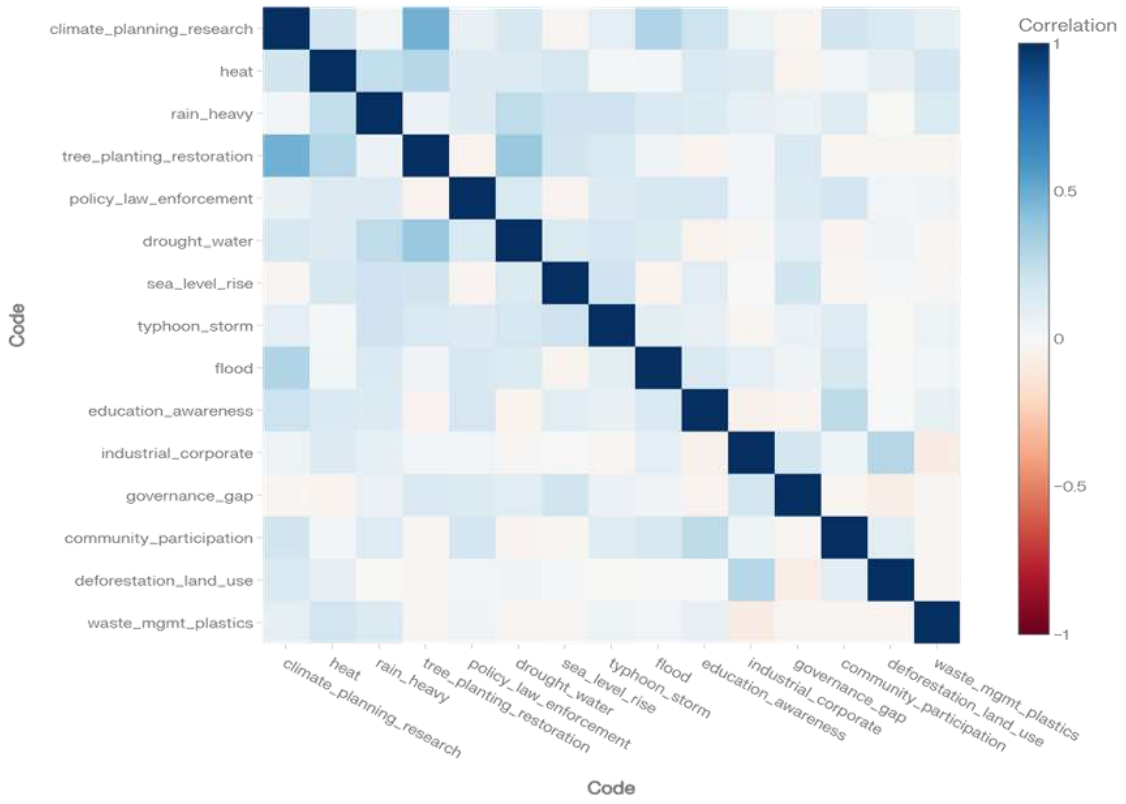


Figure 5. Correlation among key climate codes. This heatmap shows how impact, cause and action codes cluster together across responses, revealing broader perception patterns.

Perception–action profiles

To identify broader profiles of how impacts, responsibility and action are linked, we clustered respondents based on their combined code indicators. The four-cluster solution reveals distinct groups that can be interpreted as climate-risk and governance-oriented, pollution-focused, structural drivers and planning-

oriented, and corporate accountability-oriented. These are not just statistical types; they are narrative positions that reflect different ways of seeing the island's crisis and different ideas about where change should begin. Some respondents imagine adaptation through stricter rules and better information, others through cleaning up pollution and waste, and others through confronting the deeper political economy of land conversion, industrial activity and corporate power. Reading the clusters this way turns them into policy-relevant storylines rather than merely mathematical groupings.

The climate risk and governance cluster centers on flooding and storms combined with fossil-fuel attributions and support for law enforcement and education, while the pollution-focused cluster is dominated by waste and deforestation with fewer explicit action codes (Figure 6). The structural drivers and planning cluster combines deforestation, industrial responsibility and fossil-fuel narratives with strong support for planning, enforcement and community participation, and the corporate accountability cluster foregrounds industrial and corporate responsibility alongside governance gaps, signalling concern about how development and investment decisions affect local climate risks. Together, these profiles mirror recent evidence that publics in small-island states both recognise anthropogenic climate change and favour 'all-hands-on-deck' responses involving local governments, major emitters and other actors (Mildenberger et al., 2025; Mycoo et al., 2023). Reading these clusters as distinct climate-risk storylines rather than purely statistical groupings helps clarify the kinds of futures people imagine. For example, the climate risk and governance storyline expresses confidence that stronger rules and information can manage climate risks, whereas the corporate accountability storyline reflects frustration with perceived regulatory capture and unequal benefits from tourism. Such storylines can inform how adaptation interventions are framed and communicated to resonate with different segments of the island population.

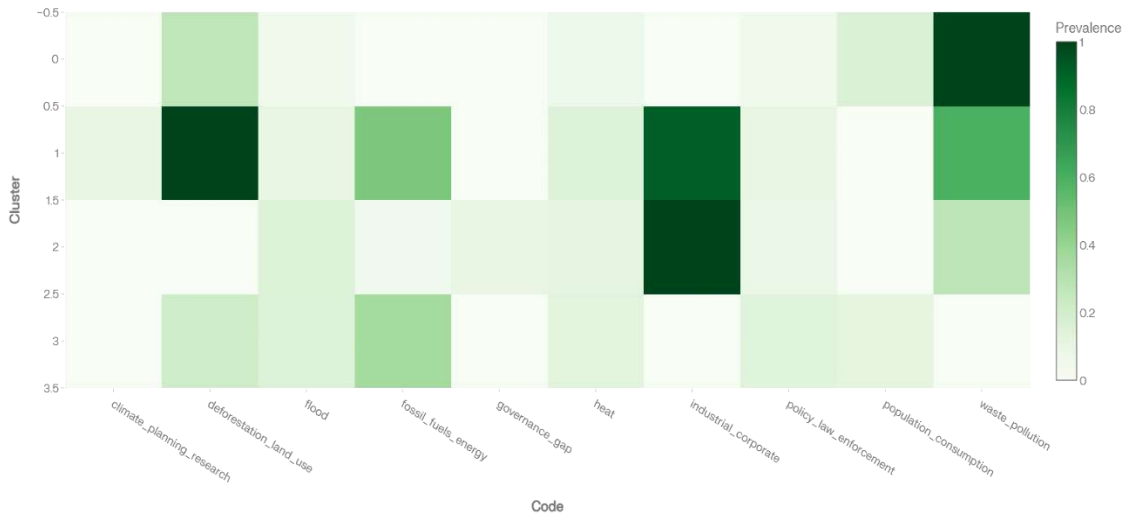


Figure 6. Cluster profiles of climate perceptions. This heatmap shows four distinct respondent profiles, each combining different emphases on impacts, causes and adaptation actions.

Discussion

This study shows that climate change in Siargao Island is perceived through a lens that combines direct experience of extreme weather and environmental degradation with critical reflections on development and governance. Flooding, storms, heavy rainfall and heat dominate respondents' descriptions of climate-related change, but the significance of those words lies in what they reveal about daily life: disrupted mobility, damaged homes, uncertain livelihoods, stressed water systems and uneasy relationships with the coast. In other words, climate risk is not experienced as an abstract future possibility; it is already embedded in routine decisions about work, travel, fishing, farming and safety. This makes Siargao a compelling case of how small-island communities translate global climate change into local social reality.

Attributions of responsibility reveal a complex interplay between global and local drivers. While fossil fuels and greenhouse gas emissions are recognized, respondents give equal or greater weight to pollution, land-use change, industrial activity and tourism-related development. That shift in emphasis is important because it shows that climate blame is not simply externalized to distant emitters; instead, people are locating risk in the island's own development trajectory. The data therefore challenges a narrow emission-only framing and points to a wider governance agenda in which waste, land conversion, enforcement failures and tourism

pressure are treated as part of the climate problem itself. Respondents hold themselves and their neighbors accountable for waste and land-use practices, yet also insist that large emitters, corporations and national governments bear a heightened duty to act, reflecting multi-scalar notions of climate justice.

The actions proposed by respondents' center on governance and institutional reform, including stricter enforcement of environmental laws, improved planning and research, and investment in education and awareness. These are powerful because they show that people are not waiting passively for outside rescue; they are already specifying what credible adaptation should look like. For policymakers, the message is clear that adaptation on Siargao should be built around enforceable rules, better coordination across agencies, meaningful education, stronger local planning and concrete support for waste management, ecosystem restoration and resilient land use. The frequent pairing of structural attributions with demands for enforcement and planning indicates that many respondents view climate change as a governance problem as much as an environmental or climatic one. The findings suggest a persistent translation gap between local climate knowledge and formal climate action. Residents already articulate concrete, context-sensitive responses, but these ideas are not yet consistently reflected in institutional adaptation planning. A more bottom-up approach would therefore be more likely to produce interventions that are both legitimate and efficient.

The perception-action clusters further highlight that there is no single way in which climate change is understood on the island. Some groups emphasize global emissions and climate risk while others focus more on local pollution or corporate responsibility, and they differ in the relative prominence of enforcement, planning and community-level action in their preferred response mixes. For policymakers and practitioners, this suggests the need for differentiated engagement and communication strategies that speak to these different narratives and build coalitions around shared priorities, such as improving waste management, protecting ecosystems and enforcing land-use regulations. In a highly social island setting, adaptation will succeed not only when it is technically sound, but when it resonates with the stories people already talk about fairness, responsibility and the future.

Methodologically, the study demonstrates the value of combining directed content analysis with clustering and topic modelling to extract multi-dimensional patterns from open-ended survey data. The approach allows

us to move beyond headline frequencies to examine how impacts, drivers and actions cohere into broader worldviews and to identify potential anchors for locally grounded adaptation pathways. At the same time, the study's real contribution lies in showing that a relatively simple open-ended survey can capture rich public reasoning about climate risk, governance and justice when the text is read carefully and narrated well. That makes the method accessible for policymakers and community researchers while remaining rigorous enough for scholarly publication.

The findings underscore that locally led adaptation on small islands must be anchored in residents' lived experiences of climate and environmental change and their expectations of governance. On Siargao, these experiences and expectations point towards a climate adaptation agenda that links waste management, ecosystem restoration, tourism governance and institutional strengthening, rather than treating climate change as a purely technical or external problem. The broader lesson for global climate knowledge is that small islands are not just sites of vulnerability; they are sites where people are already producing sophisticated theories of risk, responsibility and repair. Recognizing that fact is essential if climate policy is to be both effective and just.

Online Methods

Study area and context

Siargao Island is located in the province of Surigao del Norte in the southern Philippines and is recognized for its surf breaks, beaches and mangrove ecosystems, which have become central to its rapidly expanding tourism sector. The island lies in a region highly exposed to tropical cyclones, storm surges and coastal flooding, consistent with broader assessments of the Philippines and other small islands as climate "hotspots" facing elevated risks from sea-level rise and extreme events (Marine Climate Change Impacts Partnership, 2016; Mycoo et al., 2023). This exposure was exemplified by the extensive damage caused by Super Typhoon Rai (Odette), a Category 5 landfalling cyclone in December 2021, which severely affected tourism facilities, coastal settlements and mangrove areas on Siargao (UN Decade on Ecosystem Restoration, 2022; Cahigas et al., 2023).

Data collection

The data analyzed here come from a structured survey of residents, tourists and stakeholders on Siargao Island, designed to capture local perceptions of climate impacts, responsibility and adaptation options in line with recent work on climate change awareness and adaptation in Philippine and other small-island coastal communities (Alcantara et al., 2023; Peñalba et al., 2021; Tezar & Setiadi, 2024). The instrument included three open-ended questions asking respondents to describe notable changes in their surroundings that they associate with climate change, to identify who or what they think causes climate change and to suggest what else needs to be done, a format similar to other perception studies that combine structured items with open narratives to elicit richer, bottom-up framings (Peñalba et al., 2021; Tezar & Setiadi, 2024). Interviews were conducted last January 8-12, 2024. Responses were recorded in local languages (Bisaya and Surigaonon), translated to English, and compiled into a spreadsheet with 760 rows and three text columns; rows with no information in any of the three questions were excluded, leaving 352 responses for analysis.

Content analysis and codebook

We used a directed content-analysis approach to develop a codebook for impacts, drivers and actions, informed by climate risk and environmental governance literature on small islands and coastal communities and by established principles of qualitative content analysis (Krippendorff, 2019; Neuendorf, 2017; Klöck & Fink, 2019). Code development followed an iterative process in which initial deductive categories derived from the literature (e.g. flooding, sea-level rise, governance gaps, ecosystem-based adaptation) were refined through close reading of responses and explicit codebook construction, consistent with best practice for team-based qualitative analysis and codebook development (MacQueen et al., 1998; Krippendorff, 2019). For each domain, we defined codes with clear labels, descriptions and inclusion criteria: impact codes covered flooding, typhoons and storms, heat and heatwaves, heavy rainfall, drought and water shortages, coastal erosion, sea-level rise and biodiversity or resource degradation; driver codes captured fossil fuels and energy, deforestation and land-use change, waste and pollution, industrial and corporate activities, population and consumption, tourism and local development, and governance gaps; action codes encompassed waste management and plastics reduction, tree planting and ecosystem restoration, policy and law enforcement, education and awareness, community participation and multi-sector collaboration, climate education in

formal curricula and climate planning and research, aligning with categories used in recent adaptation studies in Philippine and Indonesian coastal communities (Peñalba et al., 2021; Tezar & Setiadi, 2024).

Operationalization and quantitative content analysis

To operationalize the codebook, we constructed keyword dictionaries for each code, including English and commonly used local terms, and implemented these as automated searches in the text, following standard procedures for computer-assisted content analysis and dictionary-based coding (Neuendorf, 2017; Krippendorff, 2019). For each response and code, a binary indicator denoted whether any associated keywords were present; we then computed frequencies and proportions for each code in each domain and calculated descriptive statistics for the number of codes triggered per response, as in recent quantitative analyses of climate-related narratives and adaptation strategies (Peñalba et al., 2021; Paz-Alberto et al., 2021). While this study relies on automated coding to enable a first quantitative exploration, full implementation in future work should include manual coding by multiple coders and estimation of intercoder reliability indices such as Krippendorff's alpha, in line with recommendations for rigorous content analysis (MacQueen et al., 1998; Krippendorff, 2019).

Co-occurrence and correlation analysis

To examine how perceived drivers and proposed actions are linked, we computed cause–action co-occurrence counts capturing the number of responses in which each pair of cause and action codes appears together, a common strategy in quantitative content analysis and network-style analyses of policy and perception data (Neuendorf, 2017; Persson et al., 2021). We also calculated a Pearson correlation matrix across all impact, driver and action indicators to identify patterns of co-occurrence and opposition among codes, an approach similar to recent studies that use correlation structures to reveal clusters of perceptions and adaptation preferences in small-island and coastal contexts (Peñalba et al., 2021; Tezar & Setiadi, 2024). These analyses provided insight into how structural attributions, governance concerns and specific adaptation measures are associated in respondents' narratives.

Cluster analysis

K-means clustering was used to identify groups of respondents with similar patterns of impact, driver and action codes, treating the binary indicators as coordinates in a multidimensional feature space, consistent with the widespread use of K-means and related partitioning algorithms in social and environmental research to derive typologies of perceptions and behaviors (Lehmann et al., 2021; Tezar & Setiadi, 2024). Clustering was restricted to respondents with at least one non-zero code and was performed for four and five clusters, each with two different random seeds and multiple initializations, to assess robustness, echoing best practice in exploratory clustering and the use of multiple k values to test the stability of perception profiles (Lehmann et al., 2021). Cluster profiles were expressed as the mean value of each code within each cluster and interpreted substantively to derive labels that capture their dominant narratives, similar to profile-based interpretations used in recent climate adaptation and risk-perception studies (Peñalba et al., 2021; Mildenberger et al., 2025).

Topic modelling

To complement the codebook-based analysis, we applied non-negative matrix factorization (NMF) topic models separately to responses for each question, an approach widely used to uncover latent themes in short text corpora such as survey responses (Lee & Seung, 1999). Text was pre-processed by lowercasing, removal of common stop words in English and local languages and transformation into term–document matrices with term frequency–inverse document frequency (TF–IDF) weighting, following standard text-mining practice. Models with four and five topics were fitted for each question, and the top terms for each topic were inspected to identify stable themes across different topic-number specifications, providing a robustness check like that employed in recent applications of topic modelling to environmental communication and climate-perception research (Klöck & Fink, 2019).

Use of computational tools

All coding, quantitative analysis and figure generation were implemented in Python using standard scientific and text-processing libraries, in line with emerging norms for reproducible, script-based analysis in climate

and environmental social-science research. A large language model assistant was used to support editing and structuring of the manuscript text; all data analysis and interpretation decisions were made by the author.

Ethics Declaration

Due to the sensitivity of the issues discussed, responses to all questions were not made mandatory, and respondents were given the freedom to respond only when they were comfortable. Respondents were also given the opportunity to ask questions. The survey and research procedures were reviewed and approved by the Institutional Ethics Committee at the Indian Institute of Technology Hyderabad.

Data availability

The anonymised survey responses and analysis outputs that support the findings of this study are available from the corresponding author on reasonable request, subject to ethical and data-protection considerations.

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Competing interests

The author declares no competing interests.

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